Communal Waste Management – Case Study for Slovenia

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The unprecedented quantities of waste produced today have critical environmental implications, from resource inefficiency and climate change to social injustice and local human health effects. In addition, the generation of waste has been one of the most prevalent byproducts of human activity in history. The old approaches of waste management as eg. burying or dumping the waste, however, are no longer acceptable: environmentally, economically, or socially. Moreover, the predicted levels of increase in population, production, and consumption in this century will raise the quantity and complexity of waste materials. If global problems such as climate change and waste remain unresolved, societies will be forced to continue attempting to incrementally reduce waste and lessen environmental impacts. Logically, there is a need for sustainable waste management, sustainable communal waste management in particular, whose goal is to eliminate waste wherever possible by encouraging a systems approach that avoids the creation of waste in the first place. Furthemore, it should be noted that waste represents potential raw materials and is being increasingly rerouted from admittedly orderly, environmentally-friendly dumps to waste recycling industry using technology which produces useful raw materials, compost or fuel. In this process of waste transformation, everyone has to take part separating waste during collection. In order to achieve their objectives of sustainable communal waste management, the European Union countries that have so far done most in this field, have applied innovative waste collection systems based upon identification technologies which encourage users to separate waste at the source of its creation. This paper presents a real examle of Communal Waste Management in Slovenia.

1. Introduction

Human activity is linked with the production and consumption of goods, and is based on using natural resources, on one hand, and on polluting the environment, on the other. The consequences of human consumption become ever more evident, on the local, as well as on the global levels, through the climate change, through forest degradation, through reduced biodiversity, water pollution and especially through creating enormous quantities of waste. Since an increasing quantity of waste is the result of the activities of modern humanity, one of the specific goals of environmental protection is waste management, that is, a sustainable waste management. If the waste problem fails to be resolved successfully, as part of an integral environmental management, it may grow into an enormous and severe burden for both the present and the future generations. The solutions to the problems generated by waste accumulation have, naturally, a lot to do with the manner in which waste is perceived, since in the course of the long history of the human civilization waste has been seen as an unavoidable byproduct of the activities of man.

Waste is directly related to the human development, from both the technological and the social aspects. Waste management may be viewed through the control of collecting, processing and disposal of various types of wastes. An inadequate waste management is one of the most serious problems as regards environmental protection, and practice so far has shown that attention must not be paid to only correcting the bad effects, but must be focused upon adopting and employing the experiences of the developed countries, as rationally and as efficiently as possible. Waste creation depends on the level of the industrial development, the standard of living, the way of living, the social environment, the consumption; therefore it can be perceived as a result of the total of the economic activity of every country and hence in direct correlation with the national economy.

According to its origin, waste can be communal, commercial and non-hazardous industrial waste [8,12Ć. The waste from urban environments and commercial waste are generally called communal waste. Communal waste includes household waste as well as any other waste that is, due to its nature, similar to household waste: non-hazardous waste from industrial, commercial institutions, hospitals, administration institutions, trade shops, as well as different types of biodegradable waste. Communal waste management includes the functions of collecting, transport, recycling, reuse, treatment and disposal of communal waste [9,10]. In the developed countries, the daily amount of waste is 1.5 kg of solid (communal) waste per citizen and a several times larger amount of industrial, agricultural and other types of waste [12]. The

cause of the increase in waste in urban regions is not only the increase in population, but also the increase of waste from the categories of packaging, the disposable packaging primarily.

2. Communal waste management and sustainability

2.1. Communal waste concept

An inadequate waste management has a broader social context, apart from the negative impacts upon the environment. The communal service of waste disposal delivered to a large number of customers by the authorities may result in dissatisfaction and mistrust of citizens as regards the institutions in charge. Hence the establishment of an integral sustainable communal waste management should start with a participant process planning so that all the stakeholders in waste management participate in making decisions based on their proposals [7]. It is for these reasons that a sustainable waste management requires a long-term committment, consistency in view of the strategic solutions proposed, the discipline of all the stakeholders, the permanent information system, continual education, as well as an efficient law enforcement. The communal waste problem is present in all the cities on this planet, and the costs of its disposal amounts to hundreds billion dollars [3].

Given that communal waste is produced within the communal infrastructure in the houlseholds, the basic components of waste are as follows [8,12]:

- organic waste (biological or biodegradable waste – food remnants, waste from the garden, grass, leaves, cut off branches, trees, as well as paper packaging "stained" with food, paper napkins and ashes and soot from wood and coal used for heating);
- paper and cardboard (newspapers, books, journals, commercial printed materials, office paper, packaging paper, cleansing paper, crepe paper);
- plastics (packaging material, boxes, bottles, plastic bags, cling-films and other products made from plastics);
- glass (bottles, jars, drink packaging, pane glass);
- metal (metal pails, tins, aluminium, iron and other metals);
- textile and leather;
- other (dirt, ashes, street garbage, dust, unindentified materials).

Communal waste management is a complex task that needs adequate organizational capacities and a collaboration among numerous stakeholders in both private and public sectors, although the main responsibility is that of the local autonomy. In devising the communal waste management plan, it is necessary that the public take part in all the phases of decision-making and in the process of adopting respective documents, in compliance with the Aarhus Convention [2,11]. The Aarhus Convention, adopted on the Fourth Conference of Ministers, "Environment for Europe", sponsored by the United Nations European Economic Committee, deals with the access to information, public participation in decision-making and the access to justice as regards environmental matters. The majority of European countries adopted or ratified the Aarhus Convention and implemented its procedures into their Local environmental agendas [2].

2.2. Communal waste management goals

Modern principles of waste management require that the waste management system be entirely structured, from waste collection on the spot of creation, to the transport, to the treatment of waste, to the final disposal. Waste is expected to be disposed of at a landfill that meets the basic criteria for a safe and proper waste disposal, in spite of the fact that the existing landfills are not built as per regulations, which is a grave sanitary and ecological problem of every region. There are numerous chemical, physical and biological processes going on within the landfills, resulting into the waste degradation. A byproduct is also the landfill gas that goes directly into the atmosphere. The need to design, work out the investment and technical documentation and solve the waste problem is a priority in environmental protection.

A long-term goal of the communal waste management plan design is solving environmental problems and improving the population's quality of life by ensuring the desired environmental conditions and protecting the nature based on the sustainable environmental management. Communal waste management goals can be seen in the following goal pyramid (Figure 1).

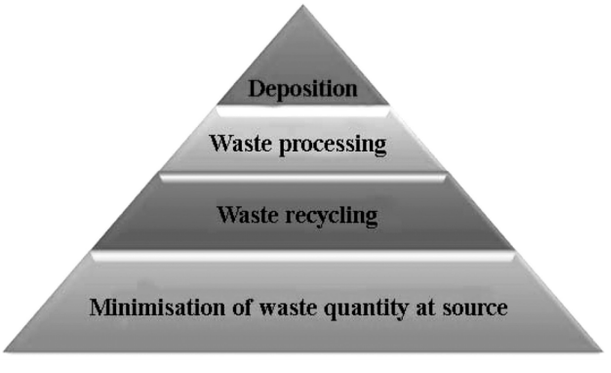

Figure 1. *Communal waste management goal pyramid*

The specific communal waste management goals are the following [12]:

- Rational use of raw materials and energy and use of alternative fuels from wastes;
- Reducing the danger from disposed waste for the future generations;
- Making use of the knowledge of national experts and of economic potentials in establishing the waste management system;
- Implementation of a more efficient administrative and professional organization;
- Ensuring stable financial resources and incentive mechanisms to invest into and conduct activities following the polluter pays and/or user pays principle;
- Implementation of information system that covers all the waste flows, quantities and locations, the plants engaged in treatment, processing and reuse of waste material as well as waste disposal plants;
- Increasing the number of population included in the communal waste collection;
- Establishment of waste treatment standards;
- Waste reduction, reuse, recycling and regeneration;
- Reducing "waste danger" by implementing the best available techniques and by substituting chemicals that threaten the envitonment and the human health;
- Raising public awareness of the waste management on all the levels of the society;
- Sustainable waste management.

2.3. Communal waste management principles

The key principles to be taken into acount when establishing and implementing the communal waste management strategy can be viewed through [1,4,15,20]:

- **The principle of sustainable growth** – Sustainable growth is a balanced system of technical and technological, economic and social activities in the overall development that uses natural and created values on the principles of economy, sensibility and rationality for the purpose of preserving and improving the quality of the environment for the present and future generations.
- **The principle of vicinity and regional approach to waste management** – The principle of vicinity assumes that waste should be treated or disposed of as close as possible to the spot it is created. The principle of vicinity should be observed in selecting the locations for the treatment plant and also disposal in order that an undesirable effect of waste transport be avoided, having in mind the need for the balance between the principles of vicinity and economic efficiency
- **The principle of precaution** – The principle of precaution says that "a danger of serious or irreparable damage, absence of full scientific reliability must not not be a reason for avoiding to undertake measures to prevent the environmental degradation in case of possible or real significant environmental impacts".
- **The polluter pays principle** – The polluter pays principle means that the polluter has to bear the full costs incurred by endangering the environment.
- **The hierarchy principle in waste management** – Hierarchy means the order of priority in waste management:
  - Prevention and reduction of waste creation – resource use minimization and the reduction of the amounts and/or danger of the waste created;
  - Reuse – reuse of the products for the same or similar purpose;
  - Recycling – waste re-treatment so that it should be used in the production of the same or a similar product;
  - Exploitation – exploitation of the waste value through various treatment technologies;
  - Waste deposition – in the absence of any other adequate solution, waste deposition into landfills.

2.4. Communal waste management concept

One of the most effective solutions to environmental protection is the waste management hierarchy concept that stresses the fact that the reduction in waste creation is achieved at the very spot where it is created. Where the reduction is not practically applicable, however, the products and the materials can be reused, for the same or for a similar purpose. The waste reduction, as one of the major communal waste management goals, has to be thought out throughout the entire life cycle of the product, therefore every decision on recource usage needs careful thinking; besides, the reduction should be carefully planned through the phases of product designing, packaging, transport and placement on the market [15,17]. The consumers should also be actively included in the waste reduction in that they should buy the products with less packaging.

For the purpose of an effective and efficient communal waste management some of the following concepts should be implemented [12,16,17,19]:

- **Reuse** – The product can be reused, for example, through the packaging design which will ensure its repeated use. The introduction of the packaging regulations in the European Union is an incentive

to the manufacturers to rethink the designing of multiple use packaging. In other cases, products can be reworked for the same or similar use. In addition to the reduction of waste itself, reuse allows for the reduction of costs for both the manufacturers and the customers, energy and cost savings as well as savings in deposition costs.

- **Recycling** – Recycling helps achieve highly important technical, ecological and economic effects (dramatic reduction of the amounts of industrial and communal waste that would otherwise have to be deposited to sanitary landfills, thereby extending the time these landfills have to be in use and significantly slowing down the process of natural resources depletion and the landfill emissions). The waste recycling system components involved in using the material and extraction of useful waste are the following: extracting various components on the spot of waste creation (from households, shops, institutions, collecting in the streets or in the centres where the recyclable waste is collected, preparation of recyclable material on the baling lines (paper, plastics), pressing (metal), trituration (glass).
- **Composting** – Composting is described as a fast, but partial decomposition of moist, solid organic matter, food wastes, garden wastes, paper, cardboard, using aerobic microorganisms and in controlled conditions.
- **Anaerobic digestion** – Anaerobic digestion is the decomposition of organic, biodegradable portion of solid waste into gasses with a high level of methane, produced by anaerobic decomposition or anaerobic fermentation in the reactor. After the fermentation of the organic waste separated at its source of origin, the rest of the fermentation is normally treated aerobically to the compost. The decomposition process gives gas, compost and water.
- **Waste burning** – The waste burning technology includes the oxidation of inflammable matter contained in the waste. Burning is used to reduce waste volume, and the energy produced in the waste burning process can be used to produce heat and/or electrical energy. When energy using burning proves to be the most practical option in favour of the environment, it is necessary that the possibility be analysed for a combined production of heat and electrical energy to be produced for the purpose of improving the efficiency of the process.
- **Pyrolysis** – Pyrolysis is a process through which organic waste is decomposed at high temperature and in the absence of air. In the process, organic waste matter is thermally decomposed, producing pyrolythic gas, oil and a solid phase rich in carbon.
- **Gasification** – Gasification is a high-temperature process of waste treatment by oxidation or in the presence of vapour to obtain inflammable gases. The gas obtained in the gasification process can be burned or used in cogeneration plants. Gasification is still not a very widespread procedure in waste treatment due to the fact that the fuel has to be relatively homogenous in composition, which means that waste treatment here needs a pre-treatment process.
- **Plasma process** – The plasma process is an alternative system of waste treatment (energy released by electrical discharge in an inert atmosphere). In the gaseous phase organic molecules are intensivly decomposed thus almost entirely eliminating hazardous emissions, which is the major advantage of the plasma procedure. Inorganic matter vitrify upon melting, hence the it can be added to construction material or can be safely deposited.
- **Waste as fuel** – Certain industrial processes and energy producing plants, such as production, operate under the conditions that allow for using the waste of high heating power instead of conventional fuels. The typical waste burnt in these processes include communal waste, automobile tyres, used solvents, waste from refineries, meat-bone flour. Thermal plants and city plants that provide heating to cities can also serve as a significant infrastructure in waste burning.
- **Physical-chemical waste treatment** – The physical-chemical way of waste treatment includes: neutralization, mineralization, solidification, oxidation, reduction, adsorption, distillation, ion exchange, reverse osmoses and other physical-chemical and chemical processes that reduce the hazardous characteristics of waste.
- **Waste depositing to landfills** – Due to the waste composition, there are three basic types of landfills:
  - non-hazardous waste landfills;
  - inert waste landfills;
  - hazardous waste landfills.

The zero waste concept, the final instance in the waste management hierarchy, requires that subsidies for raw materials acquisition and waste management be abolished, that manufacturers be responsible for their products “from cradle to cradle“. The goal of waste management through the zero waste is to improve clean production, to prevent pollution and to build communities in which products will be manufactured in a way that will allow for them to be recycled and safely brought back into the nature or into the environment [14].

3. Communal waste management in Slovenia

Solvenian households create more than 800,000 tons of waste every year, while the waste created annually in the European Union countries amounts to approximately two billion tons. Despite the fact that the amount of waste increases, the attitude towards waste management changes in the direction of sustainability. Waste is not perceived only as a surplus that belongs exclusively to landfills that become crammed with it. On the contrary, waste is viewed as prospective raw material that is increasingly redirected from orderly and ecologically-friendly landfills to the recycling industry that implements the technology that produces useful raw materials, compost or fuel.

Slovenia set out to solve the environmental problems systematically and with commitment during the preparations for admission to the European Union, since it had to bring its laws into harmony with the laws of the EU. Today, waste management is highly important since it relieves the burden on the environment and allows for the consumption of raw materials and energy in a useful manner. The European Union Directives provide that half the household waste has to be removed from the utility services flows and be recycled. The major problem Slovenia is facing is how to achieve this goal in an effective and efficient manner [3].

Waste, naturally, is an environmental, economic and social challenge for the European Union which earns as much as € 100 billion and employs between 1.2 and 1.5 million people in this sector. Thus the recycling industry in the European union produces the sources from recycled materials for 50% paper, 43% glass and 40% non-ferrous metals [5,18].

The sustainable waste management strategies aim to maximize the materiel and energy recycled from waste, minimizing at the same time the final amount of waste deposited to landfills, as well as pollution caused over all the phases of waste treatment and collection. Environmental problems have to be resolved step by step, implementing appropriate technological, economic, and social components and constants, satisfying the 4R concept: reduce, reuse, recycle and recover.

For the needs of communal waste management, Slovenia adopted respective acts complying to the European Union strategy. Implementing a set of instruments and indicators oriented towards an improved manner of waste management Slovenia establishes a unique method of solid communal collecting and depositon (such as: solid packaging, automobile tyres, used motor vehicles, obsolete electronic and electrical equipment). An active communal waste management helps collect approximately 800,000 t of communal waste in Slovenia annually, out of which 73% comes from households, 23% is the waste from manufacturing and service providing industries, and 4% is produced by public services [4,7,18].

The municipal administration in Slovenia is granted authority to adjust the waste management system on the local level, defining the best method of waste reducing, collecting and deposition, in compliance with the legislative norms of the country. The communal waste management on the local level in Slovenia includes the safety and protection of certain sites, the developmental activities oriented towards promoting the system of waste collection, however, also the necessary education of the population on the need for waste management and their participation in the process.

The Slovenian legislature provides that every territory with over 8,000 citizens should be provided with at least one waste collecting centre, while the territories with over 25,000 inhabitants should have of at least one waste collecting centre at disposal per each 8,000 citizens [3].

The Slovenian communal waste collection management operations programme is based on the following goals [3,5]:

- installing collecting points for different types of communal waste per every 500 citizens in the densely populated areas;
- installing the collecting points for different types of communal waste according to the delivery system in each municipality, in every town with over 8,000 inhabitants;
- establishing the system of hazardous types of communal waste collecting and storage at every area with over 25,000 inhabitants;
- establishing a complementary system of collecting different types of communal waste via mobile and underground collection points;
- establishing a system of collecting organic waste from hoseholds and restaurants and its biological treatment;
- ensuring a biological processing of household organic waste in home composting units and in small municipal composting units in the inhabited areas with over 10 inhabitants/ha each.

4. Instead of conclusion: an example of sustainable communal waste management – the "POTKO" project

In the last several years Slovenia has joined the European trend in the reduction of waste created from business activities and everyday living, and this resulted in an increase in recycling. The response to the growing needs for recycling was waste separation at the source of its creation.

Modern waste management systems that function in compliance with the "polluter pays" principle are complex and require a large number of data. Hence the implementation of new and adjustable information technologies is required that would allow for the whole communal waste management system to be simplified, easy-to-survey and easier to manage [13].

The "POTKO" project is an innovative approach implemented in the Snaga d.o.o. utility company. Snaga d.o.o. is a public owned company engaged in waste collecting and transport on the territory of the Ljubljana city municipality and six pertaining municipalities (Brezovica, Dobrova-Polhov Gradec, Dol pri Ljubljani, Horjul, Medvode, [kofijca) as well as 3 other municipalities (Vodice, Ig and Velike Lašče).

Figure 2. *System needed for "POTKO" establishment [13]*

The "POTKO" project is a system that implements identification technology to entirely manage the communal waste flow and encourage the users to separate the waste at its source. This refers to the communal waste which is possible to recycle: paper, glass, metal, PET bottles and other plastics, and biological waste.
The advantages of the "POTKO" system are as follows:

- System transparency;
- Increased quantities of collected sorted waste;
- Greater satisfaction of customers with community services and the utility company;
- Promoting the "pay as much as you dispose of waste" principle;
- Database establishment;
- Process automation;
- Logistics optimization;
- Reduction of the amount of the remaining waste [6].

The introduction of the "POTKO" system will aid the achievement of the goal set by the European legislature in the field of waste management, that provides that by 2020, all the European Union member-countries will have to recycle 50% of the waste they create.

With the implementation of the RFID customer identification the computer application can identify the behaviour of an individual in the process of waste disposal as well as the necessary frequency of garbage containers emptying. It is also possible to efficiently synchronise the activities of public companies that share new containers and introduce new system of waste collecting at the spot of its creation (underground containers, vacuum systems) whose basis is the RFID technology itself. The computer application is supported by the GPS 5/GPRS communication technology that al-

lows for the transmission of data from the source to the central server of the application. This in turn allows for a constant insight into the real situation in the field as well as into the needs or activities required.

REFERENCE

[1] *Life and Alliances in Solid Waste Management Contributions to Urban Sustainable Development*, *Cities,* Vol. 18, No. 1, 2001.

[2] Convention on access to information, public participation in decision-making and access to justice in environmental matters, Aarhus, Denmark, 1998. http://www.moew.government.bg/recent_doc/aarhus/cep43e.pdf

[3] EkoPLan, Studija izvodljivosti uspostave zajedničkog prekograničnog postupanja s otpadom i infrastrukturom u zaštiti okoliša, http://www.bistra.si/pdf/studija_izvedljivosti_HRV.pdf

[4] Fiorucci, P., Minciardi, R., Robba, M., Sacile, R. *Solid waste management in urban areas Development and application of a decision support system*, Resources, Conservation and Recycling 37 (2003) 3019/328, 2003.

[5] Gabrščček A., Stojanovič, B. *Popolno obvadovanje tokov komunalnih odpadkov – projekt "One Stop Tram"*, www.logistika-slo.si/data/upload/GabrscekčStojanovic.pdf, 2010.

[6] Gabrščček, A. *Opolno obvladovanje tokov komunalnih odpadkov – projekt "POTKO"*, www.ekoplus.biz/dinamic/editor/FF54ZčEkočPluščPOTKO.pdf, 2011.

[7] Gabrščček, A., Petrović, N. Način održivog upravljanja komunalnim otpadom, YUPMA, Zlatibor, 2011., Zbornik radova

[8] http://www.ecoserbia.com/vrste-otpada.html

[9] Ilić, M., Trumić, M. Upravljanje komunalnim otpadom u Srbiji – stanje i perspektive, EKOIST '06, Sokobanja, 04-07.2006., Zbornik radova.

[10] Isoski, Z., Todić, D., Dodić, D.: Izrada lokalnog plana upravljanja komunalnim otpadom uz primenu Arhuske kovencije, EKOIST '06, Sokobanja, 04-07.2006., Zbornik radova.

[11] Jamnik Ž., M. Štucin, N. Petrović: *Učešće javnosti u zaštiti životne sredine*, Zbornik radova, SYMORG 2010, Fakultet organizacionih nauka, 2010.

[12] Ministarstvo životne sredine i prostornog planiranja, Način i postupak klasifikacije otpada, Srbija, 2010.

[13] Naglič, S. *Uvajanje elektronske tehnologije za sistem zbiranja mešanih komunalnih odpadkov v Snagi d.o.o.*, Univerza v Mariboru, Maribor, 2010.

[14] Petrović, N., Išljamović, S., Jeremić, V. *Zero waste as a new concept for sustainable waste management*, Management - časopis za teoriju i praksu menadžmenta, vol. 15, iss. 57, 2010.

[15] Pires, A., Martinho, G., Chang, N.B. *Solid waste management in European countries: A review of systems analysis techniques*, Journal of Environmental Management Volume 92, Issue 4, 2011.

[16] Pratap Singha, R., Singha, P., Araujoc, A.F., HakimiIbrahima, M., Sulaimanb, O. *Management of urban solid waste: Vermicomposting a sustainable option*, article in press, Resources, ConservationandRecycling, 2011.

[17] Rushbrook P.E., Finnecy, E.E. *Planning for future waste management operations in developing countries*, Waste Management&Research, Volume 16, Issue 1, 1988.

[18] Statistični urad Slovenia, www.stat.si

[19] Sundberg, J., Gipperth, P., Wene, C.O. *A systems approach to municipal solid waste management: A pilot study of Göteborg*, Waste Management&Research, Volume 12, Issue 1, 14.

[20] Zhang D.Q., Tan, S.K., Gersberg, R.M. *Municipal solid waste management in China: Status, problems and challenges,* Journal of Environmental Management Volume 91, Issue 8, 2010.