Summary

The growing costs of extracting natural resources and the negative impact of their acquisition on the natural environment have introduced the model of the circular economy. The main assumptions of this concept assume that the circulation of raw materials takes place in a closed loop. A crucial element of the circular economy is also the issue of transport and waste collection. A review of the world literature was made and national confirms the importance of the issues raised in this dissertation concerning the optimization of transport and waste collection processes. As part of the work, a mathematical model of waste collection and transport was developed, described by the economic efficiency index and mass meters of collected waste and emissions - as factors affecting the natural environment. The work uses artificial intelligence algorithms - taboo search and ant search to optimize the routes of vehicles participating in collections. The case study and data for the model were taken from collections of segregated waste – plastics and large-scale events in urban and rural communes of the Silesian Voivodeship. Eighteen waste collection routes were selected for the study - seven plastic waste collection routes implemented in the area of compact multi-family housing, and eleven large-size waste collection routes implemented in the area of dispersed single-family housing. Economic measures (measure of mass of collected waste, economic efficiency of collection) and measures of environmental impact (NO_x, PM, CO_2 emission factors) were determined.

Selected routes were re-executed based on an optimized route plan determined according to the ant algorithm. Thanks to the use of artificial intelligence algorithms - tabu and ant search, measurable effects of improving the efficiency of transport and waste collection have been achieved. For plastic waste and bulky waste, the travel time and the length of routes were significantly reduced, ranging from 11-21% for the time of the routes and from 21-22% for the length of the routes. As a result of implementing real routes based on optimized plans for the sequence of waste collection points, very similar results were obtained to model-defined route parameters using artificial intelligence algorithms. Results of research to improve the efficiency of transport and waste collection from households, as well as the developed model and calculation method can be used in transport companies.

Elżbieta Gorgoń

15.06.2023