AI-driven Ecodriving and ETA Solutions for Truck Transport

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1. Introduction

The transport industry is facing challenges due to rising costs, labor shortages, environmental pressure, and increasing customer demands for timely delivery. In response, Inelo Polska Sp. z o.o. has developed an innovative product called Ecodriving and Estimated Time of Arrival (ETA) solutions. The AI-driven system aims to optimize the economy of driving and predict the delivery time to reduce transportation costs, increase delivery efficiency[1, 2], improve workforce quality, and reduce environmental impact. The project aimed to develop AI algorithms that could optimize driving economy and predict delivery time to enable users to make real-time adjustments. The project team integrated Ecodriving and ETA solutions into Inelo's Intelligent Transport Management System (ITMS). The ITMS enables users to manage fleets and transport orders, monitor driver behavior, and track vehicle locations in real-time. The developed AI-driven Ecodriving and ETA solutions help transport companies optimize their operations by reducing fuel consumption, increasing delivery efficiency, and improving driver behavior. The system provides drivers with real-time feedback and recommendations to optimize their driving style, reducing fuel consumption, and CO2 emissions[3]. The AI

algorithms also predict the estimated time of arrival, helping companies manage transport orders, reduce delays, and enhance customer satisfaction.

2. Integration of Multi-Criteria Optimization Algorithms for Ecodriving and ETA

Based on previous research, an effective method for integrating research conducted in earlier stages has been developed. However, the main difficulty is constructing a superior multi-criteria optimization algorithm [4] in the ISZT module, and building a system that allows for the simultaneous optimization of both travel time and cost, which is an extremely complex issue due to the apparent contradiction between these variables. The proposed algorithm allows for the development of a version of the system that integrates previously developed solutions. The system will be installed in selected vehicles of INELO's clients in the future, and dispatchers (logisticians) will have access to the ETA test version. The study will determine whether the parameters obtained under laboratory conditions are achievable in operational conditions, particularly whether the developed models still function with the expected precision (travel time estimation error < 5%, fuel savings> 5%) for many different models and versions of vehicles with varying degrees of use, different drivers, and different dispatchers (logisticians). The research will also encompass ease of use, clarity and accuracy of messages (Eco-driving).

All of these elements will only be possible after designing a theoretical model in laboratory conditions, which will enable integration. The work at this stage leads to the development of intelligent multi-criteria optimization algorithms that consider simultaneous optimization of travel costs through the Eco-driving module and travel time through the ETA system, as well as data provided by users (such as costs and commercial conditions of orders). To better estimate while considering eco-driving, optimization planning and minimizing the total distance traveled by vehicles with driver stops and rest are proposed.

The developed method proposes a multi-objective optimal intelligent planning algorithm. It is essential to introduce the model to solve the path planning problem considering all the factors described in the previous reports. The proposed multi-objective path planning algorithm uses a stochastic algorithm and variable probability individual optimization of local exchange search methods. The tested algorithm's solution and optimal solution deviation are minimal, and its efficiency and effectiveness are better than existing solutions. The significant advantage of the proposed solution is its adaptability and the possibility of further algorithm improvements and applications.

At this stage, we have identified the preliminary concept of the technology (using artificial intelligence algorithms to analyze factors affecting estimated driving time and cost efficiency and transmitting this information in real-time) and its

future applications (calculating work time – ETA – and optimizing travel costs – Eco-driving – and their integration in the ISZT).

This project employs an approach that incorporates multi-criteria optimization algorithms designed for creating AI-powered Ecodriving and ETA (Estimated Time of Arrival) solutions specific to truck transportation. These solutions were integrated into an Intelligent Transport Management System (ITMS)[5], a platform enabling real-time supervision and coordination of aspects like fleet status, transportation orders, driver behavior, and vehicular positioning. The algorithms deployed take into account simultaneous optimization of travel duration and expense via the Ecodriving and ETA systems, alongside the incorporation of user-provided data.

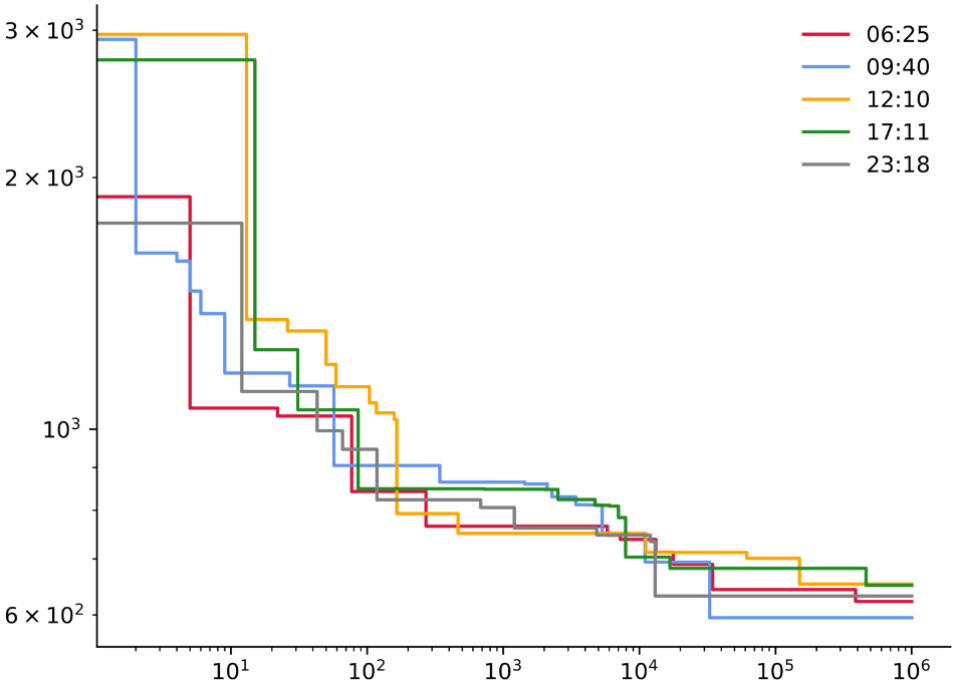

Figure 1. the dependence of the obtained quality index J on the number of iterations (epochs), for different optimisation problems, with differences due to different departure times. Source: own work.

The project team has developed a multi-objective path planning algorithm, utilizing a stochastic algorithm and the individual optimization of local exchange search methodologies with variable probability. The discrepancy between the solution generated by this algorithm and the optimal solution is minimal, demonstrating that its performance and effectiveness surpass those of existing solutions.

The objective function used in this project can be expressed as:

$$\min_x f(x) = \min_x \{c_1(x) + c_2(x)\} \tag{1}$$

where $f(x)$ is the objective function, $c_1(x)$ represents the cost of eco-driving, and $c_2(x)$ represents the estimated time of arrival. The variable x represents the various factors that affect the optimization, such as driver behavior, vehicle performance, and road conditions. The algorithm seeks to minimize $f(x)$, which is the sum of $c_1(x)$ and $c_2(x)$, to simultaneously optimize both travel time and cost. The algorithm seeks to minimize both Cost and Time simultaneously, offering an optimal solution for eco-driving and ETA.

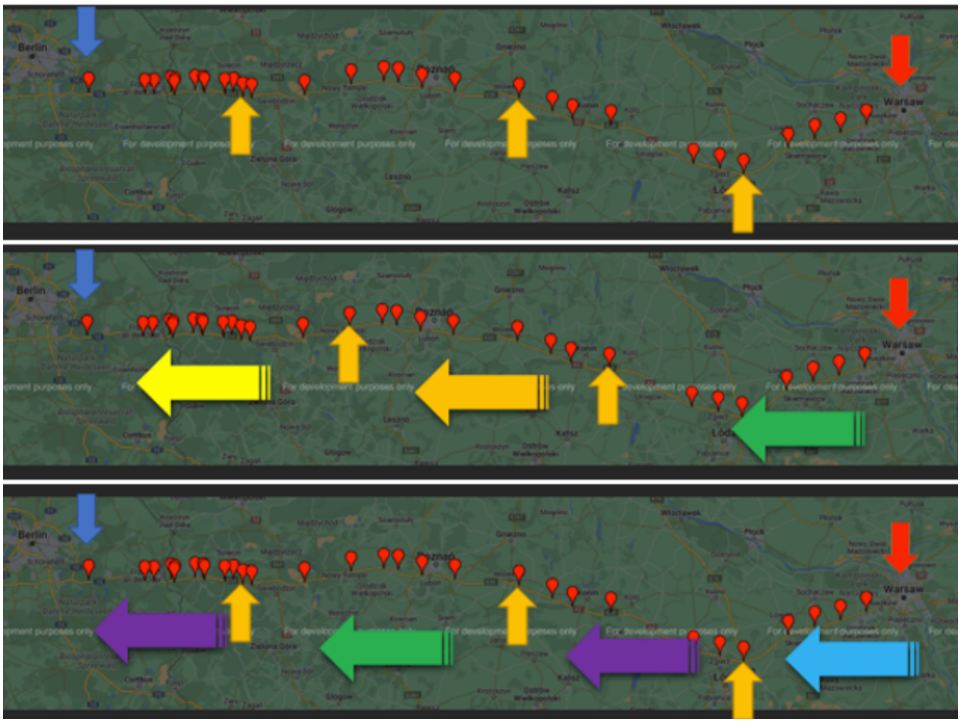

Figure 2. Method of determining stopping places and optimising journeys. Source: own work.

3. Conclusions

In this project, a multi-objective optimization algorithm was developed to address the challenges facing the transport industry. The algorithm was designed to optimize travel time and cost simultaneously by considering factors such as driving

behavior, vehicle efficiency, and delivery requirements. The algorithm was tested in realistic conditions and showed close results to the optimal solution.

Integrating intelligent multi-criteria optimization algorithms for eco-driving and ETA systems is a challenging task, but with a well-designed algorithm and a suitable system, it can be possible to achieve simultaneous optimization of travel time and cost. The proposed solutions have significant potential for application in real-world scenarios, and further research and development are essential to realize the full potential of these solutions. The AI-driven Ecodriving and ETA solutions developed by Inelo Polska Sp. z o.o. offer an innovative and effective solution for the challenges facing the transport industry. The system provides real-time feedback, recommendations, and ETA predictions, enabling users to make real-time adjustments, reduce costs, and enhance environmental performance. The system's benefits extend to transport companies, drivers, and customers, making it an essential tool for the transport industry's future.

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