

FETDE 2020**International Conference on Finance, Entrepreneurship and Technologies in
Digital Economy****DIGITAL OPPORTUNITIES AND EVALUATION FEATURES FOR
THE MUNICIPAL SOLID WASTE MANAGEMENT SYSTEM**

Aleksey Gubernatorov (a)*, Ludmila Shmeleva (b), Elena Gorbatenko (c), Evgeniy Lomov (d)

*Corresponding author

(a) Financial University under the Government of the Russian Federation, Russia,
gubernatorov.alexey@yandex.ru

(b) Financial University under the Government of the Russian Federation, Russia, gera60@ya.ru

(c) Financial University under the Government of the Russian Federation, Russia, gorbatenko.el@yandex.ru

(d) Financial University under the Government of the Russian Federation, Russia, eelomov@yandex.ru

Abstract

The article is focused on the complex evaluation of financing of the municipal solid waste management (MSW management system). To prevent the environmental disaster, it is vital to modernize the system of solid waste processing at existing and newly made landfills. In present-day Russia the critical situation with MSW management is not out of the question. It has been caused by the constant process of waste formation and accumulation and imperfect practices of handling changes in waste compositions over the past few decades. The global trend in waste management is known as the transition to a new level of MSW management called Integrated Solid Waste Management (ISWM). It is an integrated MSW management system based on full (deep) waste recycling. In Russia, solid waste without pretreatment is stored in landfills or dumps, which spread long distances causing the biosphere pollution. The sustainable economic development is proved to depend on the efficient system of MSW management. Moreover, MSW management comes out not only as ecological problem, but also as economic and financial issue, which should be handled to improve the quality of people's life and ensure the financial stability of the entire waste recycling industry. The article considers the six-dimensional model of efficient financing and evaluation of the MSW management system.

2357-1330 © 2021 Published by European Publisher.

Keywords: MSW management system, financing of the MSW management system, waste recycling industry



1. Introduction

The global urbanization is likely to cause a problem of storing and processing human activity waste. Both industrial and household waste must be efficiently decomposed at specialized dumps and landfills. The increase in the number of xenobiotics (chemicals alien to the biosphere to be naturally synthesized) and the dominance of multi-waste enterprises highlights the need to find rational methods for waste processing and recycling.

Apart from the fact that a great number of pollutants come from industry, a small proportion of municipal solid waste may highly affect the environment, destroy its functioning and cause its pollution with harmful substances. The higher is the standard of living, the more waste it brings. It is obvious that the lack of timely disposal leads to the pollution of atmosphere, soil and groundwater, which, in its turn, threatens the quality of human life.

The countries of the European Union are likely to apply a waste recycling policy which makes it possible to handle excessive pollution and provide eco-friendly waste storage, transportation or disposal. The global trend in waste management is the transition to a new level of MSW (Municipal Solid Waste) management, called Integrated Solid Waste Management (ISWM) and viewed as their complete (deep) processing (Varypaev et al., 2019). In Russia, MSW without preliminary treatment is stored in landfills or dumps that spread long distances and cause the biosphere pollution.

The number of such landfills and dumps, being already overflowing, is over 6.5 thousand within the country. To prevent an environmental catastrophe, it is necessary to modernize the system for processing municipal solid waste at already existing and newly built landfills. So far, Russia has been facing a crucial issue around MSW, which is caused by a constant increase in their generation and accumulation, imperfect practices of dealing with waste compositions and contents for over several decades.

2. Aim and goals

The research is focused on municipal solid waste management designed and implemented as a complex of funding mechanisms and ways of its evaluation.

3. Materials and methods

Solid municipal waste is generated in the process of human life (food waste, waste paper, glass, metal and plastic waste, etc.). One of the specific features of MSW is that they tend to be a mixture of components. MSW is mixed up while being generated, stored, transported and disposed. This process is obvious to produce harmful chemical compounds that pollute air and groundwater.

The ecological situation of the state is fairly to get improved without involving the population of certain territories into some reasonable activities to ensure environmental safety.

The competencies of ministries in the field of household/solid waste management are regulated by the current legislation of Russia.

Unfortunately, there is no universal method of MSW management that could completely meet present-day environmental and economic requirements. The combined method, involving the use of waste

as a source of energy and secondary raw materials, is seen as the most available. The integrated processing of MSW, including sorting, heat treatment, fermentation and other recycling stages ensures the maximum environmental and economic efficiency.

There are several common types of industrial processing of MSW, including incineration, fermentation, and sorting that are used interchangeably or as a mix.

Conformed with European companies and supplemented by the integrated evaluation of MSW and sales of finished products, the economic indicators of various technologies for MSW processing are shown in Picture 1.

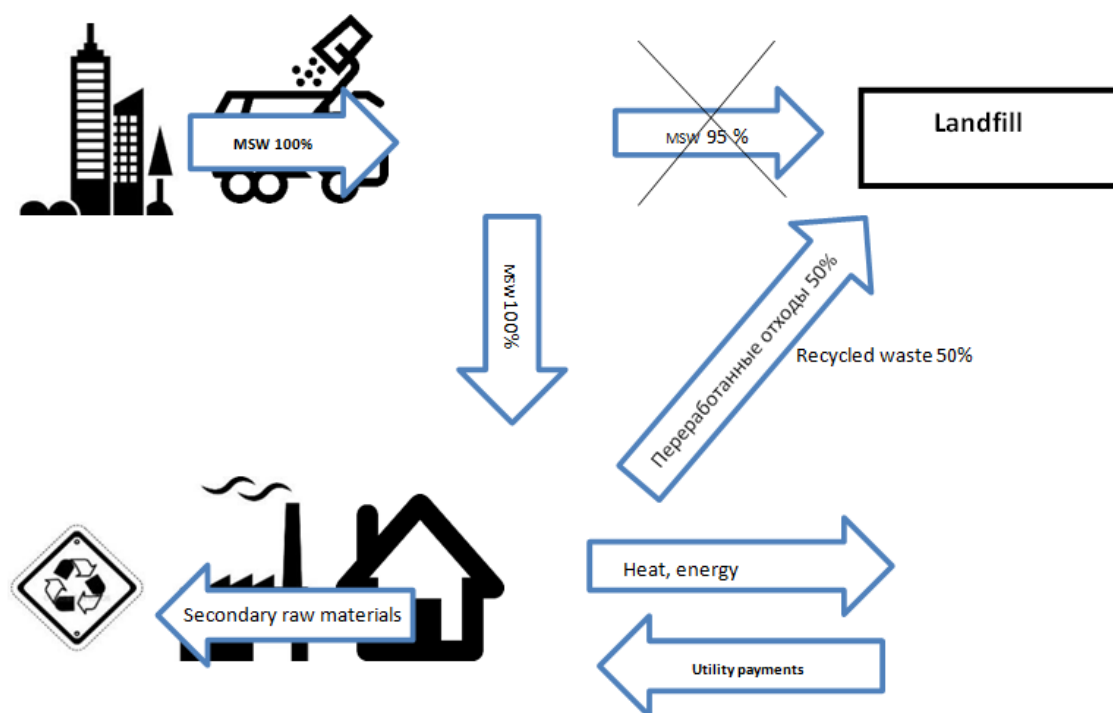


Figure 1. Complex recycling of MSW

The key disputable issues relating to MSW management are as follows:

- discrepancy in the existing sanitary and hygienic standards and environmental safety norms of most landfills and dumps;
- an outdated system for collection, transportation, storage, processing, recycling, disposal, removal and landfilling of waste, deterioration of machines and containers, which makes waste amount accumulate;
- insufficient capacities of MSW management, separate collection, sorting and removal of the estimation parameter of raw material;
- insufficient ways of collecting factual data about MSW removal in rural area;
- imperfection of legislation and the system of state regulation in the field of waste management;
- low tariffs for the removal and disposal of municipal solid waste.

However, by 2019 all aspects of the national project Ecology have been supported with significant results in MSW management:

- development of a new industry for waste management;

- birth of a new public non-profit company “Russian Environmental Operator”;
- end up of elimination of sixteen unauthorized landfills and seventeen other objects of accumulated environmental damage throughout the country;
- a number of efficient benefits for specially protected natural zones of federal significance (Hramov, 2019).

Moreover, waste management schemes for waste categories I and II have been established along with Rosatom as the federal operator of the project.

Meanwhile, the Ministry of Natural Resources keeps developing new draft projects aimed at the beneficial implementation of industry reform and selection of strategically efficient funding.

So far the Ministry of Natural Resources has developed a draft Act of the Government of the Russian Federation “On approval of norms to provide and distribute federal budget subsidies to local budgets of the constituent entities of the Russian Federation for co-financing the state projects and subprojects in waste management and re-funding the investment costs of concessionaires and private investors to provide facilities for MSW disposal as a part of the federal project “Integrated system of the municipal solid waste management”, that regulates the industry funding.

The subsidies are expected to be granted to businesses that are up to construct and start up facilities for MSW processing and disposal, along with investment into projects regarding public-private partnerships for MSW processing, recycling, disposal, removal and landfilling of waste facilities.

Most investors, concessionaires and private partners are expected to be able to apply for a 50% re-fund for the investment costs of the facilities having been put into operation.

Likewise, federal subsidies are expected to be available to most local budgets after their regional scheme and project of waste management have been approved.

Subsidies are granted as a result of applications submitted to the Ministry of Natural Resources, which make it possible to assess the financial feasibility of MSW management projects and ensure the economic benefits of their implementation.

The Ministry of Natural Resources is likely to evaluate the subsidies efficiency if a local budget provides the following indicators of its productivity:

- percentage of utilized MSW in total MSW amount;
- percentage of utilized MSW in total number of newly made MSW;
- commercial implementation of waste disposal facilities with MSW having been processed;
- commercial implementation of MSW utilization.

It is believed that an Act of the Government of the Russian Federation On procedures and conditions for budgeting from the environmental funds relating to the implementation of waste disposal norms respected by producers of goods (packaging) and importers of goods (packaging) by covering environmental charges (Shulgin, 2019).

In sum, the implementation of the waste management reform is currently challenging since in Russia there are no effective mechanisms of the waste industry funding that cannot but affect its environmental and economic tools.

4. Results and discussion

According to analysts, by 2020, businesses running solid municipal waste management will have invested over \$ 3.6 billion for digital technology expenses (Safonov, 2018). The authors of the study *The Impact of Digital Transformation on the Waste Recycling Industry* claim that there are four main aspects in the development of the digital solutions market relating to waste processing industry (Frost & Sullivan, 2018):

- Design of smart waste collection systems (i.e. “smart containers”),
- Up-grade of supply chains and specialized software and sensors for machines (“smart waste bins”),
- Production and implementation of intelligent systems for MSW processing and disposal,
- Development and application of cloud technologies and user interfaces,
- Ways to handle the issue of solid municipal waste management due to both project financing mechanisms and methods of sharing economy (Botsman, 2013; Botsman & Rogers, 2010; Henten & Windekilde, 2016).

Effective financing of the MSW system depends on:

- reasonable local scheme of waste management for different waste classes, including its location, capacity, technical facilities for waste processing, utilization, neutralization and disposal;
- mechanisms of investment attraction and value of minimum rate of the invested capital return to calculate tariffs of MSW management.

It seems reasonable to choose integrated strategic directions and aspects for funding of the MSW management system, including factors of assessment of different management levels, according to the following model: “waste collection” – “waste transportation” – “waste processing” – “waste utilization” – “waste neutralization” – “waste disposal”.

The assessment of the financial potential of the MSW management system is likely to depend on the above-mentioned components (“waste collection” – “waste transportation” – “waste processing” – “waste utilization” – “waste neutralization” – “waste disposal”), as well as their interdependence.

The financing of the MSW management system is expected to be estimated by means of the six-dimensional model of “waste collection” – “waste transportation” – “waste processing” – “waste utilization” – “waste neutralization” – “waste disposal” as the main tool of the system:

The most appropriate and simple approach of the solution is seen in the use of a system of linear equations. In this case, the system of linear equations is represented as follows:

$$\begin{aligned}
 Y_{min} &= b_1y_1 + b_2y_2 + \dots + b_my_m + y_{m+1}a_{11}y_i + \dots + a_{mi}y_m \leq C_1, \\
 a_{in}y_i + \dots + a_{mn}y_m &\leq C_n, \\
 y_{m+1} &\leq C_n, \quad y_i > 0, \quad i = 1, m + 1,
 \end{aligned}$$

where b_i – number of financial resources relating to the stage of the MSW management system ($b_i = 1, 2, \dots, m$);

y_i – number of financial resources relating to the corresponding process;

y_{m+1} – number of financial resources relating to the stage of waste planning, analysis and control;

a_{ij} – weight of i -element of investment;

C_n – norms of financial expenditures.

Weight factors for each stage are defined as a percentage ratio of resources at every stage in their overall amount.

The six-dimensional model of “waste collection (C)” – “waste transportation (T)” – “waste processing (P)” – “waste utilization (U)” – “waste neutralization (N)” – “waste disposal (D)” can be represented in its simplified form:

$$Y_{min} = 0,254Y(C) + 0,273Y(T) + 0,214Y(U) + 0,215Y(D) + \dots + y, Y(C) \leq C_1$$



$$Y(T) \leq C_2, Y(U) \leq C_3, y \leq C_4$$

The parameters C₁, C₂, C₃, stand for the number of financial resources due to the relevant stage of the MSW management system.

The total of financial efficiency of the MSW management system is represented by the Harrington’s desirability function (scale) (Table 1).

Table 1. The total of financial efficiency of the MSW management system

The total of financial efficiency of the MSW management system				Aggregate value
processing <i>P1</i>	utilization <i>P2</i>	neutralization <i>P3</i>	disposal <i>P4</i>	
0,8 ≤ <i>P1</i> < 1,0	0,8 ≤ <i>P2</i> < 1,0	0,8 ≤ <i>P3</i> < 1,0	0,8 ≤ <i>P4</i> < 1,0	High
0,6 ≤ <i>P1</i> < 0,8	0,6 ≤ <i>P2</i> < 0,8	0,6 ≤ <i>P3</i> < 0,8	0,6 ≤ <i>P4</i> < 0,8	Above average
0,4 ≤ <i>P1</i> < 0,6	0,4 ≤ <i>P2</i> < 0,6	0,4 ≤ <i>P3</i> < 0,6	0,4 ≤ <i>P4</i> < 0,6	Average
0,2 ≤ <i>P1</i> < 0,4	0,2 ≤ <i>P2</i> < 0,4	0,2 ≤ <i>P3</i> < 0,4	0,2 ≤ <i>P4</i> < 0,4	Below average
0 ≤ <i>P1</i> < 0,2	0 ≤ <i>P2</i> < 0,2	0 ≤ <i>P3</i> < 0,2	0 ≤ <i>P4</i> < 0,2	Low

 – stands for a sufficient financing level;
 – indicates the insufficient financing level.

5. Conclusions

The evaluation of the financing of the MSW management system makes it possible to choose strategic directions and options of its development. To foresee and monitor the efficient financing of the MSW management system, the research considers a mathematical tool of a six-dimensional model of “waste collection” – “waste transportation” – “waste processing” – “waste utilization” – “waste neutralization” – “waste disposal”. The interpretation of the financing level of the MSW management system is carried out with a modified scale of the Harrington’s (verbal-numerical) desirability function that helps control the interdependence between the factors by rating them.

References

- Botsman, R. (2013). *The sharing economy lacks a shared definition*. https://www.amazon.co.uk/Whats-Mine-Yours-Collaborative-Consumption/dp/0061963542/ref=as_li_tf_tl?tag=teco0a-21&ie=UTF8
- Botsman, R., & Rogers, R. (2010). *What’s Mine is Yours: The rise of collaborative consumption*. Harper Collins.
- Frost & Sullivan. (2018). *The global community is expected to invest over \$ 3.6 billion for digital technology expenses in MSW management*. http://gor-hoz.ru/gh/article_1122.html

- Henten, A. H., & Windekilde, I. M. (2016). *Transaction costs and the sharing economy*. <http://www.collaborativeconsumption.com/2013/11/22/the-sharing-economy-lacks-a-shareddefinition>
- Hramov, D. (2019). *The Ministry of Natural Resources reported the House of Federation on the key outcomes of the MSW reform in 2019*. <https://news.solidwaste.ru/2019/12/minprirody-dolozhilo-o-samyh-vazhnyh-rezultatah-reformy- tko-v-2019-g/#>
- Safonov, A. (2018). *New technologies of waste disposal*. <https://iot.ru/gorodskaya-sreda/novye-tehnologii-dlya-uborki-musora>
- Shulgin, M. (2019). *Methods and techniques of reform implementation*. <https://news.solidwaste.ru/2019/11/metodicheskoe-soprovozhdenie-realizatsii-reformy>
- Varypaev, A. E., Strizhova, S. V., & Kuznetsov, A. S. (2019). New level of waste management. *Scientific and practical bulletin Solid municipal waste*, 17.