THE LIFE CYCLE THINKING MODEL FOR APPROXIMATING NEIGHBOURHOOD ENVIRONMENTAL PRACTICE RELATING TO SOLID MUNICIPAL WASTE MANAGEMENT

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KEY WORDS: multi criteria analysis; waste management

ABSTRACT

The introduced innovative two-criteria optimization model is based on the Life Cycle Management Paradigm and describes the original assessment tools relating to Solid Municipal Waste Management, including its environmental impact and economic aspects. The model could be suited for decision making in system and process design for integrated waste management.

INTRODUCTION

The waste subject is a huge area at the economy of the every State, and it is extreme important to find the right priorities between its possible management options.

Recently the consideration of the New Directions for Environmental Management in Russia, including the waste problem, was initiated by the World Bank in view of the current administrative reform of Russian Government and the new stage in the Bank activity. During the consideration, the discussions on the Utilization Problem have been started. It was noted some doubt regarding the further progress and the right efforts at the Reuse-Recycling-Recovery option (i.e. “utilization”). Towards the problem solution there are known investigations at looking for optimal level of solid municipal waste utilization. Also, it has noted the problem on optimal waste abatement in industry.

The Problem is especially urgent for Northwest Russia as the contiguous region being two-way window to the EU. For its illustration we have pointed out the Solid Municipal Waste problem, where we have now less of 5% by utilization [1].

At last, the research into waste elimination needs to be equally broad bred in its scope to overcome this global international challenge. So, we are looking for Knowledge Management developments at the waste handling sector, and the Life Cycle Assessment looks as the prospective tool for this.

WASTE FLOW IDENTIFICATION

The Waste Technological Cycle (GOST: State standard, Russia) provides a good base for the waste flow identification.

The model for market balance of Demand and Supply at this chain is currently under consideration in view of the new tariff policy development and testing of several pilot schemes for recycling infrastructure. This technique looks also fruitful at forthcoming implementation of Producer Responsibility Principle in Russia in the part of the Packaging waste and the Waste of Electrical and Electronic Equipment, and etc. Indeed, obligation to take care on goods` utilization will shift the Supply, and the company will meet the choice to continue its environmental management. Also, one can find here the instrument for marketing of the environmental sound goods [2].

To solve the similar tasks we have tested the Multi Criteria Technique for waste handling design [3]. So, the Economic and Environmental indicators are used simultaneously. Here are represented the main data used for optimization (Tab.1, Tab.2, Tab.3).

Based on the Data (Tabs.1, 2, 3) the main waste flow models have been designed. The costs models for collection, transfer, sorting, reuse, recycling, recovery and landfill deposition as well as the appropriate impact models for air, water and soil pollution after the main waste treatment technologies are integrated in conjunction with the modern practice based on life cycle management.

WASTE FLOW MODELS

The introduced innovative two-criteria optimization models are based on the Life Cycle Management Paradigm and describe the original assessment tools relating to Solid Municipal Waste Management, including its environmental impact and economic aspects. The model could be suited for decision making in system and process design for integrated waste management.

There are for Xi – waste flow variables the following two criteria:

Damage (D) = Σ di Xi,

di – specific damage coefficients,

Cost (C) = Σ ci Xi,

ci – specific cost coefficients,

and Balance equation:

Const (X) = Σ bi Xi,

bi – specific balance coefficients

Version A:

{Xi} = W1, W2, W3 – components of waste flow to the Landfills

Optimization problem: W1*, W2*, W3*

$(D(W) \rightarrow \min)$ & $(C(W) \rightarrow \min)$

Version B:

{Xi} = W1, W2, W3 (components of waste flow to the Landfills), R1, R2, R3 (components of reuse-recycling-recovering flow to the market of raw secondary materials)

Optimization problem: W1*, W2*, W3*, R1*, R2*, R3*

$(D(W, R) \rightarrow \min)$ & $(C(W, R) \rightarrow \min)$

The chosen integrated waste management is effective to deliver both economic and environmental sustainability to the system of solid municipal waste handling (refer APPX3).

CONCLUSION

The problem of desirable waste utilization has a complicated nature based on its Environmental, Economic, Institutional and Social components. The introduced approach on looking for optimal level of waste utilization has been tested at the concepts design for waste management in Kaliningrad Oblast, Leningrad Oblast and St.-Petersburg (Northwest Russia) and provides both environmental and economic sustainability.

In particular, Fig. 1 provides the Pareto Set at the specific situation in St.-Petersburg. One can find optimal combinations between options W1 & W2 and W2 & W3. It is interesting that included into analysis the recycling activities are stability-sensitive factors in the system. Also, the balanced structure looks attracted by the option W2 & W3, i.e. waste delivering directly to landfills by low-weight trucks from the first treatment activities (collection points) is not effective measure. In turn, due Fig. 2, the balanced structure matches to the specific waste flow distribution (W1* = 0, W2*, W3*, R1*, R2*, R3* as the optimal decision).

In total - The introduced Multi Criteria Technique has a lot of variances due to a possible set of criteria. For instance, there is known after UN the system of indicators for sustainable development. The measures along the introduced directions by the World Bank for waste management look as the integrated criteria base.

Tab. 1 Solid municipal waste morphology

Component	% by mass	
	SW, Households	SW, Commercial
Food	26,0	11,1
Paper	14,8	37,7
Wood	9,3	9,3
Metal	8,1	1,7
Textiles	8,5	6,1
Glass	10,9	6,1
Leather	1,8	1,4
Stony	6,8	7,0
Plastics	11,1	14,9
Other	2,4	4,1

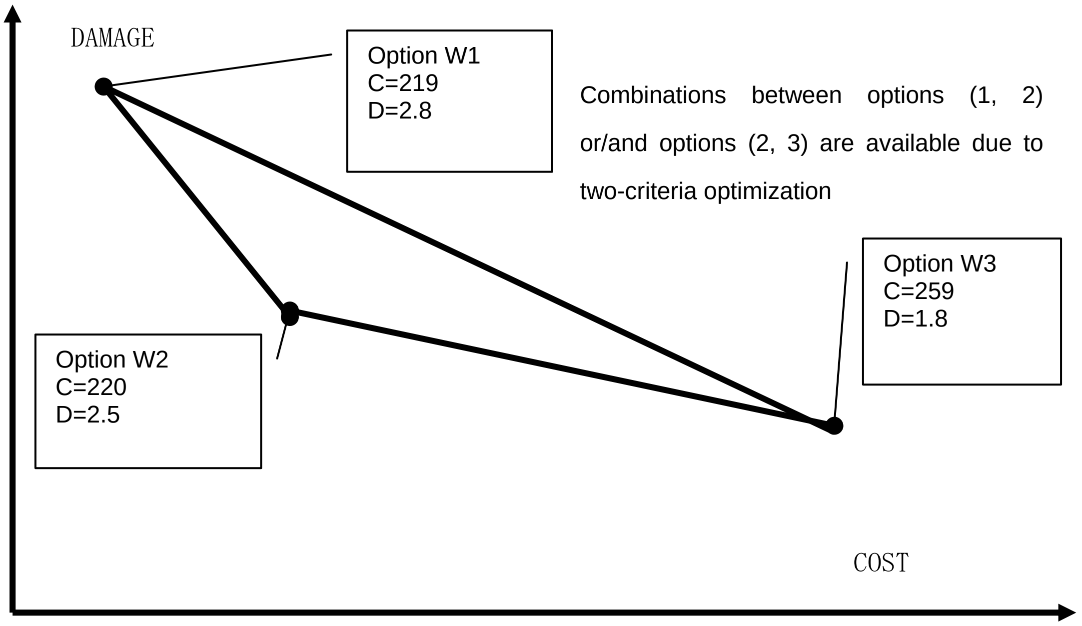
Tab. 2 Operating and maintenance costs

Tariffs for Waste Delivery			Tariffs for Landfilling			Tariffs for Waste Transfer			Tariffs for Waste Treatment			Tariffs for Waste Recycling/Price		
C_{1W}	C_{2W}	C_{3W}	C_{1L}	C_{2L}	C_{3L}	C_{1D}	C_{2D}	C_{3D}	C_{1T}	C_{2T}	C_{3T}	C_{1R}	C_{2R}	C_{3R}
54 €/t	30	30	11	11	11	0	54	30	0.8	27	14	44/100	27/46	33/114

Tab. 3 Greenhouse gas emissions from landfill and recycling activities

Waste Fraction	Dry Matter, %	Total GHG Potential, ton CO_2/ton	First Treatment, %	Second Treatment, %	Third Treatment, %
Food	30	2.257	-	-	-
Paper	90	5.240	8	-	-
Wood	80	5.779	-	15	50
Metal	100	-	-	15	50
Textiles	90	3.646	-	10	-
Glass	100	-	-	20	50
Leather	75	1.078	-	10	50
Plastics	100	-	-	-	50

SMW management options based on the waste flow data, Fig. 1 (COST/ mln. EUR; DAMAGE/ CO_2 mln. Tons)



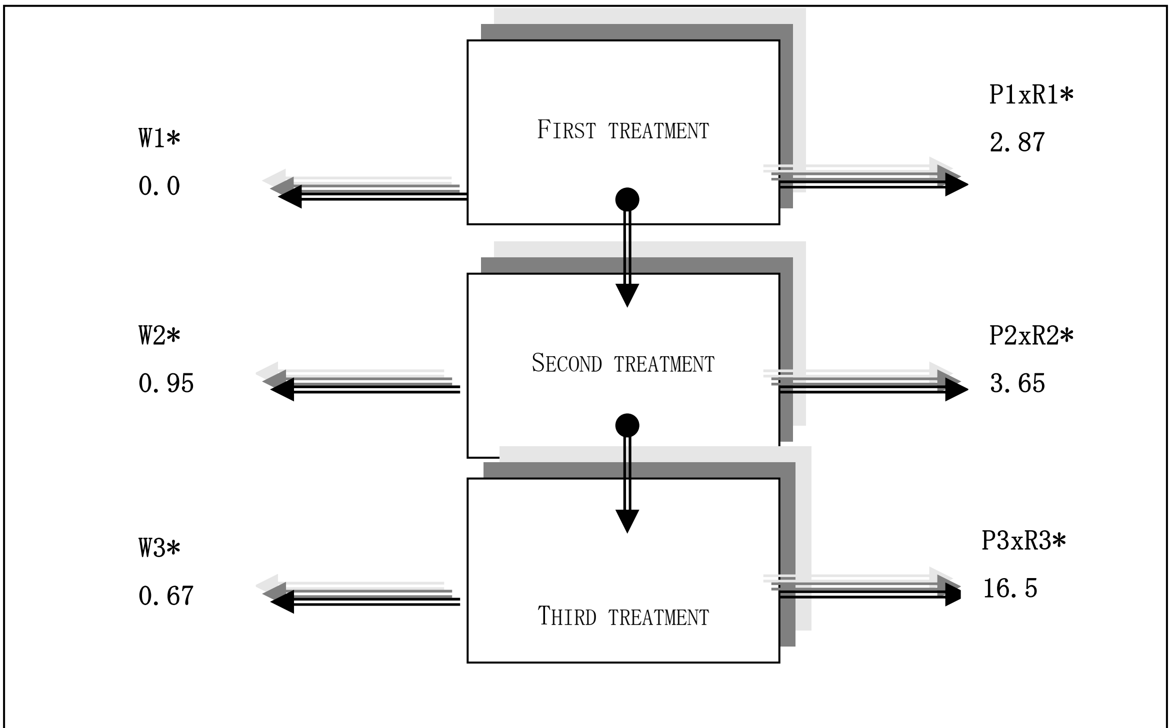


Fig. 2 Waste Flow Structure: W (mln. Tons), PxR (mln. EUR)

References

1. A. Voronov, A TREATMENT WAY FOR ACTON PLAN (with enclosed, in particular, THE INFRASTRUCTURE IMAGE DEVELOPMENTS) via the case study for solid municipal waste management, in Report/Stage_1, Life Cycle Initiative UNEP/SETAC, 2006, 17 pages.

2. A. Voronov, DEVELOPMENTS AND CASE STUDIES TOWARDS SUSTAINABLE KNOWLEDGE-BASED ECONOMY (with enclosed, in particular, SUSTAINABLE PRODUCTION AND CONSUMPTION: RESEARCH FOR INTER-REGIONAL PROBLEMS) via the case study for solid municipal waste management in Report/Stage_2, Life Cycle Initiative UNEP/SETAC, 2007, 12 pages.

3. A. Voronov, A MULTI-CRITERIA APPROACH FOR SYSTEM AND PROCESS DESIGN RELATING TO WASTE MANAGEMENT, in Geotechnical and Environmental Aspects of Waste Disposal Sites / editors R. W. Sarsby and A. J. Felton, Taylor & Francis, London, 2007, 8 pages.