

Artificial intelligence supported separated waste collection to minimize costs and environmental impact in local communities – a Polish case study

P. Nowakowski¹, M. Wala²

¹Faculty of Transport and Aviation Engineering, Silesian University of Technology, Katowice, ul. Krasińskiego 8, 40-019 Poland

²PST Transgór Rybnik S.A., 44-201, Rybnik, ul. Jankowicka 9, Poland

Keywords: artificial intelligence algorithms, waste collection and transportation, cost minimization, separated waste
Presenting author email: Piotr.Nowakowski@polsl.pl

Waste collection and transportation are two of the most essential components of waste management. From a managerial perspective, waste collection businesses want to reduce expenses and enhance the quantity of waste that they collect from homes. This is particularly crucial when home garbage is segregated into multiple distinct material groups.

We should employ some models that allow for the optimization of household garbage collection and transportation for this aim. The most crucial elements influencing the operational economic efficiency of garbage collection firms should be included in any suggested mathematical model. Waste collection should be optimized, particularly with regard to the collection vehicles, as it entails operational expenses such as gasoline and labor. Shortening the duration of waste collection routes or collection times simultaneously lowers expenses and provides benefits for the environment. From the managerial point of view waste collection companies should minimize costs and improve collected mass of waste from households. It is especially important when the waste stream from households is divided into several separated categories of materials.

For this purpose, we should apply some models enabling optimization of waste collection and transportation from households. A proposed mathematical model should include the most important components having impact on economic efficiency of waste collection companies' operation. Waste collection should be optimized, especially regarding the collection vehicles because it involves operational costs including fuel and human resources.

Reducing the duration of waste collection routes or the amount of time required for collection also lowers expenses and enables the addition of collection stations or households to a schedule.

We employ a mathematical model of waste collecting and transportation in this work, which is characterized by the weight of the collected waste and the economic efficiency index. Two artificial intelligence methods are utilized to optimize waste collection vehicles: ant colony optimization (ACO) and tabu search (TS) to optimize the routes of vehicles employed in collections. Certain emission parameters are also assessed because they are a contributing factor to the detrimental effects of the environment on nearby communities.

The case study and the model's data came from actual collections of waste that had been segregated, including common household categories including plastics, paper, glass, and biodegradable waste. The optimization's parameters take into account waste collections in typical neighborhoods and are based on data from a company that operates in the southern part of Poland. Waste collections in typical communities of the Silesian Voivodeship.

We have assessed the collection's economic criteria and contrasted them with the previously established routing and collection schedules. The weight of the rubbish collected, the collection's economic efficiency, and vehicle emissions could all be assessed thanks to the computations.

Measurable impacts were obtained with the use of artificial intelligence algorithms, specifically TS and ACO. to increase the effectiveness of garbage collection and transportation. Travel time and route length were dramatically shortened for the chosen route, with reductions of up to 21% and 22%, respectively. Waste collection firms can apply the proposed model and calculation approach, as well as the results of this research on enhancing the efficiency of transportation and separated garbage collection from houses.