

## ECOLOGICAL EVALUATION OF WASTE MANAGEMENT SYSTEMS FROM SOME EU COUNTRIES

### Doctoral Thesis – Summary

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Wastes are defined in the Basel Convention as substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law [1] while United Nations Statistics Division (UNSD) defines them as “ materials that are not prime products (that is, products produced for the market) for which the generator has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose.” [2].

The lifestyle of the modern society is characterised by the continuous growth of the consumption and is reflected in the increase of consumed resources and of the produced waste quantities. According to a report of the European Union the forecasted growth of municipal solid waste in the EU countries for the period 2006-2030 amounts ca. 40 kg/inh [3].

In parallel worldwide expands the preoccupation for the environment affected on one side by the significant decrease of natural resources and on the other side by pollution and greenhouse gasses.

The reduction of natural resources leads in the last years to price raise of ca. 80% in the euro zone. Oil price varies often due to several complex factors, but the present trend is ascending reaching the double in the period 2003-2006 ([4] quoted in [5]).

Although the contribution of waste management to the overall emissions of greenhouse gasses is reduced when comparing with other sectors (below 5% [6]), this sector has a high potential to reduce these emissions, insuring a sustainable development with relatively low costs.

Within this framework arises the opportunity to reconsider the role of the waste in the society, to classify it as secondary resources and to analyse the possible methods to recover and recycle it, or safely dispose when recovery is not possible. Recycling reduces the consumption of primary materials and refuse derived fuel is an alternative to the fossil fuel.

In this view the selective collection of waste is a necessary measure to adopt in order to improve the recycling quotes and the quality of the secondary materials.

Romania is now at the beginning of the way in the waste management and has the chance to take the advantage of the experience from countries with a long tradition in this sector. For this reason the present thesis aims at analysing possible solutions for waste treatment and recovery and with the help of LCA methodology to determine their potential to the reduction of the greenhouse gasses emissions.

### Necessity and opportunity of the research

The necessity and opportunity of the research arise from Romania's urgent need to find solutions for treatment and recovery of municipal solid waste, making possible to reach the objectives imposed by the European Union.

The present thesis looks into the problems to find the appropriate solutions to manage the generated waste in Romania. An important issue in this view is to determine first of all the quantities and the composition of the generated municipal solid waste so that on this base can be taken decisions on the collection, transport and treatment.

The objectives of the thesis imply the establishment of solutions that could be applied in Romania to achieve a performant system for waste management, meeting the demands of the European Union and protecting the environment.

### Structure of the thesis

The thesis covers nine chapters and comprises 168 pages, 6 formulae, 22 tables, 69 figures and 20 appendices. The bibliography contains 109 sources.

In the first chapter „Introduction” it is presented the research topic, the necessity and the opportunity of the research and the objectives of the thesis.

The second chapter „Waste management in European context” offers an overview on waste management, starting from the history and continuing with the principles such waste hierarchy that ground the EU concepts. Further on in this chapter are presented the models and methodologies of Life Cycle Assessment, which are often used in Europe to assess the waste impact on the environment. In this context the attention turns to the European strategies on waste management meant to protect the environment. A significant tool that serves to reach the EU goals is the selective collection of waste that is why this aspect ends chapter 2 up.

Chapter 3 „Waste management in Germany” is dedicated to the analysis of the solid waste management in Germany. After a short history of the German tradition in this sector there are presented the guidelines of the federal state Brandenburg that serve as orientation to determine the quantities and the composition of the waste. Then are presented the waste flows with information regarding the collection and recovery, followed by the waste statistics. The chapter continues with the presentation of several plants, their treatment steps and technologies. Moreover an analysis of costs and charge fees is done in order to provide an insight into the economic aspects. The German system is critically analysed in order to point out the aspects that could jeopardise the success of the waste management system.

Last but not least a series of pilot projects that were tested in Germany with aim to optimise the existing system is presented as they could serve as a model.

Chapter 4 „Waste management in Romania” analyses the waste management at national and local level in Romania. After the framing of Romanian system in the European context an analysis of the waste quantities and composition is done and the available collection and treatment methods are described. In order to insure a clear view on the waste treatment at local levels a case study for Timisoara is set up. Chapter 4 ends up with the identification of the weakness of the Romanian waste management system.

In Chapter 5 „Waste analysis” is described a series of indispensable parameters for the planning process of any waste management system. Along with the general and municipal categories of waste are presented also the material composition and the indicators to characterise waste as well as their formulae.

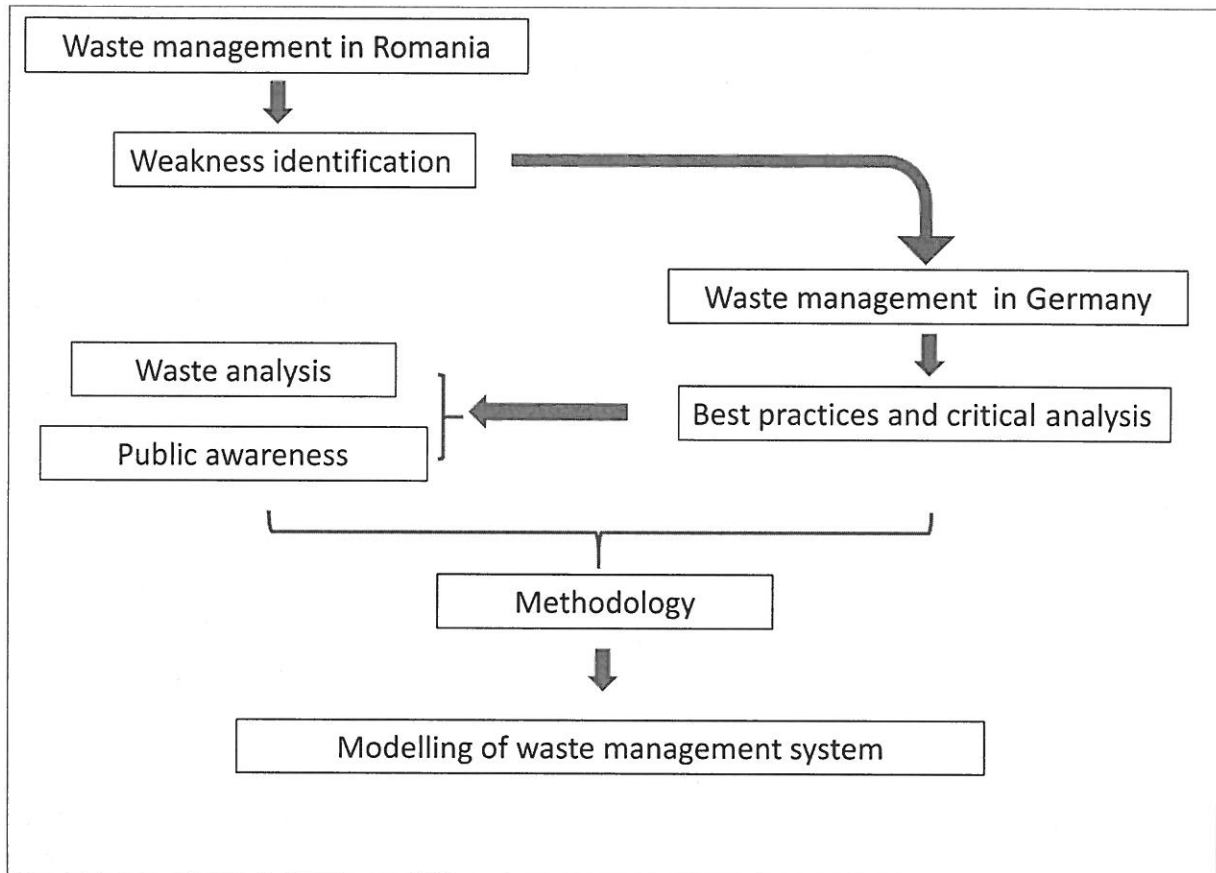
One significant aspect that contributes to the success of implementation of a waste management system based on selective collection is the population and its level of awareness. That is why Chapter 6 „Public awareness” analyses the public behaviour, describes some awareness-raising methods, identifies possible barriers and defines behaviour models and tools that can influence the public.

Chapter 7 „Methodology” presents the methodology used for the data collection for the case study in Timisoara and the Life Cycle Assessment methodology that grounds the process of scenarios modelling for the above mentioned case study.

Chapter 8 "Modelling process for the case study Timisoara" describes the models and the

scenarios for the collection and treatment. The results of the modelling are presented at the end of the chapter.

Chapter 9 discusses the results of the thesis, underlines the personal contributions and the originality aspects ending up with recommendations meant to ease the planning and implementation processes of waste management systems in Timisoara and in Romania. The figure below offers an overview on the structure of the thesis.



**Figure 1 Structure of the thesis**

### Conclusions

The thesis analyses the waste management system in Romania within the European context and highlights its weakness. In parallel is analysed the German waste management system, considered to be an example of success. The analysis of the German system allows summing up a series of best practices that could be transferred and adjusted to the Romanian particularities. To insure the success of the implementations for these best practices it is essential to have an exact evaluation of the waste quantities and composition, so the thesis highlights the importance of the waste sorting analyses. Best practices can be implemented only with the public support, so the thesis recommends tools to increase the awareness levels.. On the case study Timisoara the thesis presents a German method to collect data within the waste sorting analysis. The collected data is used as basis for modelling several scenarios and with the help of life cycle assessment are highlighted the positive effects of the modern waste management systems (including selective collection) upon the environment protection. Successful implementation of these systems leads to significant reduction of CO<sub>2</sub> emissions.

### Personal contribution and originality aspects

The main personal contributions within this thesis are the followings:

- organisation of the waste sorting analysis in 2008 in Timisoara, data preparation and results interpretation, dissemination of results within a workshop where political decision makers, representatives of the environmental protection agencies, of non-governmental agencies, waste operators were invited.
- waste composition analysis for the county Ludwigsburg in the German federal state Baden-Württemberg, within the collaboration as employee of Stuttgart University in a research project in this region. This experience was extremely useful to determine the essential aspects to be considered in the sorting analysis of waste.
- analysis of German treatment stations and data collection within visits to the waste incineration plant Stuttgart-Münster, mechanical-biological treatment plant Kahlenberg, mechanical-biological treatment plant and landfill Cröbern, biogas plant Leonberg, compost plant Zuffenhausen. The data was used in the modelling for the case study Timisoara.
- research project as employee of Stuttgart University on the selective collection of waste at national level in Germany. This project made possible a detailed overview on a success example and helped to formulate the recommendations for Romania
- participation as employee of Stuttgart Germany to the set up of a pilot project with an innovative selective collection system in the German county Neckar-Odenwald. The experience was applied in the model for the case study Timisoara.
- construction of the models for the case study Timisoara, using modern plants, to evaluate the impact on the environment.
- conception of the graphical representation of the models.
- formulation of recommendations based on acquired experience and knowledge and on the undertaken analyses.

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