# Eco-friendly Delivery Courier Services for Sustainable Transportation

Miodrag Jovanovic[1], Milana Duric[1], Branko Jotanovic[1], Gojko Sindrak[1], Gordana Jotanovic[2], Goran Jausevac[2], Dragana Sarac[3], Estera Rakic[4]

[1]*X Express, Courier Service, Branka Perduva 10A, 78000 Banja Luka, Bosnia and Herzegovina*

[2]*University of East Sarajevo, Faculty of Transport and Traffic Engineering, Vojvode Misica 52, 74000 Doboj, Bosnia and Herzegovina*

[3]*University of Novi Sad, Faculty of Technical Sciences, Trg Dositeja Obradovica 6, 21000 Novi Sad, Serbia*

[4]*X University of Mostar, Faculty of Natural Sciences, Mathematics and Educational Sciences, Trg hrvatskih velikana 1, 88000 Mostar, Bosnia and Herzegovina*

## Abstract

The case study presented in the paper aims at a long-term reduction in the price of vehicle fleet maintenance and fuel costs for the XExpress Company, which can bring financial benefits. Analysis and optimization of transportation by fuel type can lead to better route planning, reduced delivery times and increased overall efficiency of operations. The goal of the research is to focus on reducing fuel costs, as well as promoting environmentally friendly fuels in the delivery service sector, in order to reduce greenhouse gas emissions, improve air quality, reduce the environmental footprint of delivery vehicles and encourage sustainable behavior in traffic using electric vehicles. In this paper, we explore the benefits of environmentally friendly delivery services from courier companies, highlighting the key initiatives, technologies and trends that are shaping this field. Also, the aim of the case study is to highlight the importance of environmental awareness in delivery and the potential benefits arising from the implementation of sustainable approaches in courier services. The results of the case study showed that the costs per 100 km for electric vehicles are 5,03 BAM, and for vehicles with internal combustion 30,07 BAM, the savings for the company XExpress is not negligible and amounts to 83,27%.

***Keywords****: Delivery services, sustainable transport, eco-delivery, Distribution Center (DC).*

## 1 Introduction

In the modern world, where there is an increasing shift towards sustainable practices, delivery is no exception. As technological advancements and the growing demand for delivery increase the number of vehicles on the roads, so does the awareness of the need to reduce the ecological footprint. For this reason, an increasing number of companies are dedicating themselves to the development of environmentally conscious delivery services to provide an alternative to traditional delivery methods. These "green" delivery approaches, utilizing sustainable technologies and strategies, represent a crucial step towards creating more sustainable cities and planetary ecosystems.

One of the primary initiatives in this direction is the development of electric vehicles for delivery. Instead of using vehicles that rely on fossil fuels, more and more delivery companies are transitioning to electric vehicles or vehicles that utilize alternatives such as hydrogen [1-2]. These vehicles reduce CO2 emissions and other pollutants, thereby contributing to cleaner air and less impact on climate change [3].

Furthermore, companies are increasingly using technology to optimize delivery routes, reduce time losses, and minimize mileage. Smart delivery management systems utilize data on traffic, weather conditions, and other factors to provide the most efficient delivery routes. This reduces fuel consumption and emissions of harmful gases, thus enhancing the sustainability of the entire delivery process.

Recycling and the use of biodegradable materials also play a crucial role in the

Corresponding author: *Gordana Jotanovic(gordana.jotanovic@sf.ues.rs.ba)*

sustainability of delivery. Instead of single-use plastic packaging, companies are increasingly using recycled or biodegradable materials for packaging and wrapping. This reduces waste and negative environmental impacts.

Additionally, promoting sustainable delivery options among consumers plays an important role in creating a more sustainable delivery system. Educating consumers about the importance of environmentally conscious delivery options encourages them to choose companies that advocate for sustainability. This creates demand that further drives the development of environmentally friendly delivery services.

The key barrier to the expansion of environmentally conscious delivery services is cost. Electric vehicles and other sustainable technologies often require higher initial investments, which can be challenging for smaller companies. However, government support and subsidies for sustainable practices can facilitate the transition to more environmentally friendly business models. Ultimately, environmentally conscious approaches to delivery are a key component of transitioning to a more sustainable way of life. The combination of technological innovations, optimization strategies, and environmental awareness enables the creation of delivery services that are both economically viable and environmentally friendly. Through these efforts, we can work together to build a better future for our cities and planet.

The paper is structured as follows: The first chapter contains an introduction to the issue. The second part deals with thematic considerations on sustainable practices in eco-courier services. The third chapter deals with eco-friendly delivery courier services. The fourth chapter describes the eco-delivery case study. The fifth chapter deals with the results and discussion of the presented results. Concluding remarks and future research developments are presented in the sixth chapter.

## 2 Related work

Research in the field of eco-friendly delivery courier services for sustainable transportation can be developed in the directions of sustainable practices in courier services, case studies of eco-friendly courier services, environmental performance evaluation of courier services, and economic viability of eco-friendly courier services.

In paper [4], a new initiative to reduce the environmental impact of home delivery of food is proposed. Vehicle routing problem with time window (VRPTW) and heterogeneous vehicle fleet are developed to reduce CO2 emission and transportation cost.

Study [5] aimed to provide an optimized route plan to reduce transportation costs and lead to reduce cost factor of parcel delivery.

The results of the study in [6] found that the negative impact of conventional transport led to significant changes in transport management. Using modern technologies, smart route management and the use of environmentally friendly vehicles, the company will be able to reduce operating costs, increase efficiency and significantly reduce the negative impact it has on the environment.

The study in paper [7] concluded that the dominance of the service sector will increase in the information age of the twenty-first century. If environmental consequences and methods are not taken into account solving environmental challenges in that sector, the new era will be tainted by the poor quality of our basic commodities – clean air, clean water, and soil.

According to the study [8], an in-depth investigation of the electrification strategies of transport companies in Curitiba was carried out. The study provides insight into the complex interactions of costs, benefits and environmental impacts in different scenarios. The results of the study can serve as a valuable resource for both freight companies and policy makers, equip them with the knowledge needed to make informed decisions to build a sustainable and carbon-neutral future for city freight fleets in urban centers around the world.

In papers [9-11], the factors that should be taken into account when implementing green transport for global sustainability are critically discussed. A three-step strategy (ASI strategy, i.e. the strategy of avoidance, change and improvement) was explored, which was proposed to overcome challenges and barriers. Also, some ASI strategies are presented, in which Avoid can reduce 146–312 kgCO2/year, Shift can reduce 0.27 kgCO2/cycle of vehicle use and Improve can reduce CO2 emissions by 12.4%.

Based on a case study of transit operations in Atlanta, Georgia, United States of America, green driving was applied to two very different types of

services – local city services and express services [12]. Fuel consumption and fuel cycle emissions were compared in monitored driving cycles and their modified eco-driving cycles. Eco-driving savings are also compared to fuel and emissions reductions expected through the conversion of the transit fleet to Compressed Natural Gas (CNG) [13]. The results showed that green driving would be a potentially very cost-effective strategy for local and express bus transit operations.

Research [14-15] aims to analyze the effects that eco-driving has on fuel consumption and GHG emissions on courier deliveries in small cities such as Caceres (Spain). For this purpose, a real-life experiment was carried out with professional van drivers of the Spanish post office from the public sector Correos. The results of the research showed that eco-driving training is not correlated with more sustainable driving for professional drivers under the pressure of the need to deliver packages on time, but there is a trend of fuel savings when using higher capacity routes.

Several studies highlight initiatives to mitigate the environmental impact of delivery services through optimized vehicle routing and the use of heterogeneous fleets. The implementation of modern technologies and smart route management significantly reduces operating costs and environmental impacts. Sustainable transportation practices not only have environmental benefits, but also provide long-term economic benefits, such as reduced fuel and maintenance costs. A cost-effectiveness analysis of electrification strategies offers insight into the financial and environmental trade-offs of adopting environmentally friendly vehicles.

Strategies such as the Avoid-Shift-Improve (ASI) approach can effectively overcome barriers to green transport and provide significant CO2 reduction benefits. The increasing dominance of the service sector requires a focus on integrating environmental issues into transport management to ensure sustainability. Case studies, such as those conducted in urban centers such as Curitiba and Atlanta, provide valuable lessons on implementing sustainable practices in a variety of service settings.

Although the short-term benefits are obvious, further research is needed to understand the long-term economic impacts of environmentally friendly courier services, especially in different market conditions and regulatory environments. Studies often focus on specific cities or regions. There is a need for broader, comparative research that examines the scalability and adaptability of sustainable practices in different geographic and economic contexts.

Research such as the one conducted in Caceres, Spain shows that eco-driving training alone cannot lead to sustainable driving behavior under delivery pressure.

In summary, while the case study "Green Courier Delivery Services for Sustainable Transport" provides valuable insight into the benefits and strategies of sustainable transport, it also highlights several areas where further research is needed to fully realize the potential of an environmentally friendly courier service. Addressing these gaps will be key to advancing the theory and practice of sustainable transportation in the courier industry.

## 3 Eco-friendly Delivery Courier Services

In today's world, where there is an increasing emphasis on sustainable practices, delivery becomes a crucial area that requires environmental awareness and innovative approaches. While technological advancements enable greater availability and speed of product delivery, questions arise about their impact on the environment. With the rise in awareness of climate change and the need to reduce the ecological footprint, courier services worldwide are faced with the challenge of finding sustainable solutions that meet the needs of consumers while also protecting the environment. In this context, the concept of "eco delivery" is attracting more attention as an innovative approach that combines the need for fast delivery with responsibility towards the environment. Eco delivery, or environmentally conscious delivery, encompasses a wide range of strategies and technologies used to reduce the negative impacts of delivery on the environment. These approaches include the use of electric vehicles, route optimization to reduce CO2 emissions, recycling and the use of biodegradable materials for packaging, and educating consumers about eco-friendly delivery options.

Eco-delivery for sustainable transportation encompasses a range of activities undertaken by courier services:

- ✓ Analysis of various transportation modes, fuel types, and infrastructure to identify aspects contributing to negative environmental impacts.

- ✓ Research into sustainable transportation methods, focusing on the exploration and promotion of vehicles utilizing renewable energy sources such as electric vehicles, hydrogen vehicles, bicycles, and other sustainable alternatives.
- ✓ Establishment of electric vehicle infrastructure by advocating for the installation of charging stations, promoting the use of renewable energy sources for charging, and facilitating the integration of electric vehicles into transportation systems.
- ✓ Education of drivers about the environmental advantages of sustainable transportation, emphasizing the need to reduce emissions and addressing other issues related to the environmental sustainability of transportation.
- ✓ Implementation of intelligent traffic management systems employing technologies like artificial intelligence to enhance traffic system efficiency, alleviate congestion, and reduce time spent in traffic.
- ✓ Collaboration with vehicle manufacturers, electric vehicle battery producers, energy companies, government agencies, and other stakeholders to collectively develop innovative and sustainable strategies for the seamless advancement of eco-delivery through courier services.

The case study presented in this paper examines various aspects of environmentally friendly courier delivery services, highlighting key initiatives, technologies, and trends shaping this area. Through analyzing best practice examples and researching current trends, the aim is to emphasize the importance of ecological awareness in delivery and the potential benefits arising from the implementation of sustainable approaches in courier services.

## 4 Eco-Delivery Case Study

The eco-delivery case study was done in the company XExpress, which deals with courier activity. The goal of the research is to introduce environmentally friendly vehicles into the fleet and thus ensure the sustainability of transport. Eco-delivery began with the modernization of the fleet of XExspress Company with electric vehicles.

The reasons for conducting the case study are the long-term implication of cost reduction in the XExpress Company and the ecological sustainability of transport through the reduction of negative environmental impact by the introduction of electric vehicles. By introducing electric vehicles into its fleet, XExpress aims to reduce emissions of harmful gases and contribute to global efforts to combat climate change. Further, Regulatory requirements and legislation related to greenhouse gas emissions encourage companies to adapt their operations to environmental standards. XExpress recognizes the need to comply with these regulations in order to avoid potential fines and maintain its reputation. Also, the implementation of ecological solutions can bring a competitive advantage in the market. Companies that invest in sustainable practices can attract environmentally conscious clients and partners.

The case study was carried out for the Distribution Centers (DC), Banja Luka, Sarajevo and Trebinje. The mentioned Distribution Centers were chosen because they have approximately the same geographical distance from each other, and cover the largest delivery area related to the XExpress Company (see Fig. 1).


**Fig. 1.** Geographic display of Distribution Centers [16]

The task of the case study is to analyze transport by fuel type, in order to identify aspects that contribute to negative environmental impacts. The focus of the study is to establish sustainable methods of transportation with vehicles that use renewable energy sources such as electric vehicles. Also, establishing the infrastructure of electric vehicles by advocating for the installation of charging stations, securing spare batteries, and facilitating the integration of electric vehicles into eco-delivery systems. The case study in further stages enables the implementation of eco driving in the courier service in order to achieve ecological sustainability of transport.

## 5 Results and Discussion

The main goal of the research was to perform a comparative analysis of fuel consumption in relation to covered distance [km], for electric vehicles and vehicles with internal combustion for the rolling stock of Company XExpress in certain Distribution Centers (DC). The case study included a total of ten "OPEL" delivery vehicles. Five vehicles are vehicles with an internal combustion engine of the "Opel Movano" type, and five are electric vehicles of the "Opel Vivaro E" type. The research began with the expansion of the XExpress fleet with electric vehicles, and lasted from August 25, 2022 to December 31, 2023. years. Three distribution centers, Banja Luka, Sarajevo and Trebinje, participated in the study. The Banja Luka and Sarajevo distribution centers performed eco-delivery using two "Opel Movano" and two "Opel Vivaro E" vehicles. In the distribution center of Trebinje, eco-delivery was carried out by one "Opel Movano" type vehicle and one "Opel Vivaro E" type vehicle. The data collected in the mentioned DCs were analyzed according to the following attributes: ID of vehicle, Vehicle type, Distribution center, Distance traveled [km] and Fuel consumption [l and KWh] (see Table 1).

**Table 1**. Covered distance by fuel consumption

| ID | Brand of Vehicle | Distribution Center | Covered Distance [km] | Fuel Consumption [ l i KWh ] |
|---|---|---|---|---|
| 7283 | Opel Movano | Banja Luka | 7440,58 | 892,87 |
| 7291 | Opel Movano | Banja Luka | 5418,86 | 650,26 |
| 7574 | Opel Vivaro E | Banja Luka | 3856,10 | 964,03 |
| 7575 | Opel Vivaro E | Banja Luka | 5242 | 1310,50 |
| 7532 | Opel Movano | Sarajevo | 6493,48 | 649,35 |
| 7549 | Opel Movano | Sarajevo | 7011,70 | 841,40 |
| 7576 | Opel Vivaro E | Sarajevo | 3415,86 | 853,97 |
| 7577 | Opel Vivaro E | Sarajevo | 3920,09 | 980,02 |
| 7329 | Opel Movano | Trebinje | 7011,70 | 841,40 |
| 7573 | Opel Vivaro E | Trebinje | 5000,53 | 1250,13 |

In Table 1, electric vehicles are marked in blue, and internal combustion vehicles are marked in brown. Table 1 shows systematized data on covered distance [km] and fuel consumption [l and KWh] for specific vehicles marked with ID. Further analysis determined the average of fuel consumption for electric vehicles and internal combustion vehicles (see Fig. 2).

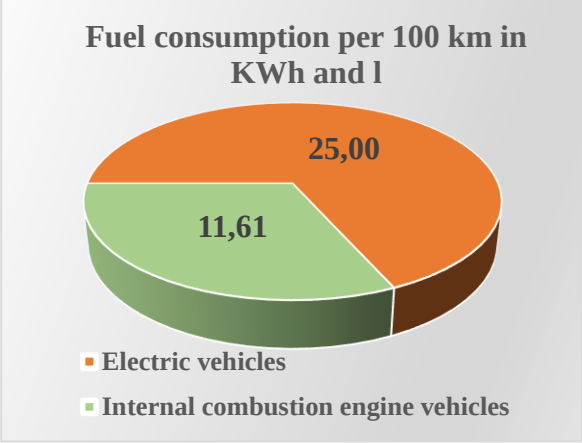


**Fig. 2.** Fuel consumption for electric vehicles and internal combustion vehicles

A comparative analysis determined that the consumption of electricity per 100 km for electric vehicles is 25,00 [KWh], and the fuel consumption per 100 km for internal combustion vehicles is 11,61 [l] liters. A cost-benefit analysis based on the data presented in Fig.2 determined the cost of consumption in BAM per 100 km for electric vehicles and internal combustion vehicles. Costs per 100 km for electric vehicles is 5,03 BAM, and for internal combustion vehicles 30,07 BAM (see Fig 3).

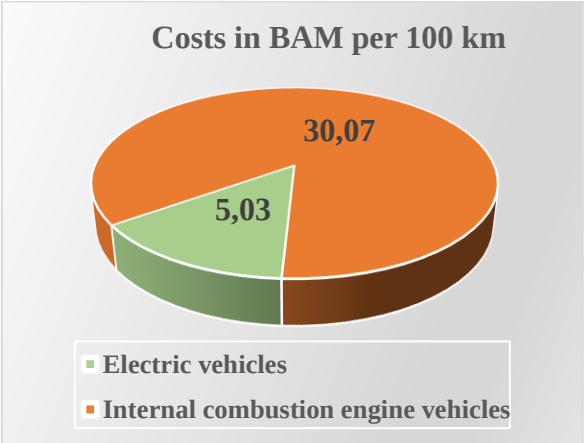


**Fig. 3.** Costs in (BAM) for electric vehicles and internal combustion vehicles

Analysis of the data collected during the research period shows that the cost in BAM for internal combustion vehicles is 83,27% higher than for electric vehicles.

The case study has long-term cost reduction implications. The introduction of electric vehicles and the corresponding infrastructure can be high. However, long-term reductions in maintenance and fuel costs can bring financial benefits to XExpress, see Fig. 3. Analysis and optimization of transportation by fuel type can lead to better route planning, reduced delivery times and increased overall efficiency of operations, see Fig. 2. Engagement in environmental initiatives it can improve brand image, thereby attracting

environmentally conscious customers and improving public relations. Establishing a network of charging stations and providing backup batteries not only facilitates the operation of electric vehicles, but can also stimulate the local economy through new business opportunities.

The case study also has certain limitations in the form of high initial costs, range of electric vehicles, willingness to accept new technologies, etc. Procuring electric vehicles and setting up the necessary infrastructure requires significant initial investment, which can be a challenge for the company. Electric vehicles currently have a limited range compared to conventional fossil fuel vehicles, which can be a problem in areas with poor charging infrastructure. Different Distribution Centers may have different levels of readiness and acceptance of new technology, which may affect the uniformity of eco-delivery implementation. The integration of electric vehicles into existing logistics processes may require significant changes in operational protocols and employee training. Although electric vehicles are more environmentally friendly in operation, the production and disposal of batteries also have an environmental impact that should be taken into account.

## 6 Conclusion

The case study on the introduction of eco-delivery in the Company XExpress represents a significant step towards achieving environmental sustainability in transport. The reasons for conducting the study are multiple, including environmental responsibility, regulatory requirements and market advantages. The implications of this initiative are positive, from long-term financial savings to brand enhancement. However, limitations such as high initial costs, technical limitations and operational challenges need to be carefully considered and addressed.

The case study aimed at comparing fuel consumption between electric vehicles and internal combustion vehicles within Company XExpress's rolling stock at specific Distribution Centers (DCs). Over the period from August 25, 2022, to December 31, 2023, ten "OPEL" delivery vehicles were studied, comprising five "Opel Movano" internal combustion vehicles and five "Opel Vivaro E" electric vehicles. The analysis focused on data such as distance traveled and fuel consumption across three participating DCs: Banja Luka, Sarajevo, and Trebinje. The findings revealed that electric vehicles consumed 25,00 KWh of electricity per 100 km, while internal combustion vehicles consumed 11,61 liters of fuel per 100 km. Based on this, the cost per 100 km for electric vehicles was calculated at 5,03 BAM, significantly lower than the 30,07 BAM cost for internal combustion vehicles. This indicates that internal combustion vehicles incurred a cost 83,27% higher than electric vehicles. Thus, the study underscores the potential economic benefits of transitioning to electric vehicles, as they offer substantial savings in fuel costs over their internal combustion counterparts within the context of Company XExpress's operations.

Future research would include the implementation of intelligent eco-delivery management systems that use technologies such as artificial intelligence to improve the efficiency of eco-delivery, alleviate congestion and reduce time spent in traffic.

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