MSc Program
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Comparative Analysis of Waste Management in Austria and Bosnia and Herzegovina

A Master's Thesis submitted for the degree of
"Master of Science"

supervised by
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Vienna, 09 June 2015

Affidavit

I, **Igor Kosic**, hereby declare

1. that I am the sole author of the present Master's Thesis, "COMPARATIVE ANALYSIS OF WASTE MANAGEMENT IN AUSTRIA AND BOSNIA AND HERZEGOVINA", 61 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

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ABSTRACT

Bosnia and Herzegovina is a country facing many challenges on its path to become an EU member. One of these challenges is waste management. As a future candidate for the EU, Bosnia and Herzegovina will have to transpose and implement the Chapter 27: Environment, which concerns waste management. The goal of this thesis is to evaluate the present situation and give suggestions in order to improve future waste management system in the country. Due many problems with the data collection and evidencing of waste, it is hard to evaluate the present situation. The main question of this thesis is whether the goals of waste management are fulfilled by current waste management system? Also are these goals in harmony with EU? And, is the current legislation effective in providing framework for waste management?

I have compared the goals of EU, Austria and Bosnia and Herzegovina to come to the conclusion that in Bosnia and Herzegovina there is only one goal; protection of human health and environment, which in my opinion is a suitable goal for the country. Also, I have compared the legislative framework of BiH and Austria and came to conclusion that for BiH, it does not provide appropriate framework for effective waste management. In order to answer the main question of thesis, I had to evaluate the current WM system. This was done using MFA and comparing the results of the research with the goals of WM. The results show that BiH is very far from fulfilling the goal of protection of human health and environment. The means for reaching this goal are not used appropriately and much harm is currently being done to environment and public health. My conclusion is that, having in mind current political and economic situation, the country needs to focus on the improvement of landfilling rather than the prevention of waste trough building regional waste management centers. Improvement in Landfilling is priority. This will solve major problems of waste management in the country, some of which are no appropriate treatment of waste, landfilling untreated waste, landfills which are not sanitary and non-evidencing of waste flows and lack of information and data on waste.

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LIST OF ABBREVIATIONS

AWG	Abfallwirtschaftsgesetz
BiH	Bosnia and Herzegovina
EU	European Union
FBiH	Federation of Bosnia and Herzegovina
GDP	Gross Domestic Product
Kt	Kilotons
MFA	Material Flow Analysis
MSW	Municipal Solid Waste
WM	Waste Management

I. INTRODUCTION

1. Background and Motivation

Constitution of Bosnia and Herzegovina and the General Framework Agreement for Peace in Bosnia and Herzegovina was adopted in 1995. Although country has gained its independence and recognition in the 1992, the period between 1992 and 1995 was marked by the civil war which as a consequence has not only had a loss of the population but also most of the country's infrastructure had been completely destroyed. In 2008 the Agreement on stabilization and joining EU has been signed and although the country still has no status of candidate for EU, it is evident that the country will continue to follow the path of European integration in the future. With this in mind, when the country reaches status of candidate it will be required to transpose and implement the whole EU legislation or *acquis communautaire*. In the EU legislation under the chapter 27 is Environment. It comprises of around 200 major legal acts which include horizontal and sectorial legislation. These include legislations and acts on waste management, air and water quality, nature protection, industrial pollution control, chemicals, climate change, noise and civil protection.

At present Bosnia and Herzegovina is facing many problems and challenges in many aspects such as economic, political and social. With one of the lowest GDP per capita in Europe, low political stability and destroyed infrastructure, the consequence is waste management which is far from European standards. Some of the problems concerning waste management had been inherited from the Socialist Federative Republic of Yugoslavia in which Bosnia and Herzegovina was one of the six republics which constituted the country. The waste management system was mostly based on controlled and engineered dumping. Nevertheless even today, almost 20 years after the war there is no adopted waste management law on the state level. The Dayton peace accords which stopped the war and brought peace have as a consequence a unique constitution, which makes countries legal system, responsibilities of the institutions, law making and implementing complicated.

Despite numerous attempts with mediations and talks, this constitution has not changed yet and is currently hindering the progress of the country.

Currently the waste management system is almost completely based on landfilling, exporting the waste to EU countries for processing and only small portions of waste are being recycled. There are still no incineration plants or any energy recovery options available in waste management system of the country. According to the latest estimates only in the entity Federation of Bosnia and Herzegovina, whose territory is around 51%, there are 340 evidenced illegal landfills (Federal Ministry of Tourism and Environment, 2011). Taking in mind that this is only half of the country and this data is related to evidenced landfills, this number is much larger for the entity itself and the whole country. Another big problem is lack of sufficient statistical data. Again a complicated legal system has as a consequence complicated division of responsibilities and the whole waste management system in general. This way it is not easy to obtain or to comprise the data that is gathered in terms of waste. This is especially evident when it comes to the municipal solid waste (MSW). According to the federal waste management plan:

"Insight in to the quantities of produced waste in Bosnia and Herzegovina as well as the estimation of growth of the quantity of waste and the estimation of composition of waste as well as the MSW flows from its generation to its disposal are needed in order to make a proposition for and integrated waste management system." (FWMP, 2011)

Another reason for this is the low awareness and long term practice of neglecting the monitoring of waste flows, quantity and composition. In order to have an efficient waste management system, one of the solutions is for an country to have integrated waste management system. It is evident from various reports that Bosnia and Herzegovina struggles even with the monitoring of waste and the creation of statistical data in these terms. Integrated waste management system would cut a lot

of costs in terms of bureaucracy and it would ensure easier collection and exchange of information regarding waste. Currently country has WM system for each entity, and the systems are connected with the inter entity agency for environment. An alternative to having an integrated system is to continue with the separate WM systems and coordination by the inter entity body, but also to create state institutions for waste management which would have competency for the inter entity body. Currently there are no state institutions for waste management.

I have identified 4 major problems of WM management in Bosnia and Herzegovina which will be examined in thesis. These problems are:

1. Municipal Solid Waste is not treated appropriately with regards to goals of WM
2. Untreated waste is predominantly landfilled
3. Almost all landfills are not sanitary and do not fulfill EU regulations
4. Lack of data concerning waste flows, leaching and emissions from landfills

It is important to be noted that in order to limit the scope of the thesis, MSW will only be taken into the account. Although there are many other types of waste which are also generated in large quantities, MSW is of the most interest for me due to the fact that it is a part of everyday life and it has adverse composition and can be potentially harmful for the environment. Also there are no regulations on the MSW either on state or on entity level and the flows as well as the quantities are unclear, because to precise data currently exists.

2. Research Aims and Question

In view of the information given above it is evident that Bosnia and Herzegovina is facing a lot of challenges and problems in waste management. The particular four problems of MSW stated in the introduction are highly neglected and due to the fourth problem (lack of data) the real state of the system is not fully known and is currently based on estimations. The main question for such a waste management is: Are the goals fulfilled by the present waste flows or not? This is the main research question of my thesis. Answering this question well create a realistic picture of the current state and help fulfill the goals of the paper. The overall goal of this paper is to develop suggestions about the improvement of waste management in Bosnia and Herzegovina.

In order to achieve the overall goal, few other specific targets and goals need to be fulfilled in this paper. And in order to fulfill them, some other research questions have to be set. Are the goals of WM in BiH the same as for the EU and Austria? How does the legal system provide the background for the Waste Management in these countries? What can be identified from the mass flows? To be able to answer these questions, the objectives of WM in both countries and EU are going to be examined. Also major legal documents are going to be identified and analyzed for Austria and BiH. Then, in the thesis, using the MFA, the MSW flows as well as its composition in the both countries are going to be analyzed. In order to achieve this, besides Bosnia and Herzegovina, the waste management system in Austria will be analyzed through the MSW flows. Austria is an EU member and the area of the territory is close to one of Bosnia and Herzegovina. Although population is higher, GDP is significantly higher the waste management system is much more advanced and effective. After comparison of the most important aspects of WM, it will be possible to identify and learn from the differences regarding the objectives of WM, future practice of WM and the importance and need for information and data collection for Bosnia and Herzegovina.

3. Structure of Thesis

As the principal methodology in the thesis, a brief description and explanation of the MFA will be done as well as the reasons for choosing this method and the benefits which it will give to the research. After this, the goals of the waste management in EU, Austria and Bosnia and Herzegovina will be examined, analyzed and compared. EU as a union where Austria is a member and Bosnia and Herzegovina is on the path of becoming one, has clear policies on waste management and well defined goals to which any country who is a member or wants to be has to accept. After the analysis of the goals, the legal background will be provided in terms of WM for two countries. A brief overview of the most important laws and regulations in terms of waste management will be given. This is done in order to confirm and support the goals as well as to give an overview of the legal structure and current legal state in terms of waste management in both countries. The main part of this thesis is the comparing of municipal solid waste flows through waste management in both countries. This will be done through MFA by a software called STAN. Subsequently, these analyses will be used as a basis for the identification of pros and cons of the differences in the waste mass flows between the two countries. These analyses will enable for the comparison between waste flows and goals of waste management in both countries. More precisely, are the goals fulfilled by the present waste flows or not? This way a much clearer picture of the waste management systems will be created. Based on the research, I will answer this question for each goal. In the end the conclusion will be given and the recommendations of how to improve the system in order to fulfill the goals of waste management.

II. RESEARCH METHODOLOGY

1. Introduction

The figures concerning mass flows in Bosnia and Herzegovina, although official are based on estimations from the statistical agencies. Most of the literature used regarding waste management in general and in the European Union was in English language, which includes legislation, studies, books and articles. For Austria most of the literature, especially legislation was in German language. Most of the crucial materials used for creating MFA for MSW mass flows in Bosnia and Herzegovina are in the official languages of Bosnia and Herzegovina (Bosnian, Croatian and Serbian).

2. Legislation Side

For the legislative basis of the thesis and for the comparison of the goals of WM, numerous documents of legislation will be used. Goals of waste management for the European Union are defined and stated in the Framework Waste Directive (2008). For Austria for the analysis of objectives and goals of waste management, Waste Management Act (Abfallwirtschaftsgesetz) will be analyzed. For Bosnia and Herzegovina documents used will be the entity laws on waste management. In order to compare and analyze the legislative frameworks for waste management of Bosnia and Herzegovina and Austria again documents of legislation will be used. In order to provide the best insight and understanding of the framework for Austria these documents will be the Waste Management Act (Abfallwirtschaftsgesetz) and Landfill Ordinance. For Bosnia and Herzegovina documents used include entity and district laws on waste management and the Packaging Ordinance. Also in order to create results, certain criteria will be set on which basis goals and legislative framework will be compared. Combined with the in depth analysis of the literature and legislation, this comparative approach should provide valuable results for better understanding and which can be used for the analysis side of the thesis.

3. Analysis Side

For the analytical side of the thesis Material Flow Analysis (MFA) method will be used.

"Material flow analysis (MFA) is a systematic assessment of the flows and stocks of materials within a system defined in space and time. It connects the sources, the pathways, and the intermediate and final sinks of a material… An MFA delivers a complete and consistent set of information about all flows and stocks of a particular material within a system. Through balancing inputs and outputs, the flows of wastes and environmental loadings become visible, and their sources can be identified" (Brunner and Rechberger, 2004)

Through Material Flow Analysis realistic and complete pictures of the current state of Waste Management systems in Austria and Bosnia and Herzegovina will be made. For the simplification of the thesis in the analysis only municipal solid waste mass flows will be used. For Austria, MFA analysis chart for the MSW mass flows made by Mag. Astrid Allesch will be used, while for Bosnia and Herzegovina, based on the research and data, I will create a MFA chart. Using this method, mass flows will be identified and can be easily compared between each country and their objectives of waste management with a goal of making conclusions and recommendations for the future of the waste management system in Bosnia and Herzegovina.

III. GOALS OF WASTE MANAGEMENT

1. Introduction

"*At the back end of metabolic system, waste management forms the main interfaces between the anthroposphere and the environment*." (Baccini and Brunner, 2012) As such waste management is considered to be an essential part of every society, especially in the developing and developed countries where the consumption of goods and materials is high or growing rapidly. Therefore the first part and the basic ground step for any successful waste management policies and waste management in general of a country are clearly defined and set goals of waste management.

The Resource Conversation and Recovery Act (RCRA, 1976), as part of the federal law in the United States, defines the goals of waste management as:

- Protecting human health and the environment from the potential hazards of waste disposal.
- Conserving energy and natural resources.
- Reducing the amount of waste generated.
- Ensuring that wastes are managed in an environmentally-sound manner

In Japan, Waste Management and Public Cleansing Law (No.135, 1970) in the Article 1 defines as the goals of the Waste management as:

- Preserving the living environment
- Improving Public Health
- Suppress the amount of waste Generated
- Appropriate management of the waste (Government of Japan; Ministry of Environment , 1970)

Finally in the European Union, the Framework Waste Directive (2008/98/EC) defines the goals of waste management and they are fairly similar to those of Japan and USA, all of which will be examined in detail in the subchapter below.

From the information above, it can be argued that the goals of waste management are generally universal and identifiable. But in order for a country to plan and implement successful waste management policies, the first step is that the state defines the goals clearly. Goals often represent well set criteria and objectives, which countries use for an assessment of waste management (Döberl et al, 2014). Therefore in this chapter I will analyze and compare the goals of waste management in European Union, Austria and Bosnia and Herzegovina.

2. Criteria for Comparison

In the introduction of this chapter I have stated that I will analyze and compare the goals of WM in the EU, Austria and BiH. For the analysis part of this chapter, various sources will be examined and presented. On the other hand, in order to compare the goals and the analyzed data, a certain criteria for comparison must be defined, by which, we can examine the differences in the goals of waste management. The criteria that will be used for this chapter will try to show the overall picture of the countries and how it influences the goals of WM and to which extent they differ in Austria and Bosnia and Herzegovina. Also the criteria used needs to reflect all the aspects that may influence the environment, resources and public health and therefore, the goals of WM.

Having this in mind, I have decided to choose 6 criteria by which we can compare the goals of waste management in the EU, Austria and Bosnia and Herzegovina. These criteria are Labor Force, GDP, Resource consumption, Resource availability, data availability, Population.

Population- it is an important factor in waste management and a very basic one. Countries with larger and smaller populations may have certain differences in goals of WM, and also the size of population affects many aspects such as industry, urbanization etc. and therefore influences the goals of WM. For comparison of the goals of waste management, population is a starting point.

Labor Force- As with population, the importance of the labor force is big. It represents the portion of the population which is available for work. This includes

both employed and unemployed portions of the population. It helps us understand the economic background and the capacities of the country.

GDP- Maybe the most important factor for the comparison. It is essential for the countries formation of WM strategy, and it tells a lot about the opportunities and limits of a country when it comes to fulfilling the goals of WM. Also for the comparison we will take into the account that a portion 0.3 of GDP per capita is spend for waste management (Brunner and Fellner, 2007).

Resource availability- This criterion is used to examine and review the resource conservation goal of WM. The domestic availability of resources and the variety of resources can tell us a lot with regards to the goals of WM. Different countries have different resources and in different amounts. This can also be used to compare the goals of WM.

Resource consumption- The consumption of resources is one of the parameters where the differences between developed, developing and least developed countries can be seen. Besides the availability, the consumption of resources determines the demand and potentially public health and welfare of the environment.

Data availability- For the understanding of WM and fulfillment of the goals of waste management, a clear picture and precise data is needed. This criterion reflects the availability of research data in the field of Waste management.

3. Goals of Waste Management in the EU

As stated in the introduction of the chapter the goals of waste management in the European Union can be identified from the Framework Waste Directive. This directive is currently the most important legislation concerning the waste in the EU and it clearly defines, regulates and sets instructions for the Member States in the European Union in terms of waste management. In Article 1 of the directive, which covers the subject matter and scope it is clearly stated that:

"*This Directive lays down measure to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use.*"

Also in the Preface of the directive paragraph 6 defines that:

"*First of objective of any waste policy should be to minimize the negative effects of the generation and management of waste on human health and environment. Waste policy should also aim at reducing the use of resources…"* (EC, 2008)

From these we can conclude that the main goals of waste management in the EU under the Waste Framework Directive are:

- Protection of human health and environment
- Resource conservation
- After care free waste management (ensuring protection of future generations)

Also it should be added that special attention is given to the reduction of the emission of greenhouse gases which is mentioned in the paragraph (36). So it can be also said that is another goal of WM in EU. By proper waste management the emissions of GHG can be reduced significantly since a large portion of these gas emissions globally comes from landfills. The composition of Landfill gas contains from 80% to 99% of Methane (CH4) and Carbon Dioxide (CO2) which are Greenhouse Gasses (Fellner et al, 2011). Also GHG emissions from Landfill gas comprise to about 3-4% of global GHG emission (EIA, 2004) and it is the third anthropogenic source of methane globally, which has approximately 20 times more global warming potential

than CO2 (EPA, 2011). In the GHG emissions reduction, the EU is a pioneer, with the reduction of 19.2 % below 1990 level and 21.6% below Kyoto level (EC, 2014). Although the unilateral commitment in the EU is to lower the emissions to 20% below the 1990 level, it is certain that this trend will continue and that even more attention will be drawn to the mitigation of the landfill gas emissions especially in developing countries, where waste is mostly dumped in landfills.

Protection of human health and environment can be said is the primary goal of waste management in EU. Improper waste management such as illegal landfills, uncontrolled dumping, burning of non-treated waste etc. can cause direct harm to public health as well as make irreversible consequences for the environment. Also through proper waste treatment such as incarnation and bio chemical treatment emissions and other negative effects which waste can produce can be minimized.

Resource conservation is another important goal of waste management in the EU. Resource scarcity especially in the energy sector is very evident today. According to the BP annual report from 2013, Global proven oil reserves can currently last for 53.5 years while natural gas reserves can last for 55.1 years (BP, 2014). It should be noted that this data is contains high degree of uncertainty since this estimates are subject to change with technology advancement. With this fact and the fact that Europe is energy dependent, resource conservation is an important goal. Incineration besides treatment of waste produces energy and recycling contributes to resource conservation significantly.

Last, the protection of future generations is an obligation of modern society and it is one of the fundamental grounds of the EU. After care free waste management therefore both covers resource conservation and protection of human health and environment. Trough appropriate waste management protection of the environment, reduction of GHG, advancements in technology and minimization of resource use, this goal will be achieved. Growth in material and substance flows as well as material stocks is significantly high when we compare primitive to modern man (Baccini and Brunner, 2012). Therefore continuous economic growth, which as a result has a growth in waste generation, produces a significant challenge for waste management of today as well as of the future. In the EU from 1990 to 1995 waste generation increased by 10% (EEA, 1999). Also in the public opinion and also in the

minds of many politicians, waste prevention is the main goal of waste management. The EU has recognized this challenge and that is why prevention and reduction in waste is the first and most important mean in achieving the goals of WM in EU.

It should be noted that the directive also promotes the means to achieving these goals in the paragraph (7) which are:

- Prevention
- Recycling
- Disposal

The means are arranged in the so-called "Waste Hierarchy" which is defined in Article 4:

- Prevention
- Reuse
- Recycling
- Recovery
- Disposal

The hierarchy means that starting from prevention which is most favorable, every step below is less favorable. So Recycling is preferred to Disposal etc. Although in the second paragraph of the same article it is stated that countries are encouraged to take the options from the hierarchy which will be the most effective environmental outcome. But another important aspect of waste management and of the goals themselves is the means to achieve these goals, which differ in the countries. It is argued that there should not be universal hierarchy in the means, since countries themselves are different in many aspects, primarily economic, GDP (Brunner and Fellner, 2007). Certain hierarchy of means might work well in the developed countries, while in the developing and least developed countries this hierarchy needs to be adapted to the lower GDP that they have in order for it to be efficient in reaching the goals of Waste management. What is interesting regarding BiH is that under the law, approach to the choice of means is not hierarchical, but oriented towards the case to case basis with regards to ecological, technical and economic benefits and feasibility. This is an interesting approach, since it is not universal and

as such can be more effective. On the other hand in case of Bosnia and Herzegovina it is questionable how effective it is considering the lack of data available. This dilemma will be more elaborated later in the paper after the analysis of the current WM system in BiH.

4. Goals of Waste Management in Austria

The Austrian Waste Management act from 2002 or Abfallwirtschaftsgesetz defines the goals of waste management in Austria. Under section 1 of the AWG these goals are defined as:

- To prevent harmful or adverse effects on humans, animals, and plants, and on their basic resources and natural environment, and generally minimize other negative effects on human well-being,
- To minimize air pollution and gases affecting the climate,
- To converse resources (raw materials, water, energy, landscapes, land areas, landfill volumes)
- In the case of recycling, to ensure that the materials reclaimed do not present a greater risk than comparable primary raw materials or products from primary raw materials
- To ensure that only such waste remains as can be stored without danger to future generations.

As a member of the EU, Austria has in many similar goals as that are stated in EU framework directive. The prevention of harmful or adverse effects and minimization of other negative effects can be considered as equivalent to the EU goal of protection of human health. Like in the EU directive, in the Austrian act, this goal is stated as the first one, thereby it can be considered arguably as the primary goal.

From 1960 to 2008 in Austria the use of resources rose from 114 to 197 million tons annually. This rise of a factor 1.7 annually is mostly through rapid development that the country has experienced in these years. From the 197, 167 million tons are extracted natural resources from Austria (Lebensministerium, 2011). Biomass

constitutes for 26%, fossil energy carriers and metals around 1% and nonmetallic minerals 72% (Lebensministerium, 2011). Some of these natural resources have a big environmental impact both during excavation and processing. These impacts can be due to the energy or waste produced during these processes. Therefore, the goal of resource conservation represents an important aspect of WM in Austria and it is also in line with the Europe 2020 strategy.

Recycling is one of the most important aspects of WM. It is one of the means to reaching all of the goals of WM. As the process, recycling consists of many stages. Some of them such as transportation, energy use and residuals from the process may have negative environmental impacts. Also as the recycling rate increases, the environmental protection increases up to certain point, after which the effort to recycle becomes significantly higher, therefore requiring more energy, costs and etc. This results in negative impacts on environmental protection. Austria recognizes this limit to recycling and states it as one of the goals. Also the Article 1 (2a) puts strong emphasis on this approach, permitting hierarchy to be changed in order for the highest level of environmental protection to be reached.

Another matching aspect is the minimization of air pollution and gases that affect climate. Although directive in Article 2 excludes gaseous effluents to atmosphere, the EU strongly puts emphasis on reduction of GHG, which originate from landfills. For Austria this is an important goal, since a large portion of the waste is disposed on the landfills. In 2012 from all waste that was produced, around 33% or around 16 000 000 ton was deposed on landfills (MFLÖ, 2013). Moreover the goal of storing the waste without danger for future generations is tightly connected with this, since sooner or later most of the waste will end up on the landfills.

5. Goals of Waste Management in the Bosnia and Herzegovina

Bosnia and Herzegovina as a country is divided in to two entities and one district by the constitution. These entities are Republika Srpska, Federation of Bosnia and Herzegovina and District Brcko. According to the constitution, all of the matters which are not stated in constitution are under jurisdiction of the entities. WM is not mentioned in constitution and falls under that jurisdiction and therefore in Bosnia

and Herzegovina there are 3 laws on WM inside those three bodies. As a consequence on the state level there is no uniform law on waste management, but goals can be identified from the entity laws on waste management. For the entity of the Federation of Bosnia and Herzegovina Article 2 of the Waste Management Law of the Federation of BiH (2002) defines the goals. Although there are different laws for each entity and district, the content is similar when it comes to goals and means of WM. Therefore goals in this article are similar to the goals for the other entity. So if we look at the Law on waste management of the Republika Srpska (2002) in the Article 2 the goals are defined as The law is differently structured then the laws on WM of EU and Austria. In the next chapter named "Priorities" it is stated:

"Waste management will be done in a way to take all the necessary measures which ensure treatment and disposal of waste without threatening health of people and creating damage or causing significant risk to nature; especially:

- *Without risk for water, air, soil, animals or plants;*
- *Without creating distractions trough noise or smell;*
- *Without harmful influence on nature or areas of specific interest"* (Parlament Federacije BiH, 2003)

From this it can be argued that protection of human health and environment is the goal of waste management in Bosnia and Herzegovina. It is the most important and primary goal of WM and the other four goals have to be fulfilled under this overall goal.

So although there is no Law on the state level and the waste management laws differ between entities, article 3, which regulates goals, is the same. Also, the Law on WM is District Brcko is absolutely the same as the law in the entity of the Federation of Bosnia and Herzegovina.

Besides the goal of protection of human health and environment, there are no other clear defined goals, which can be found in the law. What can be found is the means to achieve this goal.

In Article 3, first paragraph it is stated that waste management will be done in a way to ensure:

- Prevention of waste generation
- Waste processing for the reuse and recycling
- Extraction of raw materials from waste and their use for the production of energy
- Safe waste disposal

The encouragement and providing conditions for prevention of waste generation as a mean is equivalent to the first of means in the hierarchy in the EU and Austrian law. This is understandable as BiH is a developing country with low GDP of around 4128 euros (World Bank, 2014). Lowering the amount of waste produced has most efficient cost to environmental effectiveness ratio.

Waste processing and reuse can be seen as mean in order to reach a goal of resource conservation. Also, the third mean specifically states that extraction of raw materials from waste is encouraged and it use in energy production. This stresses the importance of resource conservation and using waste as a source of energy. This is important because as such Bosnia and Herzegovina besides being energy dependent produces most of its energy in an ecologically unfriendly way, from the using thermal power plants which mostly use coal.

The final mean of WM is the safe waste disposal. Safe waste disposal ensures protection of future generations as well as lowering the emissions of hazardous gases and leachates. This mean is another important aspect for a developing country since the studies show that in developing countries most of the MSW is disposed on landfills since it is the only option which these countries can afford (Brunner and Fellner, 2007).

Bosnia and Herzegovina is on the path of the EU and it has signed the Stabilization and Association agreement with the EU in 2008 and we can see that besides the primary goal of waste management, the two other major goals are not defined (DEI, 2014).

In the Federal Plan for waste management in period 2012-2017 it is stated that the headline goal of the strategy in the plan is:

"*Protection of environment, promotion and encouragement of sustainable use of resources, trough establishment of integrated waste management system"*.

Also with the proper implementations of the plan, 7 goals are expected to be reached:

- Establishment of Integrated system of WM
- Increasing shares of separately collected Waste
- Increase in recycling
- Pretreatment of Waste
- Lower amount of Waste on Landfills
- Less harm on environment
- Sustainability of MSW management system (Federal Ministry of Tourism and Environment, 2011)

6. Results

Based on the criteria and the analysis from this chapter I have comprised a short summary table which shows the comparison of the goals of WM.

Table 1. Goals of Waste Managment

EU	Austria	Bosnia and Herzegovina
Protection of human health and environment	Prevention of harmful or adverse effects on humans, animals, and plants, and on their basic resources and natural environment, and generally minimization of other negative effects on human well-being,	Taking all necessary measures to ensure treatment and disposal of waste without threatening health of people and creating damage or causing significant risk to nature
Resource conservation	Resource Conservation	
After care free waste management	After care free WM: To ensure that only such waste remains as can be stored without danger to future generations.	
	In the case of recycling, to ensure that the materials reclaimed do not present a greater risk than comparable primary raw materials or products from primary raw materials	
	Minimization of air pollution and gases affecting the climate	

Table below represents the results of comparison based on the criteria defined at the beginning of the chapter.

Table 2. Comparison of Criteria for the Goals of Waste Management

	EU 28	**Austria**	**Bosnia and Herzegovina**	**Ratio (BiH=1)**
Population	505,700,000	8,747,000	3,829,000	EU:132 Austria: 2
Labor Force	243,200,000	4,420,178	1,462,130	EU:173 Austria: 3
GDP per Capita	34,300 $	50,546.7 $	4,661.8 $	EU:7 Austria:12
Resources Available	Since EU 28 countries most are high Very Low: Oil, Gas	High: Water, Iron, Lead, Zinc; Low: Oil, Gas	High: Water, Coal, Iron, Wood	
Resource Consumption	60-110 t\p\a	80- 150 t\p\a	No Data Available	
Data Availability	Moderate to High	High	Low	

As we can see from the tables and if we take into the consideration the analysis of the paragraphs above, we can conclude that the primary goal of waste management for the EU, Austria and Bosnia and Herzegovina is the same. This can be said for the other goals for Austria and the EU. Basically between the goals of the EU and Austria there are no differences and the goals are matching.

If we look at the criteria used for the comparison of the goals such as population and the percentage of the labor force, the numbers are in same proportion for all three. The high numbers of resource consumption per person per year for Austria and EU is due to fact that high part of this consumption is in the stocks. These anthropogenic stocks can reach quantities similar to natural reserves (Brunner and Rechberger, 2002). The biggest differences we can see with the GDP per capita. Austria has the highest GDP per capita, while Bosnia has by far the lowest amount. If we take into the account also the energy dependence and especially the importance of energy resources for developing country and the fact that they can't afford modern technologies, we can see why a using waste for energy production is clearly stated for Bosnia and not for EU and Austria. The goals of

waste management should be universal for the countries, but the differences are in the means, which can depend on a lot of factors. With the more limited financial possibilities, it is reasonable to expect differences in Waste Management between Austrian and practices of BiH presently as well as in the future. This can be also seen by closer look at the EU. EU as a union has both developing and developed countries as its members and therefore the waste management act and goals set by EU are designed to be the goals of all EU members and European countries which want to join the Union. So no matter which economic, social or cultural differences are present between 27 members of EU, the goals of WM are same for all of them.

For Bosnia and Herzegovina, the only goal of waste management is protection of public health and environment. In the Waste Management Act of EU besides the protection of public health and environment, there are two more goals of waste management which are set; resource conservation and aftercare free waste management. Looking at this information, a question arises, weather Bosnia and Herzegovina, as the future candidate and potential member of the EU should define these goals in the law, or just continue to pursue the goal of protection of public health and environment?

This is not only the question of Bosnia and Herzegovina, but a general question on environmental policies and state intervention in the market. It is questionable whether the current policies and means are the most effective in preserving the environment. Today, environmental policies in waste management are based on assumptions such as that considerable economic growth can be achieved without extensive and large use of resources and that political power and will is enough in order to create best environmental policies. This is disputable and it is questionable to which extant government and politics can help environmental protection. Some of the reasons why socialist countries underwent economic collapse are heavy involvement of state in the market, no private property, state owning of resources and bureaucracy. Nevertheless, traces of these social policies are still present in current environmental policies (Smith and Jeffreys, 1993). The cost of waste management can be high and depending on the policies, it can reduce the economic performance as well as to higher the costs of living

and reduce purchasing power. An alternative to these policies is free market environmentalism. According to this approach the use of free market including its institutions, property rights, common low and voluntarily exchange is enough in order to protect the natural resources. Property rights on the resources alone will be enough to create incentives to preserve the value of them. According to Anderson and Leal: "*Discipline is imposed on resource users because the wealth of the property owner is at stake if bad decisions are made… Human ingenuity is switched on by market prices that signal increasing scarcity and provide rewards for those who mitigate resource constraints by reducing consumption, finding substitutes, and improving productivity"* (Anderson and Leal, 2001). In other words, free market itself and the laws of supply and demand are enough in order to protect the natural resources. The laws that govern free market are natural laws and completely unbiased, while current environmental policies are created by governments. It is not realistic to expect that when creating environmental policies, the policy makers will set aside their personal interest and therefore it is justifiable to be skeptic about EU environmental policies, such as hierarchy of means for example. How can a certain hierarchy be universal for a waste management in any country? Why is this approach favored more than case to case approach which Bosnia and Herzegovina has? Dynamic evolutionary processes lead to adaptation and ignoring the need for adaptation is contrary to natural processes and environment itself. Market failures do exist and happen and mostly this is the argument for the necessity of state intervention. On the other hand these failures need to be examined in detail to be sure that intervention is really needed and suitable for remediation.

Finally, Bosnia and Herzegovina is a developing country, with an economic growth which has been considerably slowed after the World economic crisis. The state of economy had been changing back and forth between recession and small growth for past 5 years (World Bank, 2015). My personal opinion is that resource conservation should not be a priority of WM system in Bosnia and Herzegovina, since the economy of country needs to grow and it is questionable should it be goal of any WM system at all.

IV. THE LEGISLATIVE FRAMEWORK

1. Introduction

In this chapter an overview of the legislative framework for Austria and Bosnia and Herzegovina concerning the WM will be done. Austria is a member of EU, so framework directives on Landfills and Waste management are corresponding to the laws which Austria has on WM and Landfills. Therefore, for Austria in this chapter Abfallwirtschaftsgesetz (2002) and Deponieverordnung will be viewed and analyzed. For Bosnia and Herzegovina since there is no law on the state level, the WM laws on the entity level are going to be analyzed and the regulation on packaging and packaging waste. Analysis of most important articles and parts of these regulations are going to be used to support the identification of goals of WM as well as to provide better understanding of the WM systems and their targets.

2. Criteria for Comparison

As with the goals of waste management, for the comparison of the legal framework of Austria and Bosnia and Herzegovina, certain criteria needs to be defined, which will reflect the legal framework and it importance in fulfilling the tasks of Waste Management. Besides these criteria, analysis of the most important legislations concerning WM in Bosnia and Herzegovina will provide the understanding of legal framework and there for enable easier comparison. The criteria need to cover all the points in the legal systems that are concerned with the waste management. Only with this approach and review of the main legal documents, a complete understanding of this part of WM will be achieved.

Having this in mind I have decided to choose 4 criteria for the comparison. These criteria include:

- Waste Management act\law
- Acts and directives on WM

- Structure of the legal system
- Legal entities concerning WM

Waste management act\law- In order to have an effective waste management system it is absolute necessity for every country to have a State law or an act which concerns Waste Management. This law is needed most importantly to define the goals and means to achieving these goals clearly. Waste management law sets the procedures on implementing and enforcing the law, and it is concerned with the transport, storage, treatment and generally all the aspects of waste management. It is also important because it gives the definitions of waste and all the types of waste. For an existence of any kind of proper WM system this law is absolutely essential

Acts and directive on WM- Waste management law needs to be supported by other directives acts, which are in harmony with the law. This acts and directives concern and regulate aspects of the WM which are defined in the law, but in much more detail and therefore are important aspects of legal framework concerning WM.

Structure of legal system- This criterion is concerning the legal system in general. It is about complexity of legislative system, lawmaking and constitution. Overlook of the legal structure not only of WM but of the whole country. This type of criteria will help understand the environment in which laws concerning WM exist.

Institutions- Besides the certain laws, acts and directives, in order for the country to have and efficient WM system, there is a need for certain legal bodies which are responsible for the WM in that country. By institutions, it is meant the bodies which enforce, govern and monitor the WM system in the country. There are not directly concerned with the lawmaking, but their existence is defined by the law and they are an important for WM operations and strategies.

3. Austrian Legislation

3.1 Waste Management Act (2002) (Abfallwirtschaftsgesetz)

This is the most important law regarding WM in Austria. The law is divided into 10 main sections which have all together 91 articles. The first section is concerning general provisions of the law. The goals of WM in Austria are defined in this section and clearly stated in Article 1 (1). Also, besides the goals, the means are defined, and it is explained that they are structured in the hierarchy similar to the hierarchy defined in the EU framework directive on waste. Besides laying out the hierarchy in this article, the law acknowledges the downsides that strict adherence to this hierarchy might have for the environment. So, it also lays down in paragraph 2a which considerations have to be taken into account when deciding to apply the hierarchy, especially in terms of recycling. Article 1 also recognizes the importance of collection, transport and disposal and gives the exceptions to when it is not in the public interest. Article 2 states the most important definitions required for waste management. Waste as such cannot be defined universally and generally, and it has to be looked from a case to case point of view. Therefore, in paragraph (1) two different types of waste definitions are stated: subjective and objective. The first category of waste definition is a subjective definition, which is waste to discard. The term "to discard" refers to certain objects or substances which are abandoned, because they do not serve a purpose anymore. Subjective waste has no monetary value anymore; no charge can be obtained from this object or substance. On the other hand, under the objective definition of waste the criterion is public interest. So weather a certain type of object or substance falls into this definition of objective waste is determined based on weather that object or substance poses a threat to the environment and public health in any of the stages of WM. Another criteria for object to be defined as waste under Austrian law is to be movable. So if the object is movable and it is intended to be discarded or may pose a threat for environment and it is in the public interest to define it as waste then the object or a substance is defined as waste. It should be noted that for object or substance to be waste it has to fall into the category of waste defined in Annex 1 which corresponds to the groups of waste defined in the EU framework directive. In paragraph (2) MSW is defined as

"waste from households and other waste which because of its nature and composition is similar to waste from private households". Article 3 sets the exclusions from the scope of the law while Article 4 deals with the types of waste. In the section 2 the goals of sustainable waste prevention are defined as to trough all stages of sustainable production, distribution, development of appropriate products and waste conscious consumption of the product in order to contribute to sustainability and reduce the pollution. Fourth section defines responsibilities and obligations for the waste holders, fifth the waste collection and processing, while in the sixth the waste treatment plants are defined. The rest of the sections are regulating trans-boundary transport and shipments of waste, treatment orders and transitional provisions, which apply to landfill ordinance too and finally section 10 is on final provisions.

3.2 Landfill Ordinance (Deponieverordnung)

Landfill ordinance from 2008 consists from 8 main section and 49 articles. The goal of this ordinance is defined in Article 1 and it is stated that the purpose of this regulation is to establish operational and technical requirements relating to landfills and waste policies and procedures that are used during the whole life of the landfill. Also another goal is to avoid and reduce as much as possible the negative effects of the disposal of waste on the environment, in particular the pollution of surface water, groundwater, soil and air, and global environment, including the greenhouse effect, and all associated risks to human health. Article 2 lays the scope, while Article 3 includes the definitions for the terms such as waste streams, charges or disposal phases.

Article 4 in the section 4 defines the classes and subclass of landfill as:

1. Excavated soil disposal site

2. Inert waste landfill

3. Landfills for non-hazardous waste:

   - Residual waste landfill

   - Mass waste landfill

- Demolition and construction waste landfill

4. Landfills for hazardous waste

These 4 classes are different in the structure and technical characteristics, but most importantly by the waste to which is allowed to be disposed on each of it. Article 5 deals with this system and it is defined by each single class and subclass what type of waste is allowed to be disposed. In short notes; hazardous waste only to landfills for hazardous waste, inert waste only to landfills for inert waste and non-hazardous waste and municipal solid waste to landfills for non-hazardous waste. Article 7 deals with the landfill bans and prohibition of disposal certain substances and objects. There are in total 11 categories of waste which are banned from disposal on landfill. Some of such wastes are flammable waste, wastes with high TOC percentage, used tires, explosive waste etc. Section 4 determines the waste deposition procedures and defines monitoring and control of the inputs and streams on the site. Articles in the Section 5 deal with the requirements for a landfill site as well as the investigation procedures. Article 21 for example states the criteria for location of landfill. Section 6 defines landfill technology, while section 7 deals with landfill operations such as personnel, facilities, emission control etc. (Österreichisches Parlament, 2008)

4. Legislation in Bosnia and Herzegovina

The unique structure of the state which was defined during Dayton Peace Accords in 1995 divides the states into two entities and one District. One of the entities, the Federation of Bosnia and Herzegovina, is divided into 10 cantons. For this entity, the legislative authority is the Parliament of the Federation of BiH, while for the other entity it is the National Assembly. Also, each of 10 entities has its own government, constitution and legislative power. All together there are 13 constitutions in the state. At the end there is a constitution on the level of state and state parliament of Bosnia and Herzegovina (Council of Ministers of BiH, 2015). From this we can see how the system is complicated and why the adoption of laws on the state level is a slow process or some of the laws state only on the entity levels. In fact, Waste Management Law is not adopted on the state level. By the Constitution of Bosnia and

Herzegovina, Article 3 paragraph 3, all the government functions which are not defined by the constitution are under the jurisdiction of entities. Waste management is one of them. The content of the Entity Laws on Waste Management in terms of means, goals, definitions etc. is the same, the only difference is how the responsibilities in terms of overlooking, planning, issuing permits and management of utility services.

4.1 Waste Management Law

The law on waste management for each entity had been adopted in both entities in 2003. The Law in the Federation consists of 60 articles, while in the Republika Srpska of 61 Articles. In the laws Article 1 defines the scope of the law and excludes from it radioactive waste, gasses which are emitted to the atmosphere and waste water. Article 2 sets the goals of Waste Management in each entity, which are the same and clearly defined and explained in the previous chapter. In Article 3 the means which are available for reaching the goals from Article 2 are set. They include:

Minimum generation of waste, especially minimizing the characteristics of such waste

Minimizing the quantities of waste generated, taking into account the waste flows

Treatment of waste in such way to guarantee recovery of raw materials from it

Burning or deposition on landfills in an ecologically acceptable way of the types of waste which cannot be used for raw materials, reused or used for energy recovery

Also there is no hierarchy stated for these means, but the criteria for priorities for these means are defined as depending on ecological benefits, technical feasibility for using the best available technique and economic feasibility. Article 4 in both entities sets the most important definitions for WM, and these definitions are absolutely the same in both laws. Waste Management is defined as a system of activities and actions which are related to waste including prevention, minimization of quantity of waste, treatment and disposal, collection and transport, monitoring and control and all other activities. Waste is defined as all substances or objects which the owner disposes, has an intention to dispose or is asking to be disposed in line with one of

the categories of waste from the law. Also Municipal Solid Waste is defined as a waste generated in households or other waste which has similar characteristics to those from households. Besides MSW also Inert, Hazardous, Non Hazardous waste are defined as well as other aspects of WM such as landfills, operators, producers etc. are defined. Article 5 sets basic principles of WM in Bosnia and Herzegovina and they are:

Prevention

Safety Measures

Responsibility of producer

Polluter Pays principle

Closeness

Regionalism

The inter entity body for protection of environment is responsible for the coordination and harmonization of the entities strategic plans on WM, but only if the responsibilities are transferred to the body from the entity governments. Later Articles deal with the responsibilities within the entities as well as the principles from the Article 5 in detail. Article 30 of the FBIH law and Article 37 of the RS law state that waste has to be collected separately, with the need of future treatment. Waste disposal options are allowed to be landfills, thermal disposal and other chemical and biological disposal processing.

Since there is no law on landfills in either entity or district, there is only one article which covers landfills. Actually, it only covers the content of the permits for landfills. This is Article 34 or 41 and it defines three classes of landfills: for hazardous, non-hazardous and inert waste. Also, it includes some of the responsibilities of the landfill owner. Besides this and the definition of landfills in the Bosnian legislation, there is nothing else regarding landfilling. Other articles define the inter-boundary movement of waste and the ban the import of waste in Bosnia and Herzegovina for the purposes of disposal (Narodna Skupstina Republike Srpske, 2003).

4.2 Regulation on Packaging and Packaging Waste

I have chosen this regulation, because it is the only regulation in existence concerning the waste besides the regulation on categorization of waste, which basically lists the categories and names of different types of waste. Like with the law on WM, this law is not adopted on the state level, but only on the entity level. Nevertheless the content is the same again; the only differences are the responsibilities of the different bodies within the entities. The regulation sets the rules in production, consumption, treatment and disposal of packaging waste. This regulation is in harmonization with the EU directive on Packaging and Packaging Waste. The Articles 11 to 14 of the regulation define the packaging materials, as well as responsibilities within the system of packaging waste management. Some of these responsibilities which include operators, producers etc. are to be included into the packaging waste management system, organization of space for receiving, collection, separation and temporary storage of packaging waste etc. Also, Article 20 obliges the operators of packaging waste to report to the public on all aspects of PWM. Other provisions and articles are regarding monitoring and penalties in cases of noncompliance.

5. Results

Based on the criteria and the analysis from this chapter I have comprised a short summary table which shows the comparison of the Legal framework based on these criteria.

Table 3. Comparison of Criteria for the Legal framework

	Austria	**Bosnia and Herzegovina**
Waste Management act\law (State Level)	Yes Waste Management Act (2002)	No Separate Waste Management Law for the entities
Acts and directives on WM	Large number of laws and directives concerning different waste and waste treatment exist	Small number of acts and directives
Structure of the legal system	Federal State Complex System	Decentralized State Complex system
Institutional framework concerning WM	Within Federal Republic and Provinces	Within Two entities, District, 12 Cantons

Waste Management act\law- In Austria a Waste Management Act from 1990 and revised in 2002 sets the goals, means and define the other aspects of the waste management in the state. On the other hand Bosnia and Herzegovina does not have an integrated WM system; there is no law on the state level. State is divided into two entities (Republika Srpska and FBiH) and District Brcko. According to the constitution, all of the matters which are not stated in constitution are under jurisdiction of the entities. WM falls under that jurisdiction and therefore, in Bosnia and Herzegovina there are 3 laws on WM inside those three bodies. This as a consequence has a much more costly system due to the big number of bodies within the entities and huge administration, which are inefficient due to complexity and finally data availability is low.

Acts and Directives on WM- In Austria there are numerous directives and acts, which concern WM. Landfill ordinance, WEEE ordinance, Packaging Ordinance are only some of them. There are more than 30 of these ordinances (Lebensministerium,

2011). On the contrary, in Bosnia and Herzegovina there is a low amount of regulations concerning WM. Again they are all under the authorities of the entities. There are 6 ordinances concerning Waste: Ordinances on the categories of waste, medical waste, electronic waste, packaging waste, animal waste, management of waste incineration plants.

Structure of Legal system- Austria is a Federal state which means it is composed of 9 Federal Provinces. The legal powers are shared between the Federal government and the governments of the Provinces. In reality, all of the major legislative powers and governance is held by the Federal government, while only some of the powers are held by the Provincial Governments. Nevertheless there are 9 waste management acts. In terms of waste management, it is mostly waste management of nonhazardous waste. As said, Bosnia and Herzegovina is divided into three units. Additionally, the Federation of Bosnia and Herzegovina is divided into 12 Cantons which also have their governments and legislative powers and in this sense it is pretty similar to the Austrian Federal Provinces. But in general, the legal system is complicated and unique.

Institutions concerning WM- For Bosnia and Herzegovina there are a big number of institutions. Besides the Entity Ministries for environment, there is a inter entity coordination body for WM, which is defined in the Waste Management Laws of both entities (Article 41). This body has a task of coordinating WM between the entities. Furthermore there are different institutes with the task of inspection and collection of data, other ministries and funds for the protection of environment. For Austria, the enforcement of the AWG 2002 is done by the Federal Ministry of Agriculture, Forestry, Environment and Waste management and the provincial governments. The collection and transportation of the municipal solid waste is organized by individual WM acts and it is under the authority of the city or the municipality. Each of the provinces has its own institutions and departments which are responsible for certain tasks of WM. Most of the data concerning waste flows is collected through surveys done by the Federal Ministry of Agriculture, Forestry, from the offices of the provincial governments, from documents of the Austrian administration, technical studies, by Economic Chamber of Austria and the Austrian Central Statistical Office (EEA, 2015).

V. WASTE MASS FLOWS IN AUSTRIA AND BOSNIA AND HERZEGOVINA

1. Introduction

As we can see from the previous chapters, differences exist between Bosnia and Herzegovina and Austria in legal framework as well as to some extent in the goals of waste management. Based only on these differences, it is impossible to overlook and understand the real state of waste management in both countries and to compare their waste management between them at all. The First chapters provided a framework outlook which shapes the system itself, but does not tell enough about the current state of the system. To understand the current state of the waste management system in both countries, all aspects of the waste itself in the country need to be monitored and evaluated. For simplification of the thesis, only Municipal Solid Waste will be taken into account for this thesis. The best approach to these analyses is trough analysis and the comparison of the waste flows in the two countries. For this chapter, an in-depth analysis of Waste Mass Flows in Bosnia and Herzegovina and Austria will be done. This includes the criteria which will be set and defined in order to compare two waste flows and a brief overview of the main treatment and disposal options that are encountered in the flow of waste. The data collected on the waste mass flows will be presented in the MFA using the diagrams from software STAN. After the data is presented and explained for both countries, it will be summarized and compared. At the end of the chapter, hopefully this approach will provide an understanding of the waste flows, their differences and waste management of two countries in general, which will later serve as the basis for the identification of pros and cons of waste flow for both countries.

2. Overview of options for waste treatment and disposal

Again for the overview of the options for the waste treatment and disposal, a short review of the Waste Management Act of the EU has to be done. There two important definitions are written down.

Waste is defined as: "*waste' means any substance or object which the holder discards or intends or is required to discard".*

Waste Management is defined as: "*waste management means the collection, transport, recovery and disposal of waste, including the supervision of such operations and the after-care of disposal sites, and including actions taken as a dealer or broker".*

These two definitions provide the essential understanding of waste. Waste as a substance or an object is discarded, but it is still well present in our everyday lives. Like anything that consists of matter, waste can only change its state, react with other substances, decompose, but never disappear. It has a flow and it is carried through the system called a waste management system. Waste can only be reused, treated or discarded. Therefore in any flow of the waste certain treatment and disposal options are essential and they utilize the efficiency and shape waste management system of the country. For this brief overview, I have chosen to explain and define the processes, such as incineration, separation collection and recycling, biological-mechanical treatment and landfilling.

1.1 Separate collection and Recycling

Separate collection of MSW is one of the most important steps in the treatment process of waste and in the flow of waste in general. Separate collection makes easier diversification between glass, metal, paper and some other materials, which is important for recycling and other treatment options. Trough separate collection, a lot of time and costs are saved. It is a precondition for the optimization of waste treatment and recycling. Recycling is a central part of means of waste management and the EU waste hierarchy. With recycling all three major goals of waste management can be fulfilled. The biggest impact it has is on the resource conservation. With recycling materials are reused, and there is no need for new resource consumption. Trough recycling, the time of materials and substances is

prolonged, but again, all of these materials will eventually end up on landfill. Due to the laws of thermodynamics, recycling is not a final solution but an important step in waste management (Brunner and Rechberger, 2002). Also when talking about the recycling, energy required for the process and costs need to be taken into the account as well as the concentrations of certain elements. As an example in Practical Handbook of MFA it was stated that recycling can enrich the concentration of heavy metals in recycled plastics.

1.2 Mechanical-biological waste treatment

Mechanical biological waste treatment basically consist of two main stages; mechanical separation of waste and biological treatment of a fraction of the separated waste. Waste can be separated in numerous ways, some of them are: eddy current separation, magnetic separation, air separation, trommels and screens etc. When it comes to Biological treatment, there are 3 key options, which are mostly differed by the presence of air. These options are:

1. Aerobic Decomposition (composting)

2. Anaerobic Decomposition (digestion)

Each of these options has its own specific applications and is used in different methodologies (UK Goverment Department for Environment, Food nad Rural Affairs, 2013). There are four main objectives of MBT. The First objective is the mast reduction which can be to around 30% mostly due to the high water content that waste treated this way has. Another objective is to reduce the reactivity of certain substances and compounds which can be found in the waste such as ammonium etc. Separation enables selective energy recovery. And last the objective, which contains an important aspect of WM, is low costs. For effective MBT, costs need~~s~~ to be pre-calculated precisely. Unlike incineration, MBT does not oxidize organic hazardous substances and because of this, products of MBT must be further treated. So MBT might have a low cost, but in order for waste to remove hazardous organic substances from waste it is not enough and additional treatment costs should be taken into account.

1.3 Incineration

Incineration represents a waste treatment option in which as the name states the organic substances in waste are incinerated. When it comes to the Municipal Solid Waste, the primary goal of incarnation is complete oxidation of hazardous organic substances. Energy recovery and the reduction in the amount of waste that is deposited landfills are additional aspects and advantages. Waste to energy (WTE) plants are designed in specific way, which enables combustion of waste for the purposes of energy recovery. A Typical incineration plant consists from the furnace, boiler, electrostatic precipitator, air pollution control and stack. In the Incineration, the heat is produced by combustion of waste; this heat can be used for production of electricity and district heating. For example, the Spittelau Incineration Plant in Vienna annually produces 40 GWh of electricity and 470 GWh of district heating (Wien Energie, 2015). On the other hand, besides energy recovery during the incineration process a lot of residues are created. Main residues from the Municipal Solid Waste include:

1. Bottom Ash - consisting of non-combustible materials, 25% of original waste input

2. APC residues – may be in solid, liquid or sludge form, 10% of Bottom ash or around 2.5% of original waste (Sabbas et al, 2001)

1.4 Landfilling

Landfills are sites on which waste is disposed. This is the end point of waste flow. It is the least costly option and therefore the most used one in the World. All the countries eventually deposit waste on the Landfills, but there are a lot of differences between landfills and landfilling processes in general. First of all, the waste that comes to landfills can be pretreated which also differs to which extend is treated and not treated. Also there are different types of landfills and landfill processes which differ by the degree of complexity and level to which they are efficient in achieving the goals of WM.

These include:

-Open dumping

-Controlled dumping

-Engineered landfill

-Sanitary landfill

-Sanitary landfill for pre-treated waste

-Final storage landfill

The most effective options are on the bottom of the list, while the least effective are the open and controlled dumping. Least developed and some developing countries almost completely rely their WM system on the first and second option, since they are the cheapest. In reality, this kind of system can be dangerous since not only landfills emit GHG, but also leaching can occur and various types of contaminations, such as ground water contamination etc. The Most advanced landfill systems have prevention and treatment methods such as leachate collection systems, percolating filters, bio filters etc.

3. Criteria for Comparison

In order for the WM systems in Austria and Bosnia and Herzegovina to be presented and compared, certain criteria need to be defined. By using these criteria presenting and evaluating of current state of waste management will be done. The starting points for me in the process of choosing the criteria are goals of waste management. The best approach to evaluation and comparison of WM systems is to examine to which extent it fulfills its goals. Three universal goals of WM had been written in the previous chapters and they include protection of public health and environment, resource conservation and after care free waste management. Protection of public health and environment implies general reduction in the amounts of waste generated, and a proper treatment of waste, especially hazardous waste and substances. Resource conservation implies reuse and reduction of the amount of resources that are used. Finally, the goal of aftercare free waste management considers the reduction of hazardous substances in the future, their circulation and proper landfilling, which will not be dangerous or make consequences for the future generations. To present waste management systems and compare them, it is the best to follow the path of the waste. This means that trough the generation of MSW until

its deposition the whole cycle is monitored and presented. This way we can see all the stages of MSW and how it is treated, weather there is a potential or a possibility for it to have an effect on human health or environment. Also we can see to which extent the resources are used, recycled and how much energy is produced trough waste management system. Finally we can compare the WM systems and see to which extent they differ in fulfilling the goals of WM.

With this having in mind, I have decided to use only one criterion for presenting and comparing the WM systems of Austria and Bosnia and Herzegovina. This criterion is the Material Flow Analysis.

Material Flow Analysis can present a lot about the waste management system. It shows the path of MSW from the generation until the disposal. In this path it includes all the stages that waste can possibly undergo such as collection, different types of treatment, recycling and disposal. Also the amounts of waste at each stage are presented giving an insight into the structure of the system. Material flow analysis will provide a skeleton of the waste management system; depict its composition and help get the general idea of how it works. After the mass flow analysis, not only the structure of the system will be presented but also the quantifiable amounts of waste that flow through that system. With the quantitative data and the general view of the system, the understanding of the current WM systems of the countries should be possible. Also, amounts of waste can be compared then, on which basis economic and other analysis can be done. This way positive and negative sides can be identified and it is possible to make recommendations for the future of the WM system in both countries.

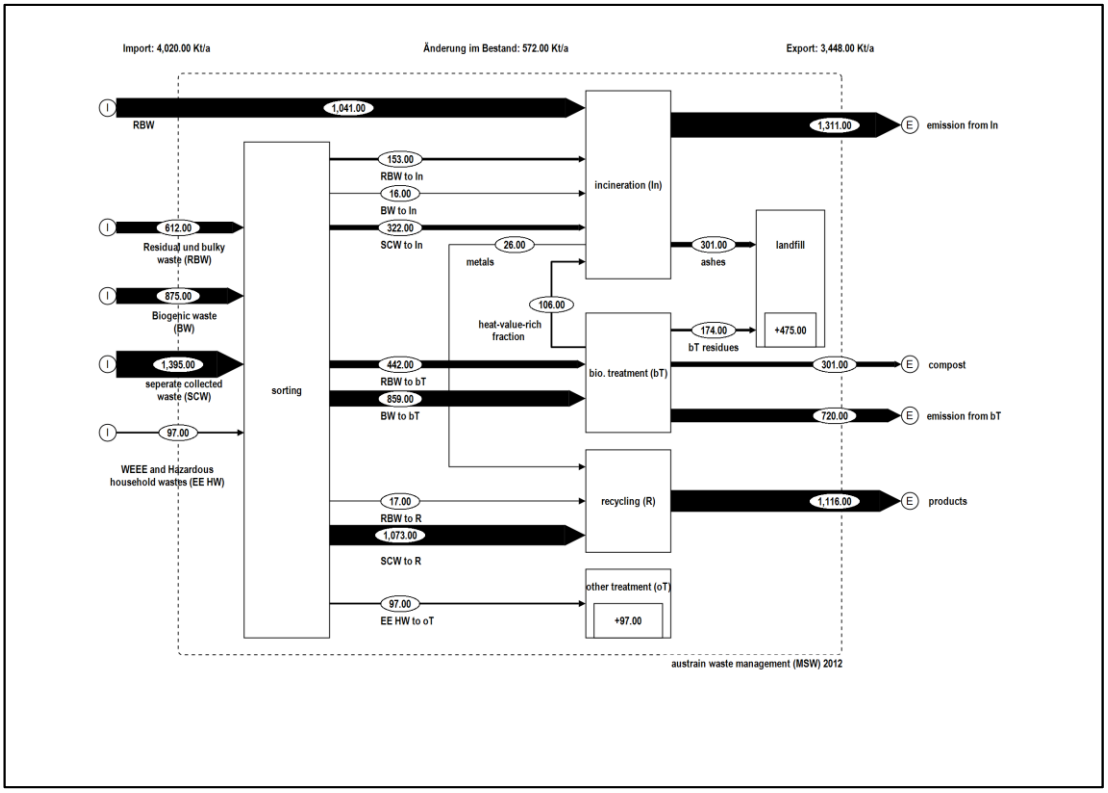
4. Mass Flows in Austria

Austria as a developed country has an advanced Waste Management System and it is one of the pioneers of WM in the European Union. Before presenting the MFA for MSW, I will briefly write down a summary of main practices and trends of Austrian waste management in the past.

If we look at the past data on the municipal solid waste, we can see that most of the treatment options are available. Also, Austria has a long tradition of diverting MSW from the landfills and it is one of the most efficient countries when it comes to other treatment options like incineration and recycling. For the past 10 years, the trend of MSW generation had been stable and subject to a small percentage changes which usually vary within few percent increase and decrease. In terms of recycling, Austria has had the highest rate of recycling in the past years with the overall recycling rate of 55% to 63%, which was measured in 2010. No country in the EU has been able to reach such high rate of recycling. Also, this high rate trend of recycling has been generally stable with a small increase throughout last ten years. With having this in mind we can see that Austria has already fulfilled the goal set by the EU´s Waste Management Act in which, is stated that countries should have a recycling rate of 50% by 2020 (EEA, 2013). In terms of incineration, Austria has 3 plants which are specifically designed for MSW. These three plants are: "Spittelau" with a capacity of 260 kt\y, "Floetzersteig" with a capacity of of 200 kt\y, which are located in Vienna and one in Upper Austria which has a smaller capacity of around 60 kt\y (FEA, 2002). If we look at past trend of Landfilling, we can easily notice that the amount of MSW that has been deposed on the landfills has decreased by 28% from 2003 to 2010. Generally the trend was an increase in incarnation and energy recovery from the MSW, while the amount of MSW disposed on landfills had annually dropped and in 2010 it had only constituted to about 7% of the total MSW.

Now we can look at the Material flow analysis of Municipal Solid Waste in Austria from the 2013 annual report of the Austrian Ministry of Environment based on the data from 2012.

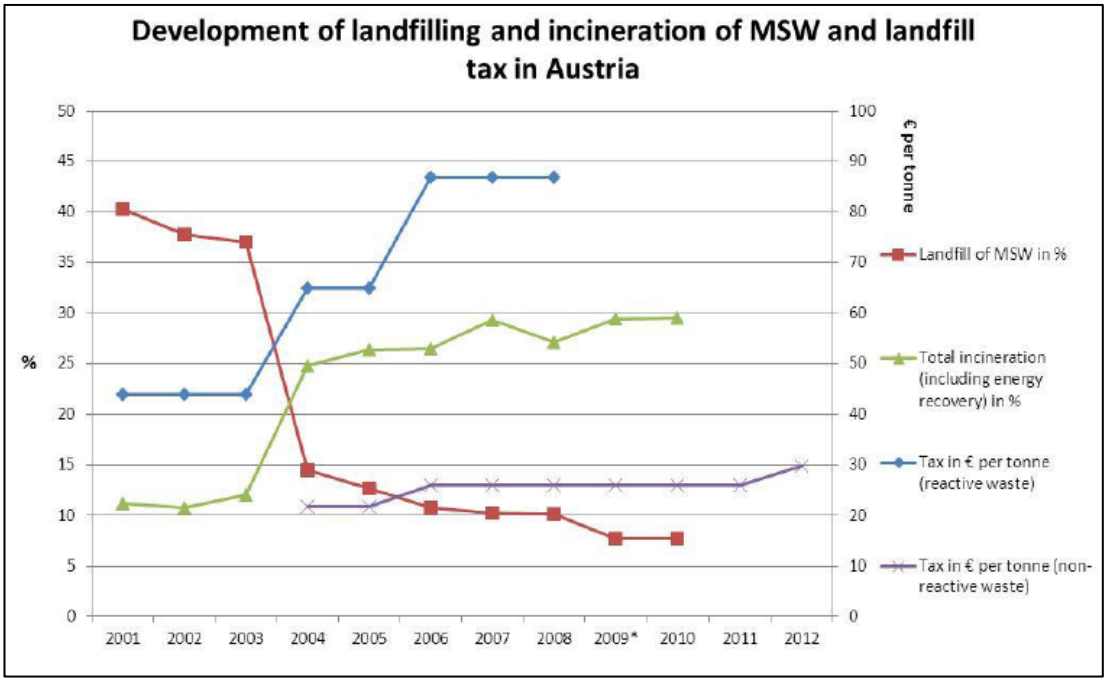
Graph 1 - Material Flow Analysis – Austria (Allesch, 2014)



As we can see on the MFA diagram above, the trend that had been present in the past years, continues. According to the data from 2012, all together 4,020 kilotons of MSW were created in Austria. That is a slight increase in comparison to 2010, when this number was 3,895 kilotons. By far the largest portion of the waste is from the Residual waste and Biogenic waste. Two thirds of the residual waste combined with the bulky waste goes directly for incineration, while one third is sorted and sent for the further treatment. Besides residual and bulky wastes which go directly for the incineration, all other MSW types are sorted before the treatment. Another big group of MSW as we can see on the MFA comprises the separately collected wastes which consist of paper, glass, plastic, textiles etc. If we look at the number of the waste deposited on the landfills we can see that it is 475 kilotons which is around 11% of the total MSW. This is an increase compared to the level of 2010. Almost 65% of the waste disposed on landfills is from the ashes after incineration.

Below we can see the graph of the percentages that are incinerated and percentages of MSW disposed on the landfills (EEA, 2013).

Chart 1 - Development of landfilling and incineration of MSW and landfill tax in Austria



If we take a look at the graph above we can see the total percentages of MSW that has been incinerated. Possible increase in the rate of incineration and the ashes disposed to landfills might explain the increase in the amount of MSW that is disposed in landfills.

We can see that the flow of MSW is much diversified and it includes mechanical-biological treatment, incineration, recycling , other treatments options and that most of the waste is either recycled or in the forms of emissions after the treatment. Another data that shows development of WM system in Austria is the high level of recycled MSW. Separately collected waste is 35% of the total MSW. From these 35% more than 75% is recycled and the rest is incinerated. These are high percentages and they show how separated collecting of waste is important in fulfilling the goals of Waste management. Biological treatment is another important aspect of the WM in Austria. Large portions of residual and bulky and biogenic waste undergo this treatment. Further on 23% of the MSW that has undergone biological treatment is used for composting.

We can see from the MFA of MSW in Austria that all of the collected MSW is treated before disposed. Low amounts of waste are deposited on the landfill and most of the waste is recycled. All of the other waste is used for energy production and is emitted as clean, pretreated gas. This way, we can see that Austria is fulfilling the goals of waste management both set by the EU and Austrian waste management act and it can be recognized as a good example and one of the pioneers in waste management.

5. Mass Flows in Bosnia and Herzegovina

As mentioned in the previous chapters of the paper, one of the consequences of a complicated legal system is the lack of precise data. There are no clear records of the data for the past, and data on waste flows in the period since after the Bosnian War until the adoption of Waste Management Laws practically does not exist. All of the data that will be presented in this subchapter will be based on estimations, since all of the official data from the Federal Ministry for environment and ecology is based on the estimations.

Collection of Waste is under the authority of the municipalities. There, another problem arises, because none of the municipalities has a beam scale in their possession and the waste which comes to the landfills is not evidenced.

Nevertheless, I will give a brief overview of the data collected. According to the Federal Plan of Waste Management Strategy in Bosnia and Herzegovina there are around 552 evidenced illegal landfills in the whole country (340 in the Federation and 202 in the Republika Srpska). According to the same source, on the legal landfills, almost all of the waste is deposited. This includes MSW, medical, animal, industrial hazardous and nonhazardous etc. Almost all of the landfills are not sanitation landfills.

The Federation of Bosnia and Herzegovina has a population of 2 327 318 people, while Republika Srpska 1 433 038. It is estimated that annually in the Federation of Bosnia and Herzegovina 1,07 kg\apartment\day of waste is created. For the Republika Srpska, the estimation is that 0,76 kg\apartment\day of waste is created.

I have prepared a table which shows the amounts of MSW collected based on the data from the Institute of the Statistics of the FBiH and the Republika Srpska Institute of Statistics from 2011. This is the official data as presented in the reports.

Table 4. Municipal Solid Waste collected in Bosnia and Herzegovina (2011)

	Federation of Bosnia and Herzegovina	**Republika Srpska**	**Bosnia and Herzegovina**
Separately Collected Waste (Kt\a)	97	1,6	98
Waste from Gardens and Parks (Kt\a)	25	6,3	31
Other MSW(Kt\a)	599	241	841
Packaiging Waste (Kt\a)	6,1	0,4	6,5
Total Amount of collected Waste (Kt\a)	728	250	978

Table below shows the total amounts of MSW disposed in Bosnia and Herzegovina.

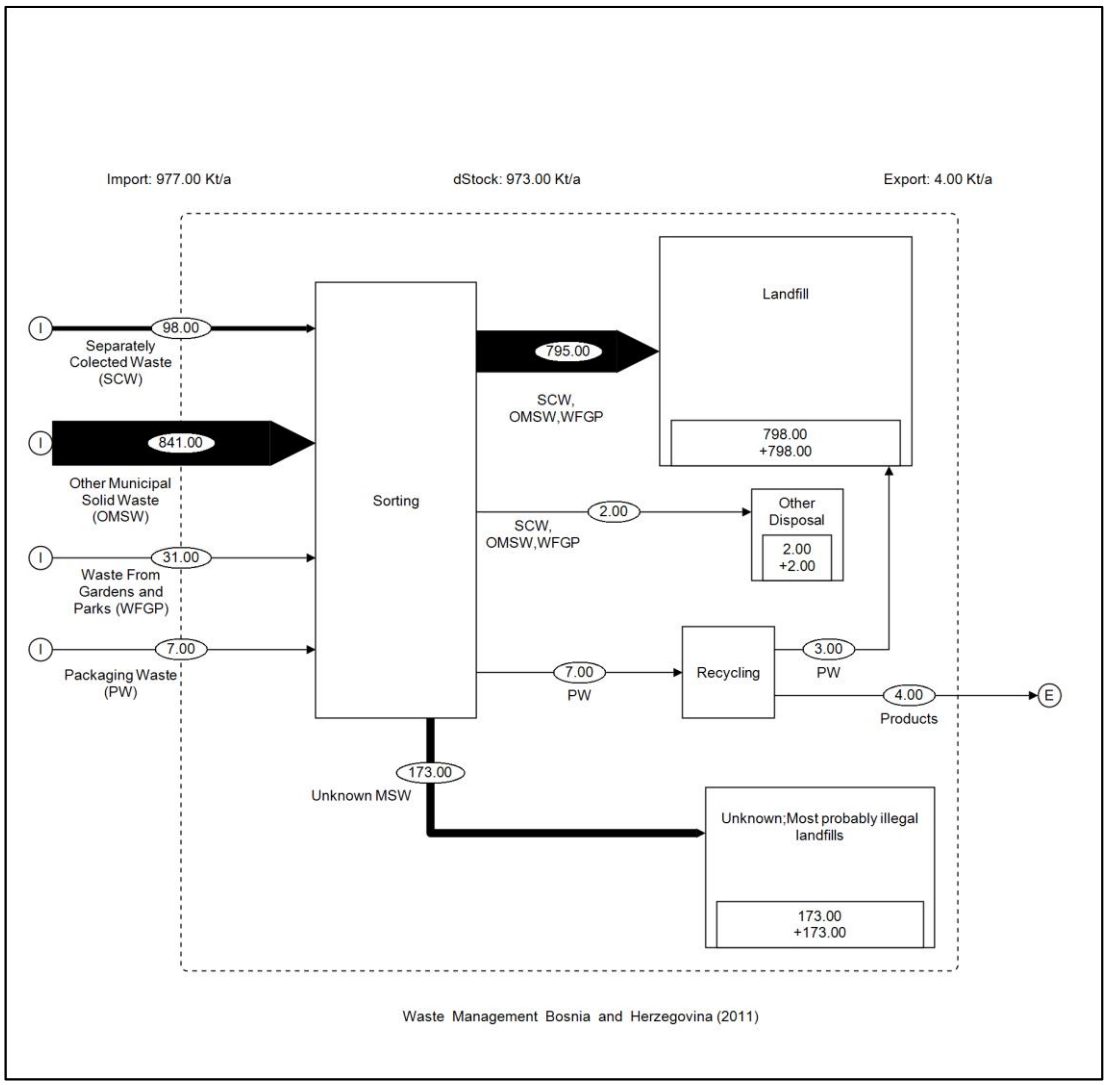
Table 5. Municipal Solid Waste disposal in Bosnia and Herzegovina (2011)

	Federation of Bosnia and Herzegovina	**Republika Srpska**	**Bosnia and Herzegovina**
Total Amount of Disposed Waste (Kt\a)	516	286	803
Landfill (Kt\a)	512	284	797
Other Disposal Options (Kt\a)	1,6	0,07	1,6
Recovered Waste (Kt\a)	2,4	1,6	4,1

It should be noted that the MSW produced in the District of Brcko is collected by local authorities, but it is disposed in the Republika Srpska and this why the amount of disposed waste in the RS is higher than amount collected. Furthermore, the Republika Srpska Institute of Statistics gives the estimation of number of MSW produced, which is 376 kt\a. That means 66% of the waste produced is collected, transported and disposed legally (Republika Srpska Institute of Statistics, 2012) There is no data for the Federation, but in the Federal Plan for Waste Management strategy, it is estimated that this percentage is somewhere between 63-70%. Therefore, I have decided to take the mean value of 66,5 % for the Federation and then total amount of waste produced would be 1 094 kt\a.

Based on this data I collected prepared the Material Flow Analysis for the Municipal Solid Waste in Bosnia and Herzegovina.

Graph 2 - Material Flow Analysis – Bosnia and Herzegovina



As we can see MFA is simple. There are not many processes and waste flows are not very diversified. Almost all of the MSW collected is disposed on the landfills. As said before, most of these landfills that are legal and registered and not sanitary landfills. As we can see no waste is pretreated, after collection it is dumped on the landfills straight away. Some of the waste that is disposed on the landfills is burned, but there are no data which would evidence how many tons of waste it is. Also, there is no record on the amount of leaching and the gas emissions from the landfills. A small fraction of the waste is disposed outside of the landfills on other disposal operations. By other waste disposal operations, it is referred to deep injection,

surface impoundment, waste incineration without energy recovery etc. (RSIS, 2012). Another interested data that can be seen on the chart is that from collected waste, around 17% has unknown final destination. This waste is either deposited on illegal landfills or it is simply not measured on the landfills, since as stated previously there are no beam scales. Besides this loss of 174 kilotons, the collection of MSW covers only around 65%, and most of the 35% are disposed on illegal landfills. Only packaging waste is recycled, with around 2\3 of input that become products. The rest of the packaging waste is disposed on the Landfills. As we can see almost all of the MSW that enters the system, stays in the system. These 4,094 tons, which are recycled, are the only amount of waste that exits the system. So from 978 kilotons of MSW that enter the system only 4,09 kilotons exit the system. This is a very large stock and it means that 99,6 % of the MSW stays in the system. This probably is not a realistic number since some of the waste is burned and it is done on the landfills but as stated above there is no record on the amounts of the waste burned. Also there are no incineration plants for MSW in the country. There is a significant amount of waste which is collected separately, but as we can see like with other MSW it is disposed on the landfills. Also, the amount of MSW in the Republika Srpska that is collected separately is low and amounts to just more than 1,5 kilotons. Therefore most of the SCW comes from the Federation. It is interesting that in the Federation significant amount of MSW is collected separately, yet it is disposed together with all other waste. I could not find any strong evidence to why this is happening. The only certain fact is that some of the municipalities have bins for separate collection from the donations and my assumption is that they are used for separate collection and evidenced, but due to no infrastructure which would enable treatment of this waste, it is disposed together with all other waste. Other types of collected waste are mostly in proportion with the total waste collected. When it comes to disposal of the waste, the numbers of disposed waste to different options of disposal are also on proportion between the entities.

6. Results

After presenting MFA charts for both countries, we can compare quantified mass flows between the two countries in order to evaluate whether the current mass flows represent primary objectives of WM in both countries and to which extent.

For both countries the main and the important objective of WM is protection of human health and environment. In order to evaluate to which extent this goal is fulfilled, I will first compare mass flows to the means which are defined in order to reach this objective, compare how effective they are and conclude about the main objective.

Looking at the flows, it is easy to notice that MFA chart supports the identification of 4 main problems for BiH which have been set in the introduction of the thesis. Waste is not pretreated, it is dumped on landfills which are not sanitary, other treatment options like incineration and biological treatment do not exist and a lack of data and evidencing is so severe, that 174 kT disappear from the evidence after the collection.

Compared to Austria, there is a big difference between the amounts of waste that exits or stays in the system. In Austria, only a small portion of the inputs, stay in the system as a stock. It is approximately around 14%. This is a big difference when it is compared to 99,6% of waste which stays in WM system of Bosnia and Herzegovina. This low amount of the waste that stays in the system for Austria shows how developed the WM system is. For developing countries, high rates of waste which stay in the system do not represent a problem or deviation from the goals if waste is treated properly and disposed on sanitary landfills. For Bosnia and Herzegovina it is a problem since the MFA has shown that the MSW is not pretreated and that there are almost no sanitary landfills. On MFA for Austria the origin and type of MSW is known, while in Bosnia and Herzegovina more than 80% of the waste is labeled as "Other waste". There is no separation between hazardous and nonhazardous MSW waste. Therefore it can be seen that unlike Austria, all types of untreated MSW are disposed on landfills. If a country has most of its waste disposed untreated on the landfills and burned uncontrollably, then it is safe to say that the safe waste disposal policies are far from being fulfilled. Austria has a variety of treatment options and

almost all of the waste is pretreated and disposed in a way to ensure no risk for the health of future generations.

We can see that for Austria the level of collected waste to produced waste is high, while for Bosnia and Herzegovina it is only around 65%. If we look at the inputs into WM system, we can see that in Austria the largest part of MSW is the separately collected waste, which is important since it is easier to treat waste collected this way. Again in Bosnia and Herzegovina it is only 10% that is separately collected, but it is not of a big relevance, since this waste is not treated or recycled, but just disposed on landfills. Collection is the most expensive part of the Waste Management, especially in the developing countries which do not have treatment options like waste to energy incineration. An increase in the collection systems would increase the costs of WM significantly (World Bank, 2011). Austria has a high recycling rate, unlike BiH where only a small fraction; 0,4% of collected waste is recycled. Recycling rate of below 1% shows again strong deviation from the main objective of waste management. Waste processing reuse and recycling as a mean is not met at almost any level.

The WM system for Austria is different and more complex. Unlike BiH, in Austria there are different waste treatment options such as incineration and biological treatment. In Bosnia and Herzegovina, biological treatment of MSW does not exist, while in Austria it represents an important waste treatment system. The flows of waste that are divided between incineration, recycling and biological treatment are equally separated with most of the waste going for incineration. This way, energy is recovered, while in Bosnia and Herzegovina no energy is recovered from MSW. Although this is mentioned in the law as one of the means to reaching primary goal, for the time being, extraction of raw materials from waste for the purpose of energy recovery is not met at all.

Finally looking at the data presented and comparing it to the primary goal of waste management, protection of human health and environment, we can conclude that the research has shown that Austria is fulfilling this goal through recycling, incineration and generally low amount of waste staying in the system. On the contrary, in Bosnia and Herzegovina waste is not disposed safely, neither is it reused and recycled in big numbers and there is no energy recovery from the Waste Management. Currently, the

country is not close to the fulfillment of its only and primary goal of WM. The way waste management system is functioning currently, it poses a risk for human health and environment.

VI. IDENTIFICATION OF PROS AND CONS BASED ON MASS FLOW DIFFERENCES

1. Introduction

If we take a look at the results of the comparisons from the previous chapters we can see that there are many differences between Bosnia and Herzegovina and Austria. Besides the fact that Austria is a larger country both in terms of land and population and that this has a consequence of more MSW produced, Austria is also a developed country with significantly higher GDP per capita than BiH. The goals of WM differ for two countries to a certain degree and Austria has a much more detailed and developed legal and institutional structure for WM.

Therefore, it would be logical to expect and as we could see in the previous chapter, there are significant differences in mass flows of MSW for Austria and Bosnia and Herzegovina. These differences are not only in the amount of waste but also in the proportion to where this waste goes and the treatment options which are available for the MSW. A Material flow analysis of MSW for both countries has provided us with the realistic view on the current state of WM in both countries. Now, that the data is gathered and it is in a presentable manner, it needs to be analyzed in order to be useful. In this chapter, mass flows and differences in mass flows will be analyzed and from these differences, pros and cons will be identified, which will suit as a basis in order to give future recommendations for WM practices in Bosnia and Herzegovina.

2. Identification of Pros

The differences in the mass flows for the two countries are large. Looking at the MFAs it is really hard to identify any pros from the differences in mass flows for Bosnia and Herzegovina. Compared to the objectives of WM in Bosnia and Herzegovina hardly anything is fulfilled. The only positive difference which can be identified could be the fact that the system is much more economic in the short run and at such an undeveloped level. Almost no money is invested and this way there is

an opportunity for a blank start. The Current state of WM is far off from fulfilling the objectives of the EU or the country itself, but the fact that there is no proper infrastructure, can give an opportunity for a new plan; a new start and all the options are available. On the other hand, looking at the MFA for Austria, we can see that compared to the mass flows of Bosnia and Herzegovina it is on much different and higher level; starting from the waste collection coverage and the percentage of total waste which is separately collected, up to whole structure of the WM system. Waste collection to a certain extant determines waste composition. In Austria, the largest portion of waste is separately collected waste and this percentage is much higher than in BiH, which is an important first step in fulfilling objectives of WM. Also, further on Austria has much more different categories of waste, which are treated differently and this is important, because it goes in line with the objectives of protection of public health and environment, minimization of air pollution and after care free waste management. Also, as mention in previous chapters, compared to BiH in Austria a large portion of the input mass exits the system. And what stays in system it is pretreated. This is important in fulfilling the objective of having a WM system which will provide a safe future for the next generations. Large portion of the total waste in Austria is used for energy production, as well as recycled which helps valuable resource conservation. If we look at MFA for BiH, it is completely opposite, and the largest portion of waste ends up on landfills untreated. If we compare the differences in mass flows, for BiH, the percentage of materials recycled is almost zero. What is encouraging for BiH and can be seen on the MFA is that after the adoption of the EU packaging directive, a small but still important fraction of MSW is first collected as a packaging waste, then it is recycled and treated, and it is the only type of input which actually exits the system. This shows how a directive modeled by the EU waste directives has made a positive impact on the WM in BiH.

3. Identification of Cons

If we look at the MFAs, we can see that for this subchapter it is an opposite situation than in previous subchapters. If we compare the mass flows, it is hard to identify any cons for Austria especially if the WM in Bosnia and Herzegovina is compared to the Austrian one. On the other hand, this is where all the shortcomings and problems of

the WM system in BiH can be seen. Compared to Austria, first of all the coverage of collection of waste is much smaller, and there is no evidence of what happens to the 45% of waste which is not collected. As said before, we can see that small amount of waste is separately collected compared to Austria, but also in general. And what else can be seen from the MFA is that currently nothing is done with the separately collected waste. At the end of the chart it is disposed on the same landfill together with all other waste which includes medical, electronic etc. The fact that such higher percentage of the waste than in Austria is disposed on the landfills is not very worrying, since BiH is a developing country. On the other hand, what is worrying is that these are not sanitation landfills which are built under EU standards. There is no protection from leaching, there is no monitoring or evidencing of the waste which is disposed on these landfills and untreated waste is uncontrollably burned. All of this is completely contrary to all of the objectives of WM in BiH. Compared to Austria, in BiH there are no treatment options for waste and there is no use of waste for the energy production. Another big problem is part of the waste, which is evidenced as collected, but not as disposed. If we look at MFA for Austria, we can see that all mass flows are evidenced and can be easily monitored since their input in the WM system. There is not a single ton, which is missing and all of the inputs are well evidenced even in incinerators and during biological treatment. In BiH, part of the waste gets lost in the system and most probably ends up in illegal landfills, since there are more than 500 of these which are evidenced. On the other hand, this might be due to another big problem which is a lack of precise data. No scale beams at the landfills, mean that all of this data is an approximation and this difference might only be due to bad approximation. Both cases are bad, but my guess is that some of the waste does end up on illegal landfills and some of the difference is just due to the bad approximation of the amount of waste which reaches landfills. Nevertheless, this shows perfectly, how information gathering and proper evidencing is important and how BiH has a problem with this. As said before, only from looking at both MFA and comparing the mass flows we can really see how many problems are present in WM system of Bosnia and Herzegovina.

4. Summary of Pros and Cons

Based on the analyses and review of MFA charts for both countries we can conclude that there is a big difference between two waste management systems. On the one hand in Austria, waste management system is well developed and effective. Availability of information is high and the collection of waste is done separately in high percentages. Combined with the fact that Austria is a developed country with a high GDP per capita, this leads to a lot of different solutions and treatment processes which can be applied and used in order to meet the objectives of waste management. With high tones of MSW which are used for energy production, which are treated and reused, my conclusion would be that Austria fulfills the objectives of WM identified and defined in AWG to a high extent. The only question for Austria is efficiency. This means; how well to balance the costs and the high rates of waste which is treated and recycled in most effective and environmental friendly way.

On the other hand, MFA for Bosnia and Herzegovina reveals a lot of basic problems in the waste management system of that country. Compared to Austria, it is significantly different. If we look at the objective of WM which is set, we can see that mass flows reveal noncompliance to this objective. The means which are supposed to ensure fulfillment of objective are not being fulfilled. Safe waste disposal is obviously not met due to numerous reasons mentioned above such as no evidencing of waste, uncontrolled burning and no pretreatment. Waste processing for reuse and recycling is done in insignificant amounts, it is only 0,4 % of MSW. The only encouraging fact is that a few years ago it was 0%. Extraction of raw materials from waste and their use for energy recovery is not done at all, since waste is only uncontrollably and openly burned on the landfills. Finally, there is not a lot which is done in the field of waste prevention and it is questionable how can it be monitored at all since there is still no complete and appropriate collecting and evidencing information on the amounts of waste in the country.

VII. CONCLUSIONS AND RECOMMENDATIONS

In this thesis an extensive analysis of waste management systems in Austria and Bosnia and Herzegovina has been done. This includes comparisons of the goals of WM, legal framework and presentation and analysis of current waste management system by MFA using STAN software. For the simplification of the study, for MFA only MSW mass flows had been taken account. I have made MFA chart for Bosnia and Herzegovina based on the MFA chart for Austria done by Mag. Astrid Allesch and the data used for BiH is from the official statistical institutions from both entities.

As we can see from the chapter V, Bosnia and Herzegovina is far from reaching the goal of waste management set by the law. According to the EU hierarchy of means, the first step which Bosnia and Herzegovina should take in order to improve WM system is prevention. This is disputable, since the four main problems concerning WM are mostly due lack of treatment of waste and inappropriate landfills. It is questionable should prevention of waste be the primary focus in the short term future of the WM system of Bosnia and Herzegovina. 1,07 kg/apartment/day of MSW which is created is not a significant number and even if Bosnia and Herzegovina, would reduce the amount of waste, this wouldn't solve the problem of untreated waste and landfills. Therefore only a lower amount of untreated waste would end up on non-sanitation landfills. This way the primary goal of waste management would not be met, so in my opinion prevention of waste is not a priority.

The priority in protection of human health and environment is to assure that waste is disposed on sanitation landfills. There are only few sanitary landfills in the country where not treated waste is disposed, but more than 90% of landfills are not sanitary and there are a large number of illegal landfills. New infrastructure has to be built, where waste will be disposed on sanitary landfills. These landfills have to be a part of regional waste management centers. So, instead of having hundreds of municipal landfills, couple of large regional centers for waste management which contain sanitation landfills should be opened. These regional centers for waste management besides sanitation landfills should contain sorting area, recycling yards (where

separately collected waste can be stored), zones for composting and zones for biogas and leachate collection and treatment. Building centers by EU standards should provide proper control, monitoring and evidencing on waste flows, emissions from burning and concentrations of leachate. This requires big investments, but it is necessary. Only recovery and closing of the existing landfills in the Federation is projected to cost 125 million euros. The cost of creating these regional waste management centers is around 80 million euros for the Federation (Federal Ministry of Tourism and Environment of BiH, 2011). Considering that the state of the WM system is similar in both entities and they are almost equal in size and population, we can double these numbers to get the cost for the country. Croatia, which is a member of the EU since 2013, has done something similar creating by regional waste management centers. WTE plants are currently too expansive, but a system consisting of MBT, sanitary landfills, recycling and pretreatment of waste in these regional centers would bring the system closer to fulfilling its goal. Also, the prevention of waste is a very important part and a lot should be done, but my opinion is that the situation with landfills has to be solved urgently.

Regional waste management centers would solve the problem of separately collected waste from the Federation which is currently done without any purpose. In the Republika Srpska, it is almost nonexistent, so in overall percentage of waste collected separately has to increase. More bins for separate collection should be set up and campaign for raising public awareness should be done. Waste collection rate of 65% must be increased. This is low collection coverage and this is the most expensive part of WM. In my opinion, currently priorities are landfills, but in a long run, money should be invested in order to increase collection rate. Moreover recycling rate is another important aspect of WM in BiH which needs to be improved. Current rate of recycling is below 1%, increasing this percentage would bring closer BiH to fulfillment of its goal of WM. Regional Centers for Waste Management, separate collection and higher collection rate will help increase this rate. Although it is not a priority as landfills are, recycling is something that must be improved and important aspect in future of WM in BiH.

What can be seen in the thesis is that Austria and Bosnia and Herzegovina are different in many aspects including waste management. Bosnia and Herzegovina is a

developing country with more than 12 times lower GDP per capita than Austria and a different legal structure. A big problem for Bosnia and Herzegovina is that there is no law on waste management on the state level, which should be a basic and ground step for any country which wants to meet the objectives of WM. The Constitution of Bosnia and Herzegovina was adopted and defined trough the Dayton peace Accords, under which WM falls under the jurisdiction of entities. Although in terms of waste management laws on entity have same content to a high extent, non-existence of WM law on state level creates excess of administration and costs, a lot problems with data collection, sharing and monitoring and in general it is much harder to have an effective WM system when there is no proper legal framework to give support to it. What is most important there are no institutions on state level which are dealing with WM.

On the other hand, it is questionable how realistic it is to expect that BiH will adopt a State law on Waste Management. The political situation in the country is complicated, progress is slow and it is hard to find compromise even in the areas where there is much higher public participation and awareness. Without this step it will be hard to advance in any aspect of Waste Management. But for the long term, the establishment of state law and state institutions is needed. It is important to stress that the creation of state law and creation of institutions would significantly reduce the costs of administration and improve the problems with information on waste. The goal of protection of environment and public health is suitable for BiH and in my opinion as elaborated in the previous chapters there is no need for adding new goals.

Besides the State law on WM, Bosnia and Herzegovina needs to continue to adopt directives concerning waste modeled by the EU ones. In Austria, there are more than 30 of these ordinances, while in Bosnia currently around 6. Their adoption is a necessity and only one of the preconditions which needs to be fulfilled in order for a country to enter the European Union. It is not easy to say whether having such high number of ordinances as in Austria is effective, but for Bosnia and Herzegovina some ordinances, like Landfill ordinance must be adopted, because it is a precondition for having proper landfills which will be managed adequately.

We can see from the thesis that unlike Austria, Bosnia and Herzegovina is far from fulfilling its objectives of Waste Management. Human health and environment in this

system is endangered. Because of this, primary mean of reaching the goals of WM should be safe waste disposal. Austria is a good model as a pioneer of waste management. So looking at the Austrian WM and how it has evolved during the years to reach such a high level of development, Bosnia and Herzegovina needs to model an effective and efficient WM system which meets the objectives of WM of the EU and the country. At the end of June of 2015, the stabilization and joining agreement signed with the EU in 2008 has finally come into the force. This means that Bosnia and Herzegovina is one step closer to the European Union. It also clearly shows that the future path of the country is joining the European Union. To join the Union, BiH will need to transpose and implement EU legislation, which includes waste management. This means that the progress has to be made in the future. Compliance with the acquis will require significant investment. Also, a strong and well-equipped administration at the national and local level is imperative for the application and enforcement of the acquis. The current state of the system lacks political willingness, financial means, public awareness and legal background. Waste should be seen as a potential valuable resource rather than a problem for which dumping is a solution. The future for waste management in Bosnia and Herzegovina is to follow the Waste Framework Directive of the EU and model its system as financial means allow it by the EU and the members which have an effective system as, for example, Austria.

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