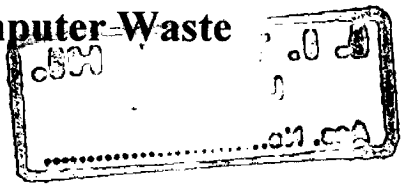
Multi-objective and Multi-time-step Decision Support Model for the Management of Computer Waste



by
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Submitted
In fulfillment of the requirements for the degree of

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To

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Certificate

This is to certify that the thesis entitled "Multi-objective and Multi-time-step Decision Support Model for the Management of Computer Waste", being submitted by Mrs. Poonam Khanijo Ahluwalia, to the Indian Institute of Technology, Delhi, for the award of 'Doctor of Philosophy' in Civil Engineering is a record of the bonafide research work carried out by her under my supervision and guidance. She has fulfilled the requirements for the submission of this thesis, which to the best of my knowledge has reached the requisite standard.

The material contained in the thesis has not been submitted in part or full to any other University or Institute for the award of any degree or diploma.

April, 2007

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Abstract

The accelerating pace of waste generation from used electrical and electronic equipment is of growing global concern. Within this waste stream, computer hardware is quite significant in terms of both volume and risk to the human health and the environment because of the hazardous materials within it. The present study focuses on one of the emerging threats to the environment (especially in India, which is global Information Technology hub) i.e., computer waste. A multi-objective model that can help decision-makers in integrated management of computer waste has been presented. Environmental and economic issues related to computer waste have been addressed in integrated perspective taking into account the reverse flow of waste in terms of reuse and its reappearance in future years. The importance of the societal perception of the risk, environmental and health risks associated with computer waste management activities has been emphasized and a methodology has been presented to address the same. Selection of optimum capacities at the proposed facilities is another major concern for the municipal authorities/ managers. The same has been addressed by proposing suitable logical constraints. A methodology has also been presented to arrive at the "optimum reuse time span" of the waste under the conflicting objectives of minimization of cost, minimization of environmental and socially perceived risk.

The model has been used to evaluate management cost, associated risks and optimum reuse time span of various streams of computer waste and to select optimum capacities at various proposed facilities for different objectives of economy, environmental risk, socially perceived risk and health risk. The optimum reuse time span of a computer desktop was observed to be shorter while minimizing various associated risks than while optimizing cost.

Estimation of the future quantities of the computer waste is a complex issue. Different scenarios of waste generation were predicted for each case study using expert opinion. Issue of has addressed the uncertainty involved in computer waste quantities in a convincing manner using Monte Carlo simulation technique. As the data available is scarce, the data gaps have been abridged in an appropriate manner.

The application of the proposed model has been demonstrated using several example problems, two of which were inspired by Delhi and Chennai, the metro cities of India in terms of network configuration, demonstrating the utility of the model for practical problems. The model results for different scenarios of waste generation were analyzed to understand the trade-offs between cost and various associated risks.

The outcome of the thesis has a potential application in organizing the industrial units involved in handling computer waste. Proposed decision support model can be useful for determining the optimum configuration of waste management facilities as well as optimum reuse span of computer reuse, for urban centers where computer waste related issues are of growing concern.

Key Words: Computer waste; Integrated waste management; Multi-objective optimization; Environmental risk; Health risk; Socially perceived risk; Capacity planning; Monte Carlo simulation.

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