SYSTEMS MODELLING OF WASTE MANAGEMENT IN NATIONAL PLANNING

by

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DEDICATED TO

PARENTS

CERTIFICATE

The thesis entitled "Systems Modelling of Waste Management in National Planning" submitted by Mr.Sushil Kumar Agrawal to the Indian Institute of Technology,Delhi, for the award of the degree of Doctor of Philosophy, is a record of bonafide research work carried out by him. He has worked under my guidance and supervision and has fulfilled the requirements for the submission of this thesis, which has attained the standard required for a Ph.D.degree of this Institute. The results presented in this thesis have not been submitted elsewhere for the award of any degree or diploma.

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ABSTRACT

This thesis aims at developing a methodology for modelling and analysis of Waste Management (WM) aspects in growth oriented national planning in systems' framework. From systems' view point the term waste has been defined as any unnecessary input to, or any undesirable output from the system.

Initially, a general introduction to the problem is given with an overview of systems concepts, systems theories, and macro-economic modelling. A comprehensive review of the literature is reported, and it is attempted to present the growth of the different facets of the subject in chronological order. The details of a national survey on WM covering various sectors of Indian economy are presented. It is observed that the current state of the art is very much disappointing, and there is vast potential for improvement.

A new concept of wastivity has been introduced, which is defined as the ratio of the waste to input. Some wastivity indices are proposed, and an attempt has been made to interlink it with productivity. Wastivity has also been reported as a technological measure. The concept is illustrated for energy sector. Based on wastivity concept a theory of economic growth has been hypothesized. A wastivity-growth (W-G) simulation model has been formulated to develop scenarios of economic growth for different wastivity reduction functions.

An attempt has been made to give a new dimension to the input-output model to incorporate WM aspects in the framework of an I-O-W (input-output-waste) model, which may prove to be a versatile tool for WM policy analysis. The proposed I-O-W model has been generalized for different types of resources, viz., material, energy, manpower, capital and services.

A graph theoretic system model of a multisectoral national economy including WM sectors is developed. The system model of the economy is integrated to a multiobjective Goal programming model to fulfil WM goals in a particular

planning period. The resource and waste flows in the agriculture sector have been modelled in a Branch-Chord (B-C) framework. The flow diagram of a simulation model is developed for optimizing overall system wastivity.

A co-ordinated view of the previously discussed models is presented in the form of a flow chart. Some broad guidelines to national policy on WM have been enumerated, and certain waste monitoring systems are proposed. Implementation strategies with respect to various functional elements and interfaces of WM are highlighted. A stage wise waste reduction procedure is outlined with possible waste reduction measures. The nature of waste collection, recycling and disposal systems is analysed. The role of WM in the context of interfaces, viz., environment control, nature conservation, and unemployment has been examined.

The last section provides a summary of major findings and recommendations, highlighting significant research contributions made by this study, and proposing the possible avenues of future research. It is concluded that there is a limit to economic growth governed by availability of natural resources, and lower the wastivity in successive time periods longer the economy will survive with higher cumulative growth. Many of the socio-economic problems, e.g., environmental pollution, unemployment, resource crisis, poverty etc., may be resolved and the objective of sustained economic growth can be achieved by incorporating WM aspects in national planning. The agriculture and industry are identified as critical sectors to be given top priority for WM efforts. The extent of waste recycling is moderately sensitive to the cost of recycling, and the priorities assigned for national planning.

The main text of the thesis is supported by an extensive bibliography on the subject, followed by appendices.

Substantial part of this research has been presented/published by the author in various conferences/journals.

C O N T E N T S