Possibilities for improvement of municipal waste collection system in transition countries

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Abstract

The waste collection and transportation is a very important part in the waste management system that has the highest expenditures. In the Republic of Serbia, collection system is mostly based on the one bin for mixed waste, but as a potential candidate for EU, waste management system demands development in accordance with EU legislation. New practice in waste collection system is necessary for easier implementation of advanced technologies, in order to fulfill requirements prescribed by EU directives on packaging waste and biodegradable waste. According to input data about waste quantities and composition, driven by some of the goals from EU directives, an appropriate solution for the waste collection system could be found. Two bin system with a few variations is an appropriate initial solution.

Key words: waste collection, developing countries, two bin system, Serbia

Introduction

Waste management in developing countries is a complex problem. It is usually based on landfilling, with a few treatment plants in operation or in development progress. The main problems are landfills, which in the most of the cases, are not sanitary. Due to that, landfills represent potential contaminants to air and water, by generating landfill gas and leachate. Another problem is that there are parts of the population not included in the system of waste collection, therefore a great number of open dumps is generated. Countries in transition tend to have modern waste treatments, but there is a question, considering the current situation in the waste management area, are they ready for that step?

The waste collection system in the Republic of Serbia is mostly based on the one bin collection of mixed waste. Primary selection is implemented in some cities in Serbia, but that is only for few fractions, such as PET bottles, paper and cardboard, and results are not significant. In many small municipalities in Serbia, public utility companies (PUCs) have several assignments and lack of employees, and they are not in situation to improve their waste collection management.

One of the problems is that collection vehicles are too old, from 15 to 20 years, so maintenance is expensive and there are frequent breakdowns [1]. New vehicles are available only through some EU donations, and similar projects, because the PUCs generally are not profitable. Coverage with organized waste collection in the Republic of Serbia is around 60-65% of the population, or 80% of territory [1-3]. This value is not constant, and it varies from region to region; for example, there are regions with coverage of 100% that include about 2,632,119 citizens [1]. A problem with coverage lies in the fact that vehicles have to drive too many kilometers for a small amount of waste, to reach the small settlements on peripheral parts of municipalities.

The decision of the appropriate waste collection system for Serbia should be driven by the experience and practice from the developed countries. The waste collection system depends on waste treatment that is going to be applied, and that should be decided based on waste composition and generated amounts of waste.

The goal of this paper is to help all developing countries, through a case study of a representative country, such as Serbia. The contribution of such study is wide-reaching and it is of great importance for all developing countries.

Background

The collection of municipal solid waste is one of the most difficult operational problems faced by local authorities in a municipality. In recent years, due to a number of economic, health, and environmental concerns, many municipalities have been forced to assess their solid waste management and examine its cost-effectiveness and environmental impacts, e.g. in terms of designing collection routes [4].

The main focus of the waste management development is on different waste treatments. Also, both collection and transport are extremely important from the financial aspect, because they represent the most expensive part of every waste management system [5]. That is why the focus is on the different collection models, as an important part of the whole waste management system development, mainly because of the limited financial resources in developing countries.

Serbia as one of the countries in transition, and as a potential candidate for EU, must invest in the development of waste management. Development should be driven in accordance with the legislation. Since the legislation in the field of waste management is also undeveloped, the new legislation should be based on EU standards. Existing legislation in Serbia that does rely on EU directives is focused on four legal documents: The Law on Waste Management, The National Waste Management Strategy, The Law on Packaging and Packaging Waste and The Decree on Waste Landfilling [1]. The goals in the waste management field, set by aforementioned legislation, could be accomplished much easier by setting appropriate waste collection system.

Waste management in Serbia is facing a period of fundamental changes. The waste management system consisted of collecting and disposing of waste to municipal landfills, which are non-sanitary in most of the cases, and are now in the process of transfer to regional centers with sanitary landfills [1].

In Serbia, currently, there are about 3500 wild landfills, but waste management regions are in development: about six sanitary landfills are constructed and a few more are under construction [7]. Waste is mostly collected as a mixed stream, with exceptions in some cities, where a separate collection of PET bottles and paper and cardboard exists. Around 80% of the territory is covered with organized waste collecting, and the GDP is 5600 € per capita [3, 7].

A country applying to become a member of the EU can deviate from the EU objectives during the negotiation process, but defined goals will be active in Serbia as soon as negotiations for membership begin. The existence of these objectives and their definition in the legislative documents represent a very important sign from the government and reflect an awareness of the importance for synchronizing legislation and waste management practices.

Materials and methods

General issues in collection and transport of municipal solid waste [11]:

- Lack of appropriate bins for collection;
- Inadequate container capacity at the communal collection points;
- High collection costs and lower service levels - collection service does not cover all the population and is often infrequent (less than once a week in the rural areas);
- Inadequate cooperation from citizens with collection schedules and methods;
- Poor labor management and supervision;
- Failure to optimize vehicle productivity by selecting the appropriate crew size and shift duration;
- Inappropriate or lack of vehicles for waste collection;
- Inappropriate type and size of collection vehicles;
- Non-rational routes for collection service;
- Retention time for loading waste;
- Long vehicle down-times from poor equipment maintenance and repair;
- Long haulage times to disposal sites coupled with lack of transfer stations;
- Harsh driving conditions at disposal sites causing vehicle and tire damage.

Setting a good basis in this field will definitely determine a future direction of waste management development. It is extremely important that relevant institutions and decision makers recognize the importance of investment in the field of waste management.

In the city of Novi Sad, there was an attempt of conducting the separate collection of PET bottles in special containers that were distributed around the city. People were interested and they accepted this kind of PET bottles disposes, but scavengers started to destroy these containers and take the collected waste. While police and local government discussed about the competences, citizens were slowly but surely losing enthusiasm for this kind of separation.

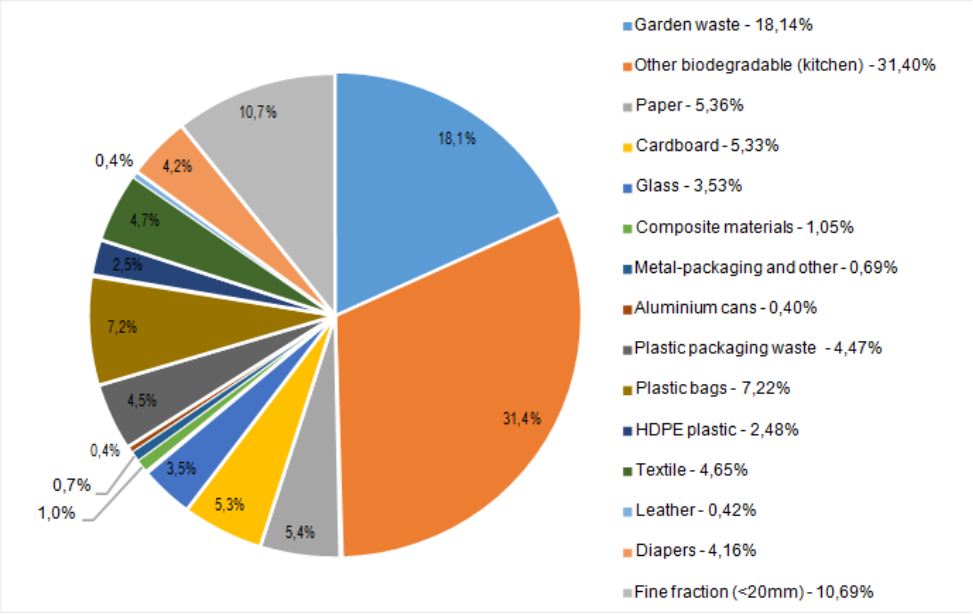
Another example, also for Novi Sad, was a collection system with two bins, one for packaging waste and another for the rest of the waste. This action wasn't accompanied with any training or education courses. Citizens started to separate waste anyway, but the PUC estimated that there are too many impurities. Both bins were disposed in the same garbage truck, so citizens didn't see the point of waste separation. As a result, citizens now have two bins with mixed waste.

Both examples showed that there are no serious decisions from the PUC and local authorities. This problem is due to the political situation in the Republic, where government is often changed and most of the agreements made with the previous government are cancelled by the new government, while the problems consist. PUC represents a source of permanent job positions, driven by local authorities. Even when there is an initiative to develop a new and improved system in the waste management, the idea is not fully conducted.

For successful planning of waste management program, waste managers need information about quantities and waste composition generated within their municipality. Determination of reliable data about waste quantities and morphological composition is fundamental. Analysis of these data is the essential first step towards sustainable and feasible long-term waste management strategy regarding reduction, treatment and disposal [12].

Last waste analysis in Serbia was conducted within projector quantification and morphological composition of municipal solid waste in 9 representative Serbian municipalities with diverse socio-economic status, IMG project [13]. In order to determine waste composition, random household solid waste samples of 500kg were collected from three municipal sectors: individual households in urban zones, collective cohabitation and commercial zone, and rural zone. Collected samples were classified manually according to catalog which includes 16 different waste fractions.

The results of the obtained analysis show that the biodegradable fraction is dominant with a total share of 49.5% (Graph 1) [13]. Potentially recyclable categories have a total share of 35.2%, with the highest contribution of plastic bags with 7.2%, followed by paper and cardboard with 5.3%. Plastic packaging waste has a share of about 4.5%, while the mass share of glass is about 3.5%. Other recyclable categories, such as metals are not widely present in the morphological composition of Serbian municipal waste. Also, a significant proportion of fine elements with a share of 10.7% can be noticed, that also complicates processes of material separation.



Graph 1: Morphological composition of municipal solid waste in Serbia (%) [13]

On the basis of the results of waste truck measurements, obtained at the municipal level, it is possible to get the total quantity of municipal waste generated in the Republic of Serbia. According to measured and estimated data, projection show that Serbia currently generates 2,464,133 tons of municipal waste annually, which corresponds to 343

kg per capita per year, or 0.94 kg per day. In relation to the Study, which was conducted on the same principle in 2008/09, conclusion is that annual production of waste increased by 3.8% in the observed period (table 1) [10, 13].

Table 1: Comparison of results regarding waste amounts in the period 2008-2015 [13]

Municipal solid waste quantities in the Republic of Serbia	t/year	kg/cap/year	kg/cap/day
2008/09	2,374,375	317.5	0.87
2014/15	2,464,133	343.0	0.94
Percentage change (2008 - 2015)	+ 3.8%		+ 8.0%

Estimates indicate that 90% of overall generated waste in Serbia is landfilled without any pre-treatment, while the remaining 10% consists mainly of polyethylene terephthalate containers (PET), paper and metal, which are recycled or sold as secondary material [1].

Moisture content of municipal solid waste in addition to data such as generated quantity and morphological composition, represents necessary information for setting appropriate waste management system. Kitchen waste has the largest share of moisture, and this fraction is the most represented in overall waste composition in Serbia, so in the mixed waste stream this category of waste has the largest impact on the overall moisture content. Waste categories with higher moisture content are also plastic bags (37.6%), cardboard (31.9%), and diapers with 28% of moisture [9].

Results and discussion

Based on input data, such as morphological composition of municipal waste and generated amount, and in accordance with national legislation, potential solution for the collection system and appropriate treatment, depending on what is the main object, should be developed.

Solutions for the waste collection system which can be considered:

- Organic waste, with higher moisture content, should be disposed in one bin and recyclable materials and other materials, with low moisture content, in another. Moisture content is one of the factors that indicate which kind of waste treatments should be applied, and it has an influence on efficiency of waste separation.
    - Two bins, wet and dry;
- Considering Decree on Waste landfilling ("Official Gazette" No. 92/2010), biodegradable waste represents a problem, so this kind of waste should be separated and sent to some stabilization treatment. Another solution is home composting, but environmental awareness of the inhabitants is too low, so this solution requires additional education. For accomplishing objects of the Decree, aimed at reducing the negative environmental impact as a result from its direct landfilling, waste collection should be driven by these requirements.
    - Organic waste separated at source;
    - Organic waste separated and disposed on distributed drop-off points;
- The Law on Packaging and Packaging Waste [14] was written in accordance with existing EU laws related to the ‘‘Green Dot’’ system. The goal of this law is to reduce packaging waste and encourage the use of recyclable materials in order to reduce the amount for final disposal. Although the Law on Packaging and Packaging Waste in Serbia has no goal-oriented system for the collection of packaging waste, the adoption of this law and the establishment of a new system for the collection and recycling of packaging waste is a very significant improvement in the overall understanding of modern waste management systems. Some collection system driven by this law can be:
    - Single or double stream of recyclable materials;

- Recyclable materials separated and disposed on distributed drop-off points.

For accomplishing further progress in this field it is necessary to continue work on activities aimed at [15]:

1) Raising awareness of the population and the capacity of legal persons.
2) Closer involvement of public utility companies to join into the system of packaging and packaging waste.
3) A more intensive inspection of the implementation of the Law on Packaging and Packaging Waste.

Establishing of the appropriate collection system and increasing the number of population under organized waste collection, ensures that all generated waste is treated in harmony with waste management goals, with no harmful effects on human health and the environment. Chosen solution also need to be economical acceptable, because collection and transporting of solid waste makes the biggest demand on municipal budget and have the greatest impact on urban living [8].

Waste collection system should be developed considering the current economic situation. For example, in the city of Novi Sad, one citizen pays approximately 15€ per year for waste management [6], which cannot be compared to Vienna, where one citizen pays about 106€ per year [5]. Almost 60% of the budget in Vienna was required for collection; the rest was spent on the treatment (29%) and disposal of waste and residues (12%) [5].

Conclusion

One of the problems in transition and developing countries is organization and planning of waste collection, in an adequate way for the application of some organized waste treatments. First of all, there is a need for establishing a good system for waste collection, which will prevent the creation of new illegal dumps and all generated waste would be under control at every step. Next step, when the economy stabilizes, could be consideration of the waste treatments. Collection and transporting of solid waste makes the biggest demand on municipal budgets and has the greatest impact on urban living, so it is necessary to choose an economically acceptable solution. Increasing the coverage of organized waste collection system would minimize the number of open dumps. It's necessary to invest in the system of waste collection and transportation in order to meet the objectives prescribed by national regulations. Thereby, further progress in waste management would be enabled, and better conditions for investments into modern waste treatments would be established.

With input data about waste quantity, composition and moisture content, preconditions were created for detailed modeling of the waste collection system. According to quantities and composition of municipal waste in some specific city or region, system with two bins should be gradually introduced. Depending on what decision-makers want to achieve, they can choose appropriate variation of mentioned system. Collection and transport of municipal waste are very important, but currently the emphasis is not on them. Research in this field is more than necessary because of high and long-term investments, and it will contribute to decision makers in this context.

References

[1] G. Vujic, B. Nemanja Stanisavljevic, B. Bojan Batinic, Z. Jurakic, and B. Dejan Ubavin, Barriers for implementation of "waste to energy'' in developing and transition countries: a case study of Serbia, J. Mater. Cycles Waste Manag, 2015.

[2] Faculty of Technical Science, Novi Sad MOPRORK— determination of contamination from landfills and monitoring models, risk assessment, determination of amount of waste with modern satellite information technology to support the implementation of legislation, 2012.

[3] Statistical Office of the Republic of Serbia, Municipalities and regions in Serbia (Republički zavod za statistiku, Opštine i regioni u Srbiji), ISSN 1450-9075 (in Serbian) (2012)

[4] Nuortio T., Kytöjokib J., Niskaa H., Bräysy O. Improved route planning and scheduling of waste collection and transport, Expert Systems with Applications 30, 223–232, 2006.

[5] P. H. Brunner and J. Fellner, "Setting priorities for waste management strategies in developing countries," Waste Manag. Res., vol. 25, no. 3, pp. 234–240, Jun. 2007.

[6] Official web site of PUC "Gradska cistoca" Novi Sad, http://www.cistocans.co.rs/, (Last accessed September 2015)

[7] Vujić, G., Batinić, B., Stanisavljević, N., Ubavin, D., Živančev, M., Analiza stanja i strateški okvir upravljanja otpadom u Republici Srbiji, Reciklaža i održivi razvoj, 3 (1) 14-19, 2012.
[8] [Collection of Municipal Solid Waste in Developing Countries, United Nations Human Settlements Programme (UN-HABITAT), ISBN: (Volume) 978-92-1-132254-5, 2010.
[9] B. Batinić, M. Živancev, D. Ubavin, N. Stanisavljević, G. Vujić, Comparison of moisture content in MSW considering different collection systems, International conference on Sustainable landfills and Waste Management, ISWA BEACON Novi Sad, Serbia, 2013.
[10] Bojan Batinic, Goran Vujic, Miodrag Zivancev, Dejan Ubavin and Nemanja Stanisavljevic, Knowledge of the MSW quantity and composition as a basic prerequisite for the successful implementation of the EU Directives, Proceedings of the Symposium "The Role of Communication in Waste Management", Zadar, Croatia, 2015.
[11] Anonim. Solid waste collection and transport, The Asia Foundation, Sri Lanka, 2008.
[12] Bojan Batinic, Goran Vujic, Miodrag Zivancev, Dejan Ubavin and Nemanja Stanisavljevic, Knowledge of the MSW quantity and composition as a basic prerequisite for the successful implementation of the EU Directives, Proceedings of the Symposium "The Role of Communication in Waste Management", Zadar, Croatia, 2015.
[13] Faculty of Technical Sciences, Novi Sad, Report on quantities and morphological composition of waste in 9 representative municipalities in Serbia, 2015.
[14] The Law on Packaging and Packaging Waste ("Official Gazette" No. 36/2009), Belgrade, http://www.eko.minpolj.gov.rs/en/documents/ (Last accessed September 2015)
[15] The Agency for Environmental Protection, The report on the management of packaging and packaging waste in 2014, Ministry of Agriculture and Environmental Protection, Belgrade, May 2015