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Multi-period sustainable and integrated recycling network for municipal solid waste – A case study in Tehran

Ali Mirdar Harijani ^a, Saeed Mansour ^{a*}, Behrooz Karimi ^a, Chi-Guhn Lee ^b

^a Department of Industrial Engineering and Management Systems, Amirkabir University of Technology, Tehran, Iran.

^b Department of Mechanical and Industrial Engineering, University of Toronto, Toronto, Canada

* Corresponding author: Department of Industrial Engineering and Management Systems, Amirkabir University of Technology, Tehran, Iran. Tel.: +98 21 64545362; Fax: +98 21 66954569; E-mail address: s.mansour@aut.ac.ir

Abstract

The sheer amount of Municipal Solid Waste (MSW) produced from residential and commercial activities has posed a big threat to the modern society, especially to large cities by causing environmental issues such as greenhouse gas emission, leakage of leachate and contamination of air, soil and water resources. The urban managers are keen on improving MSW management to mitigate the environmental impacts and to improve the sustainability of their cities. This study proposes a systematic approach to build an integrated recycling and disposal network for MSW by explicitly considering the sustainability with an objective to maximize the total profit with a budget constraint. A multi-period mixed integer linear programming model was proposed to design the network optimally as well as to optimally operate the network. The optimization model involves decisions related to facilities selection, capacity level and location of facilities, allocation of solid waste to facilities, transportation of waste among facilities and distribution of recycled materials. This paper also extended the developed social life cycle assessment methodology to model the social impacts of the network. The model was applied to a real-world case in Tehran, Iran, and could provide the profit of USD 43.49 M over a five-year planning period. In order to show the impacts of sustainability and budget limitations, the model was compared with three models: I) the model without sustainability, II) the model without budget limitations and III) the model without sustainability and budget limitations. The models I and III led to the loss of USD -308.60 and -362.80 M, which are not desirable. This shows the consideration of sustainability will improve the profit in the long term. The model II could provide the profit of USD 99.73 M over a five-year planning period, indicating that limited budget have significant impact on the way the recycling network is operating.

Keywords: Sustainable development; mathematical model; Optimization; Municipal solid waste; recycling network; Social life cycle assessment;

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