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# Zero Waste MSW Management Challenges in Klaipėda District

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**Abstract.** Production volumes are increasing by growing economy and consumption processes. Industry and other economic activities generate municipal solid waste stream. With growth of the industry, economy and pace of consumption major key is to avoid municipal solid waste (MSW) generation. The majority of developing countries are seeking to alter the prevailing waste management practices and to adapt the concept of Zero Waste society. This study aims to provide guidance in Klaipėda district and gives an opportunity to become the first district in Lithuania, which provides an objective assessment of the public municipal waste management service area and identifies the real situation of the municipal waste management sector. This paper develops that the path towards Zero Waste society is essential for the approximation of the different waste treatment technologies. To achieve this objective is a difficult task because the solution requires a holistic approach to waste generation, collection, processing and disposal. The main conclusions of the study offers a major challenges faced by Klaipėda district of limited data quantifying and characterizing waste generation patterns also suggesting that "way to Zero Waste" society require renewed governmental leadership as well as founding of effective national regulatory framework to reduce waste generation or conserve resources.

**Keywords:** zero waste, zero waste indicators, municipal solid waste, waste management.

**Conference topic:** Environmental protection.

## Introduction

Many developed countries are using a challenging Zero Waste concept to change current waste management practices to more sustainable methods of managing waste (Cole *et al.* 2014: 64–75). Zero Waste management refers to the reducing of waste amounts through using less of a resources and to recover of all resources from waste; conduct change. Increasing resource consumption has brought with it the global rise of a middle class, but also increasing waste generation. These have continued in lockstep with economic growth since the dawn of the industrial age (Murphy, Pincetl 2013: 40–51).

Local authorities (LAs) of the first level, municipalities and communities, have a key role to play in supporting changes towards sustainable development (Zotos *et al.* 2009: 1686–1692). In the 2010 existing waste management systems in Lithuania, were described. Following *Government Waste Treatment Strategy*, in the 2014 existing waste management systems have proven of more effective alternatives, ex. "green" waste treatment and bulky waste collecting. Systems and policies to address issues such as resource conservation and climate change decrease under a rubric of Zero Waste have never been conducted in Lithuania.

Complicity of this paper is to assess the effectiveness of working waste management systems in the Klaipeda district according performance of Zero Waste indicators investigated by Zaman (2014a) and to putting new waste treatment priority tasks for Klaipeda "way to Zero Waste" society.

## Materials and methods

Klaipėda district is the third largest district in Lithuania with 331 553 inhabitants living in 5 209 km$^2$ of urban or village areas (Klaipėdos regiono atliekų… 2014). West Lithuania is regarded as the marine region. Klaipėda district has a high income and high consuming (according to Lithuanian average); in 2013 GDP per capita as EU€12 600 (Statistics Lithuania 2016). Nowadays central city of district – Klaipėda is an administrative center of industry, business, education and science, culture and sports, healthcare, tourism and recreation. Klaipėda is one of the most successful developing municipalities in Western Lithuania. City accounts for about 12% of the country's GDP and nearly 80% of Western Lithuanian GDP (Klaipėda municipality 2016). According *Statistics Lithuania* amount of 1–2 private households – 31 016 and amount of apartments – 4 710 (with total of 107 616 households). Klaipėda district is covered by traditional waste management services provided by region waste authorities.

### *Waste generation and composition*

Separate collection system is used to recover around 18% of the total production of MSW. The waste streams included in the analysis are organic fraction, metal, glass, plastic, old electrical appliances (WEEE – waste electrical and electronic equipment), bulky waste and used tires stream. Construction and demolition (C&D) also as hazardous waste and textiles are "other" fraction and are not investigated in this study.

The average composition of MSW in Klaipėda district is organic (46%), plastic (15%), glass (7.5%), metals (3%), WEEE (0.5%), bulky waste (2.7%), used tires (0.5%) and others (mostly C&D). A total 150 438 tonnes of municipal solid waste was generated in 2013 and the average person generated around 454 kg of MSW.

Incineration is the main waste municipal method and accounts for 56% of municipal waste treatment. Western Lithuania possesses the highest WtE (waste-to-energy) record in country. Waste incineration is the main waste management technique in Klaipėda district. In 2013 around 135 092 tonnes of all MSW from Klaipėda district was diverted from landfill.

In Table 1 the qualitative composition of produced MSW is shown in terms of amount (t/year) and percentage (%): less than half of the dumped waste consists of organic materials (46%), while the remaining half include metal, glass, plastic and other materials. Moreover, separately collected waste fractions amount (t/year) and percentage (%) shown in bold.

Table 1. Composition and amount of the waste fractions produced, collected and separate sourced (Klaipėdos regiono atliekų… 2014)

| Waste fraction | Amount of produced MSW (t/year) | % | Amount of collected MSW (t/year) | % | $\%_{SSS}$ |
|---|---|---|---|---|---|
| Organic | 69 135 | 46 | **15 325** | **10.2** | 22.17 |
| Plastic | 22 612 | 15 | **968** | **0.6** | 4.28 |
| Glass | 11 317 | 7.5 | **1 632** | **1.1** | 14.42 |
| Metals | 4 571 | 3 | **2 033** | **1.4** | 44.48 |
| WEEE | 783 | 0.5 | **739** | **0.5** | 94.38 |
| Bulky waste | 4 088 | 2.7 | **4 088** | **2.7** | 100 |
| Used tires | 811 | 0.5 | **811** | **0.5** | 100 |
| Others | 37 121 | – | **1 467** | – | – |

The reported percentages of separate sourcing size ($\%_{SSS}$) calculated as the ratio between the amount of separately collected waste and amount of all produced MSW (included separately collected which is already calculated in "amount of produced MSW"). In other words, $\%_{SSS}$ refers to the actual qualitative composition of the produced MSW of which only a small part is sorted separately by residents For ex. 69 135 t/year of organic stream is found in the total amount of MSW produced and only 15 325 t/year is collected separately (22.17%). As revealed in the table the separate collection model allows high separate sourcing size of EEE, used tires (taxable items) and bulky waste, other studied waste fractions are not properly sorted.

*Waste collection and recycling*

Klaipėda district municipality provides waste bins (recycling and general waste) to residents. Bulky waste, used tires, C&D, hazardous and textiles is collected door-to-door. Residents can deliver their bulky, green and organic waste to special collectiong plants by themselves. Waste bins are emptied by waste collection vehicles and part of content taken to the incineration plant, other part to a packaging and secondary to materials transfer stations. After sorting and processing in the packaging and secondary materials transfer stations, waste is sent to landfill or if possible to incineration plant for energy recovering processes. After incineration hazardous ash is shipped to Norway, non-hazardous to local landfill.

The treatment and disposal facilities for Klaipėda's MSW include: 1 Mechanical Biological Treatment (MBT) plant, for a planned treatment capacity of about 75 000 t/year, one active landfill, a WtE plant with a nominal capacity of 180 000 t/year, a number of recycling (garden waste) plants, storage (bulky waste) and sorting platforms which are part of separate collection system. WEEE is sent outside Klaipėda region because of the lack of sufficient local treatment plants.

*Waste treatment, incineration and disposal*

The local waste management center provides waste services to residents and controls waste collecting companies. In Klaipėda district 7 waste companies collect waste from households via kerbside waste collection systems. All recyclables (paper & cardboard, glass, plastic) are sent to recycling industries for remanufacturing. Unsorted household waste is collected and sent to incineration plant or to a packaging and secondary materials transfer stations for energy or materials recovery processes. Currently 56% of household waste collected in Klaipėda district is incinerated; 16% is recycled; 18% is landfilled (Fig. 1).

Klaipėda's garden waste offer collection system. Around 5% of all separately collected waste content is garden or "green" waste. The local recycling industries have not been promoted by government or municipality bodies. Here is no data about treated waste used locally or shipped overseas.

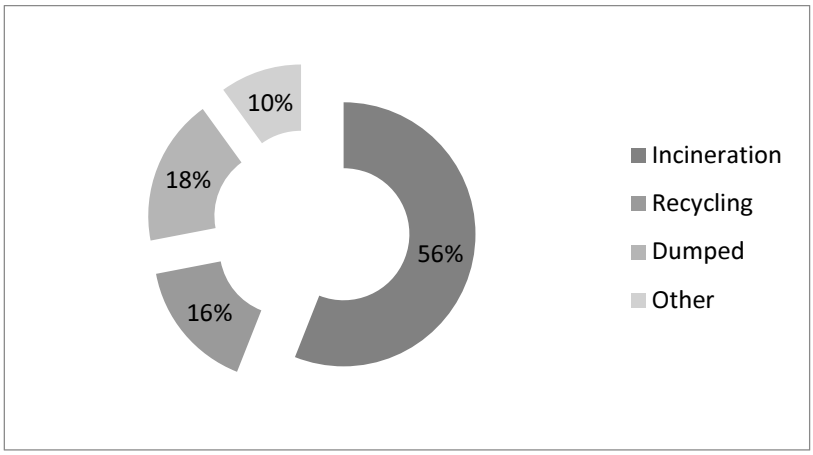


Fig. 1. From toll payers collected MSW treatment (Klaipėdos regiono atliekų… 2014)

Most of recycling, storage and sorting platforms accept almost all types of waste, except hazardous (hazardous waste can be dumped only in special incineration plant or special hazardous materials landfill in Šiauliai region). Electronic waste can be deposited for free as garden, bulky, furniture and C&D have special amounts which can be deposited for free by one resident in one year. After resource and energy recovery, the residual wastes are sent to landfill site.

*Indicators of zero waste MSW management*

Klaipėda region Waste Treatment Framework (2014–2020) institutionalized MSW management at the local level. Existing systems to manage MSW use unlimited quantities of waste as a given and try to manage them. There is no national regulatory framework or legislation to reduce waste generation or conserve recourses. Lithuanian waste management policy has enacted recycling goals to divert waste from landfill. However, *Government Waste Treatment Strategy* (2014–2020) is too limited in scope to decrease waste generation quantities. A linear model of waste and resource management is best characterized as end-of-pipe approach. Klaipėda district could improve management of existing waste flows under the rubric of zero waste management.

To measure the performance and progress in zero waste management, it is important to have certain indicators that sketch different waste management systems and predict effective development scenarios. Table 2 shows 8 of 56 indicators which were identified as the most important indicators (domain "Management") for zero waste management systems and were rated as nearly very high priority indicators by the waste experts (Zaman 2014a: 682–693).

First of all, the main purpose of the study is to understand firstly, waste management activities efficiency in Klaipėda district by using zero waste management indicators such as:

- characteristic (types of waste); waste properties (density, moisture cont. & chemical com.));
- avoidance (avoidance programme; item exchanged/resell; item reused);
- generation (waste streams);
- storage and separation (no. of bins; types of bins; size of bins);
- collection and transportation (types of waste collected separately; frequency of collection; collected in formal/informal);
- recycle (accessibility of recycling deport to public; recycled/cap; recycling efficiency; formal/informal recycling);
- process and treatment (materials processed in different facilities; materials recovery; sorting efficiency);
- disposal (controlled disposal; deposal/cap; diversion rate; lifespan of landfill; illegal dumping).

Secondly, to determine future waste management priorities based on the SWOT profile.

Table 2. Identified most significant key indicators of zero waste management systems (domain "Management") (Zaman 2014a: 407–419)

| Domains in ZWM | Priority areas | Key indicators |
|---|---|---|
| Management | Characteristic | Types of waste (MSW, C&I, C&D, E-waste, hard-waste) |
| | | Waste properties (density, moisture cont. & chemical com.) |
| | Avoidance | Avoidance programme |
| | | Item exchanged/resell |
| | | Item reused |

End of Table 2

| Domains in ZWM | Priority areas | Key indicators |
|---|---|---|
| | Waste generation | Waste streams (household, C&I, C&D) |
| | Storage and separation | No. of bins |
| | | Types of bins |
| | | Size of the bins |
| | Collection and transportation | Types of waste collected separately |
| | | Frequency of collection |
| | | Collected in for./informal |
| | Recycle | Accessibility of recycling deport to public |
| | | Recycled/cap |
| | | Recycling efficiency |
| | | Formal/informal recycling |
| | Process and treatment | Materials processed in different facilities |
| | | Materials recovery |
| | | Sorting efficiency |
| | Disposal | Controlled disposal |
| | | Deposal/cap |
| | | Diversion rate |
| | | Lifespan of landfill |
| | | Illegal dumping |

**Results and discussions**

*Performance of zero waste MSWmanagement indicators in Klaipėda district*

*Waste sources and quantities*. Waste sources and quantity are fundamental variables in waste management system. Waste type and quantity vary according to waste generation. Fig. 2 shows waste sources collected separately and all MSW stream quantities.

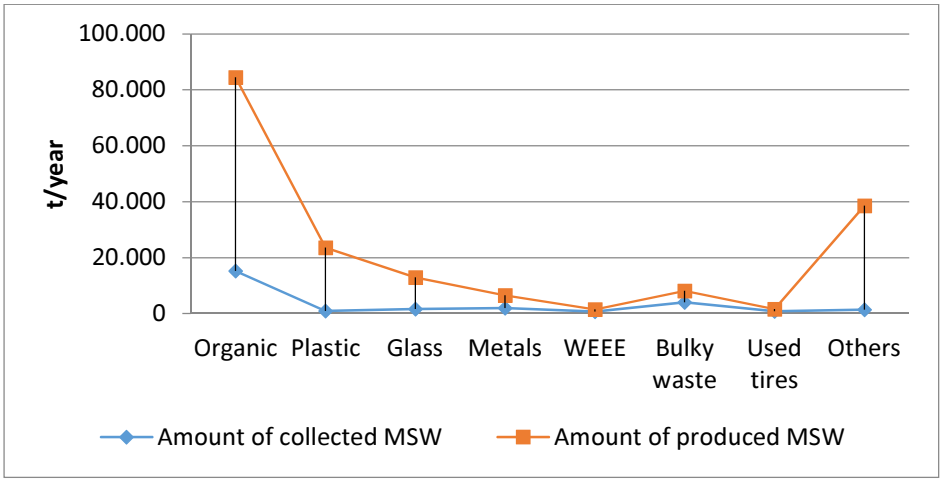


Fig. 2. Amount of collected and produced MSW according to waste sources (Klaipėdos regiono atliekų… 2014)

*Waste compositions and characteristics*. Waste composition and characteristics data influences on waste management design parameters such as number and size of bins, types of collection vehicles and treatment technologies. Data of waste properties (density, moisture content & chemical composition) are not collected in Klaipėda city (Table 3).

*Waste avoidance and reuse.* Waste avoidance indicators are difficult to assess because it can not be measured because easily due to waste stream no longer exist in the waste stream. Table 3 shows importance of Avoidance programme and lack of data.

Table 3. Waste properties and avoidance indicators performace in Klaipėda district

| Waste properties | Indicator performance | Avoidance | Indicator performance |
|---|---|---|---|
| Density | No data available | Avoidance programme | No data available |
| Moisture content | No data available | Item exchanged/resell/reused | No data available |
| Chemical composition | No data available | | |

*Waste generation.* Waste streams generation included analysis of MSW from toll payers (150 438 t/year), mixed MSW from non-toll payers (2 355 t/year), neglected MSW (1 611 t/year), industrial and other business waste (93 455 t/year) (Table 4).

*Waste storage and separation.* Waste recycling and resource recovery are based on waste storage and separation. It is not accomplishable to provide a large number of bins for separate collection by cause of low economical return. No. of bins of separate collection system in Klaipėda district are 11 706, types of bins – "Bells", MOLOK and size of bins varies 2–30 $m^3$.

Table 4. Waste generation and storage and separation indicators performace in Klaipėda district

| Waste generation | Waste streams (t/year) | Storage and separation | Indicator performance |
|---|---|---|---|
| MSW from toll payers | 150 438 | No. of bins | 11 706 |
| Mixed MSW from non-toll payers | 2 355 | Types of bins | "Bells", MOLOK |
| Neglected MSW | 1 611 | Size of bins | 2–30 $m^3$ |
| Industrial and other business waste | 93 455 | | |

*Waste collection and transportation.* For local authorities the most expensive part in waste management is collection and transportation. 3 different types of waste collected separately by separate collecting bins include glass, plastic and paper & cardboard (Table 5).

*Waste recycling*. Accessibility of recycling deport to public is 99.7%, recycled and treated 2 834 t/year, recycling efficiency – 19%.

Table 5. Waste collection, separation and recycle indicators performace in Klaipėda district

| Collection and separation | Indicator performance | Recycle | Indicator performance |
|---|---|---|---|
| Types of waste collected separately | Glass<br>Plastic<br>Paper & cardboard<br>"Green waste"<br>Bulky waste<br>WEEE | Accessibility of recycling deport to public | 99.7% |
| Frequency of collection | 2 per week to 1 per year | Recycled/cap | 2 834 t/year |
| Collected in formal/ informal | No data available | Recycling efficiency | 19% |
| | | Formal/ informal recycling | No data available |

Waste treatment, resource recovery and waste disposal. Lack of available information about materials processed in different facilities, materials recovery rates and sorting efficiency through industry supply chains. A safe and effective controlled disposal in Klaipeda district includes disposal of WEEE, used tires and hazardous waste. Public landfill (Klaipėda district landfill in Dumpiai village) was able to muster 170 000 t/year (2013–2014), diversion rate are not calculated. Landfill has been open since 2009 and it is expected to operate until 2028, a total of 19 years. An amount of illegal or neglected dumping, but treated MSW in 2013 was 1 611 t/year (Table 6).

The current Zero Waste indicators survey of MSW management was firstly assessed as baseline in order to model waste management key issues like waste source, quantities, compositions and characteristics, waste avoidance and reuse, waste generation, waste storage and separation, waste collection and transportation, waste recycling, waste treatment and resource recovery and waste disposal in Klaipėda district in 2013. The characterized results of waste management performance are shown in Table 3, Table 4, Table 5 and Table 6.

The actions considered by Klaipėda district will decresase reliance on landfills, increase protections and waste for industry workers, local jobs, reduce impacts from waste collections. Better handling of materials such as separating glass, plastic and paper & cardboard from trash, supplemeted by new infrastructure and conversion technologies are

important in waste management practise. However, these advances do not meet Zero Waste indicator performance tools introduced in the study.

Table 6. Waste process, treatment and disposal indicators performace in Klaipėda district

| Process and treatment | Indicator performance | Disposal | Indicator performance |
|---|---|---|---|
| Materials processed in different facilities | No data available | Controlled disposal | WEEE<br>Used tires<br>Hazardous |
| Materials recovery | No data available | Deposal/cap | 170 000 t/year |
| Sorting efficiency | No data available | Diversion rate | No data available |
| | | Lifespan of landfill | 2028 year |
| | | Illegal dumping | 1 611 t/year |

*MSW management tools*

Table 7. SWOT analysis based on Klaipėda district zero waste indicators performance

| **STRENGTHS** | **WEAKNESSES** |
|---|---|
| Expanding diversion programs<br>Developing additional waste proccesing and conversion infra-structure<br>Increasing oversight over private waste haulers<br>Setting aggressive diversion targets | Quality of diverted materials<br>Monitoring efficiency<br>No understanding of own emissions and external costs<br>No additional responsibility on producers<br>No industrial policies that promote use of recovered resources<br>Waste incineration<br>No avoidance programme |
| **OPPORTUNITIES** | **THREATS** |
| Funding schemes (EU, national, private sector)<br>Economic incentives to reduce packaging, design products to recovery<br>Infrastructure for recovered products translate into services<br>Policies adoption at the district and federal level<br>Strong resource conservation targets | High cost of recovered products<br>Improper separate collecting<br>Improper “green” waste recycling<br>Disinterested citizens<br>Global warming<br>Business as usual mentality |

System can be improved by:

- arranging long-term recycling industries programme, based on screening and proper waste stream quality evaluation. Application areas included organic waste, food and kitchen waste, metal, packages, plastic, C&D, bulky waste and textiles; accountability to documented supply chains.
- setting up convenient waste minimization and reuse programmes, including repair shops for old household goods.
- providing clear, continuously available guidelines (written, web based, hotline) for existing waste management activities (e.g., collection, recycling of various streams, separate collection of bulky wastes, etc.) (Zotos *et al.* 2009: 1686–1692).
- The goal to lead to sustainable waste management system and increase waste facilities performance via innovative technologies could by reached by political, environmental and economical drivers.
- A shift in the end-of-life management responsibility for product wastes from Klaipeda district municipalities to producers by federal waste management policies to shift responsibility to producers for particularly noxious fractions of the solid waste streams.

As illustrated in Table 7 for tools described above integrating and possible impacts performance a SWOT analysis of this system was performed.

## Conclusions and recommendations

A major challenge in waste management improving in Klaipėda district and "way to Zero Waste society" is effective national regulatory framework to reduce waste generation or conserve resources, founding. Klaipėda district policies focus on recycling goals to divert waste from landfills and WtE waste management technique, what cannot be treated as an effective Zero Waste management technique. Incineration of waste may generate heat and energy but the resources that could potentially be recovered are permanently depleted by the mass burn (incineration) systems (Zaman 2014b: 407–419).

Study of zero waste indexes of Klaipėda district has identified significant data limitations such as lack of proper data reporting, lack of waste characterization studies to identify waste chemical composition and other important physical properties. Better understanding of the tonnage and composition of waste flows can improve accountability, transparency, and the targeting of programs and policies (Murphy, Pincetl 2013: 40–51).

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