Network Flow Based Model Applied to Sources, Sinks and Optimal Transport of Combustible Waste

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Abstract

Waste management has been an expanding field, which demands continuous enhancement by waste transportation and treatment capacities optimisation. Reuse and recycling is a preferred option as much as it is applicable. A new strategy is proposed and analysed compared to the current state. Presently the waste treatment is a key information for effectivity assessment of a newly designed system. The known parameters are usually: production (sources) and processing (sinks) of given combustible waste in specific territory unit (node) from considered area and transportation between these nodes. For real life data analysis, available information is production and different ways of treatment (according to the waste hierarchy). Transportation between the nodes is not always evident, which can lead to a lack of knowledge of the total cost and expenses for individual producers. To gather information it is necessary to obtain and assess available data. This research presents a tool for pre-processed data where the potential for combustible waste suitable for energy recovery and/or recycling in pre-defined nodes is determined. The tool is based on the reverse logistic problem, which is a specific case of supply chain model. The objective is to optimise the system of network flow of unusable products from the producer to the treatment facility. It describes an approach to determine the flow of the network with the utilisation of uncertainties, arising from incomplete or unknown information. Decision-making is done in relation to transportation distance criterion. This criterion naturally prefers closer treatment facilities instead of more distant. In order to reflect the uncertainty in the decision-making process, a probability function that links preferences for the particular type of waste is implemented. Developed mathematical model gives an estimation of mean value for a decision variable (potential for energy recovery) and also provides additional information about variability for each node. As a result of this analysis,
an assessment creates a distribution function for the amount of waste for specific processing in particular node. The potential for energy recovery depends on the amount of combustible waste, which is currently landfilled and not used for recycling. These data outputs are further used for prognosis and form the necessary foundation for the planning of future treatment facilities. This tool has been tested through a case study involving the particular stream of combustible waste (network with 206 nodes). It has been found that it is suitable for various applications. The results of the optimisation can also provide a guidance for GHG (greenhouse gas) footprint reduction. However, any commodity, which is included in supply chain models can be handled in a similar way. In further research, possible extensions for the presented tool are additional criterions, i.e. more specific transportation cost, waste treatment cost criterion or influence from stakeholders in decision-making.