The Concept of Circular Economy in the Context of Implementation of Innovative Technologies

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Abstract: This paper investigates the formation of special economic zone (SEZ) mechanics on the basis of the 5R concept. Practical implementation of the concept in the context of implementation of innovative technologies within the new SEZ contains specific proposals: the SEZ resident appraisal rating system that can evaluate current environmental friendliness of the residents as well as control and stimulate their activity was developed; separate waste collection system and action plan that can not only draw attention to environmental issues but also reduce growth in plastic waste were suggested. The research purpose is to develop a method of effective use of circular economy concept mechanics when creating a new SEZ. Innovative technologies for the SEZ functioning organization are used as the object of the research in this paper. Circular economy concept implementation mechanics for comprehensive solution of innovation problems of the new SEZ are the subject of the research.

1 INTRODUCTION

Urgency of the proposed solution stems from the fact that the problem of hydrocarbon cycle is deep and complex for Russia. Considering that development of this sector is promising, effective technologies that can be used in it are promising as well. By 2010, total area of both authorized and unauthorized waste deposits reached 100 thousand ha. By various estimates, from 7 to 10 billion tons of waste are generated in Russia every year. The major part of waste is generated by mineral extraction companies - 6.9 billion tons. 85 billion tons of solid waste have accumulated in the territory of the Russian Federation. Only 10% of plastic waste is recycled and 90% of all types of trash is dumped at landfills.

Circular economy is a generalized term based on waste minimization and renewable resource utilization in contrast to the linear economy (take, make, dispose).

The 5R system is an element of the circular economy. Waste minimization principles.

Technologies are a combination of engineering and scientific knowledge used to obtain a certain product or service.

The advantage of our technologies: increase in recyclable raw materials; elimination of trash impact on the environment; availability of containers in the system; payback period is 6-8 years; reduction of costs for electricity, garbage removal, fuel consumption; expenses involved in construction of a plastics processing plant start from 6.5 million rubles; for example, construction of an operative waste sorting plant with a capacity of 200 thousand tons per year in Novokuznetsk required only 1 billion rubles.

2 RESEARCH METHODOLOGY

The following general scientific research methods were used in this paper: analysis, comparison, generalization and systematization of information.

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The purpose of this paper is to develop a method of effective use of circular economy concept mechanics when creating a new SEZ.

In order to achieve the purpose, the following research problems were set:

- to investigate theoretical issues of formation of circular economy concept mechanisms when creating a new SEZ;
- to analyze existing mechanisms of circular economy concept implementation with regard to the object under observation;
- to offer a set of recommendations for comprehensive solution of innovation problems of the new SEZ.

Innovative technologies for the SEZ functioning organization are used as the object of the research in this paper.

Virtual object under observation in this research is the city of Novosibirsk and the industrial site of the SIBUR Company in the city of Tobolsk.

Circular economy concept implementation mechanics for comprehensive solution of innovation problems of the new SEZ are the subject of the research.

The elements of novelty are a dedicated online survey conducted based on Google Forms and a developed SEZ resident appraisal rating system (environmental friendliness rating).

3 RESEARCH RESULTS

Our team selected the city of Novosibirsk and the industrial site of the SIBUR Company in the city of Tobolsk as the object of the research. We focused on the issue of municipal solid waste volume reduction and improvement of plastic waste collection efficiency. The reasons for selecting the object: the problem of MSW landfill overfilling; high waste volumes; availability of raw material processing infrastructure. Consequently, active measures aimed at waste collection and management have to be implemented.

Areas of concern that have allowed coming up with the offered solution: the city of 1.6 million people generates 645.15 thousand tons of trash per year; 45 thousand tons of plastic waste are generated over a year; more than 100 plastic products companies in the city; 334 unauthorized landfills were found in the region. The problem of MSW landfill overfilling and large waste volumes together with availability of raw material processing infrastructure show that active measures aimed at waste collection and management have to be taken!

The first element of novelty in this paper is a survey of city residents in order to evaluate the effectiveness of waste collection measures. The questionnaire was developed specifically for the research. Small online survey based on a Google Form and dedicated to waste sorting at home was conducted in our locality. The number of people in the survey - 112. It was found that 62% of people does not sort trash. The main reasons: 41% of people does not know how to do that; 34% of people sees no point in it, which is shown in Figures 1 and 2.

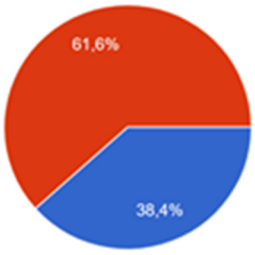

Figure 1: Results of responses to the question: “Do you sort trash at home?” (112 responses).

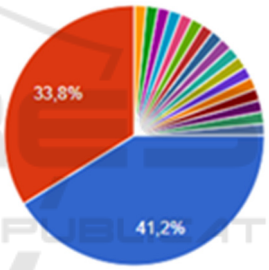

Figure 2: Results of responses to the question: “Why don’t you sort trash?” (68 responses).

Conclusion: it is necessary to teach people how to do that and convince them that this is important.

This is why RETHINK is the key direction in solving the waste recycling problem. In Brazil, the underclass got involved in waste recycling. As a result, the city of Curitiba got ahead of all the others and took the first place in valuable municipal solid waste collection in the world. One of the main principles of waste collection in Japan is separate waste collection. Moreover, this principle is legislated. Tossing the garbage in undesignated areas is prohibited and subject to criminal prosecution and heavy fines. In order to improve efficiency of the recycle stage, the following is required: Based on experience of Japan, mandatory separate waste collection should be legislated. Based on experience of Brazil, more people should be put to work at landfills. Reverse vending machines should be placed in crowded places. More plastic collection facilities

should be opened and a reward for its collection should be increased. Containers for plastic waste should be placed in the areas where there are none. Many people do not sort trash because they simply do not know how to do that and where to take it afterwards. The best way of plastic waste sorting is to place separate containers for PET and other types of plastic. If every type of plastic has its own separate container, the people may get confused and become reluctant to this more complicated way. And raw material recycling plants perform their own re-sorting. For example, Armada-Polymer Company does that in Novosibirsk. Sales of finished products are relevant to the following areas of activity: recyclables are desirable in chemical industry; flakes and granules are cheaper than primary products, which is cost-efficient for polymer product manufacturers; depending on the quality of granules, cleanliness of recycled plastic, flakes may be appropriate for food container production; some flake types can only be used as an additive to plastic materials in production of wash basins, goods for gardeners, PVC pipes, construction materials; plastic bottles are used in production of new bottles, PES fibers for clothes and shoes, house and outdoor furniture. The following operating plastic waste processing enterprises are located in Russia: Khartiya, LLC - the company offers a full range of services in transportation, sorting and recycling of MSW and oversize bulk waste in the territory of North-East Administrative District and East Administrative District of Moscow. ECO-UFA, LLC - the company provides operating and strategic management of the project for collection, transportation, high-level processing and recovery of secondary raw materials, land disposal of municipal solid waste from all the districts of Ufa. Eco-city, LLC - the company collects waste paper, polyethylene and plastic for further processing and recycling. According to our records, out of 7 groups of plastic-containing products in Russia, no one recycles polyvinyl chloride (produces dioxins when combusted) and other types of plastic, such as water dispenser bottles, baby bottles made of polycarbonate, biodegradable plastic products. Everything else is efficiently recycled or can be recycled in Russia.

We have discovered through an analysis that around 2.5 million tons of plastic waste were in Russia in 2019. If we assume that growth in waste increases by an average of 10% per year, then we will have 4.4 million tons of plastic waste by 2025. If new approaches to the problem of plastics pollution are gradually implemented in our country, we will be able to reduce growth in plastic waste down to 3.5 million tons by 2025, which is shown in Figure 3.

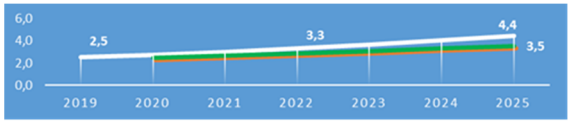

Figure 3: Forecast of growth in plastic waste in the Russian Federation, million tons (volume growth of 10% per year, processing growth by 2%).

Our forecast is based on open-source information (rupec.ru; www.polymerbranch.com).

In reliance on the analysis of literature sources and results of enterprise practices, one can tell that issues related to a variety of disadvantages during implementation appear on each stage of 5R concept implementation.

Our solution for organization of a new special economic zone functioning is based on the circular economy concept with emission minimization and renewable energy sector. We were inspired by Hammarby Sjöstad in Sweden (rodovid.me). More than 4 million tons of trash are generated in this country every year. More than 1.3 million tons of waste were additionally imported from other countries in 2015. Yet, 99% of all waste is recycled: 34% is reprocessed; 49.2% is combusted to generate energy; 16% goes in the compost; 0.8% goes to landfills. We can all learn from them.

Target audience of potential SEZ residents is represented by four focus groups — the companies that are interested in solving the problem of plastics pollution. The first one is the world leaders in the use of plastics: the Coca-Cola Company, PepsiCo, Nestle, Danon; the second one is the sector of consumer goods, foreign companies as well, such as Unilever, Colgate-Palmolive, Mars; the third one is fast food; the fourth one is the public, enterprises of the region and other regions. In other words, on one hand we have consumers with high environmental responsibility and on the other - the SIBUR Company with its enormous scientific and innovative potential. According to declarations of the companies specified above, total amount of plastic waste will be 10 million tons per year. According to provisions of environmental policies, the companies plan on recycling 28 million tons by 2025. Which means that there will be a lot of work.

Suggested tax preferences in comparison to the existing SEZ in Naberezhnye Chelny and an option without preferences are presented in table 1.

Table 1: Tax preferences for attraction of investors and residents of the SEZ.

Preferences	New SEZ	Priority Social and Economic Development Area, Naberezhnye Chelny	Without preferences
VAT on the sale	Exemption for 5 years	18%	18%
Income tax, incl. Russian Federation Tumen Oblast	0% 0-13%	0-5% 0%	2% 18%
Corporate property tax	Exemption for 10 years	0%	2.2%
Land tax	Exemption for 5 years	0%	1.5% on average
Transport tax	Exemption for 10 years		Collected
Reduced rate of insurance for 5 years Compulsory pension insurance Compulsory social insurance Compulsory health insurance	28% 20% 2.9% 5.1%	7.6% 6% 1.5% 0.1%	30% 22% 2.9% 5.1%
Customs duty relief (duty-free zone procedure)	0%	Collected	Collected

As we can see, opportunities for attraction of investors and residents do exist. Moreover, administrative, social and economic preferences were presented. Administrative preferences are special legal status and simplified business registration procedure. Social ones are creation of jobs for competent persons; preservation and development of intelligent potential. Economic ones are reduced rates of housing services and utilities; reduction of office lease prices; accelerated amortization scheme with coefficient 2; foreign investments in industry; stimulation of domestic producers. We suggest introducing economic preferences on the basis of environmental impact evaluation and environmental friendliness rating described below.

As the second element of novelty, we have developed a procedure for determining environmental friendliness rating of a company. Economic preferences will be granted based on its results. We should prepare environmental friendliness rating of residents on the basis of the expert method and use it to determine the scope of activities and preferences of the SEZ residents.

Quantitative criteria (resident ranking criteria) are determined using the 5R system; they are assigned with weight coefficients:

1) rethink - the number of awareness events held (the number per quarter/weight coefficient 0.2);
2) refuse - the amount of disposable unrecyclable cutlery used (kgs per quarter/weight coefficient 0.1);
3) reduce - CO_2 emission reduction criterion. The more negative the company is about CO_2, the higher the score is in our rating (the number of vehicles/weight coefficient 0.3);
4) reuse - the amount of processed raw materials used (kgs per quarter/weight coefficient 0.2);
5) recycle - the amount of raw materials brought for recycling (kgs per quarter/weight coefficient 0.2).

In our view, the formula of current environmental friendliness of residents may appear as follows:

$$\frac{a_1x_1+a_2x_2+a_3x_3+a_4x_4+a_5x_5}{a_1x'_1+a_2x'_2+a_3x'_3+a_4x'_4+a_5x'_5} = \{0\text{-}1\}, \quad (1)$$

where x is ranking criterion; a is weight coefficient; x' is maximum criterion value.

Our formula of current environmental friendliness of residents can be used to determine their rankings in the rating. For example, the more electric cars the company has, the higher the number of awareness events held by it per quarter and the amount of processed raw materials used by it, the higher the ranking will be and the more economic preferences it will get. Maximum value can be determined in reliance on common sense and expert opinion. For example, we can set one awareness event per day (the maximum of 66 eco-events per quarter. 90-24 (3 months-24 weekend days)) This is a relative coefficient, total in relation to maximum.

Protection measures against environmental impact of the SEZ enterprises include: setting an environmental emission limit for our SEZ; emission monitoring; sanctions for violation of the emission limit; incentives for those obeying it.

Separate waste collection system for the zone under discussion. MetroTaifun Company system operation principle was taken as a basis of our system. The system carries waste and recyclable materials to

a drop-off point via underground/land pipelines, the length of which can be up to 4 km. Our system can sort 4 types of trash: plastic (orange containers), organic (black containers), paper (blue containers), glass (green containers). These containers will be placed in public places, at production sites and in residential quarters. Trash from these containers will be carried to a drop-off point via underground pipelines and from the drop-off point it will be transported to a recycling facility or for incineration or disposal. Containers can be placed outside or built into building walls. Since they are sealed, no smell is emitted and they cannot become a nesting place for rodents because trash is not exposed to environment.
Social environmental issue awareness events. In order to solve this problem, action plan based on the 5R concept (rethink, refuse, reduce, reuse, recycle) was developed:

- give compulsory eco-lessons in all schools of Russia and place information stands in schools and other educational institutions with information on the importance of waste sorting;
- upload video content (social advertising) to video hosting platforms and social networks;
- place reverse vending machines in crowded places and open more plastics collection facilities;
- place containers for plastic waste where there are none.
- ban on composite types of consumer goods and on excessive packing.

If new approaches to the problem of plastics pollution are gradually implemented in our country, according to our forecast, we will be able to reduce growth in plastic waste down to 3.5 million tons by 2025.

4 DISCUSSION

Highlights and obtained research results were discussed and won approval at a scientific conference and Case-in International Engineering Championship in the spring of 2020.

5 CONCLUSIONS

This paper investigates the formation of special economic zone mechanics on the basis of the 5R concept. Procedure for an enterprise activity planning in the context of new engineering system implementation was reviewed. Practical implementation of the concept in the context of implementation of innovative technologies within the new SEZ contains specific proposals: online survey based on a Google Form and dedicated to waste sorting was conducted; the SEZ resident appraisal rating system that can evaluate current environmental friendliness of the residents as well as control and stimulate their activity was developed; separate waste collection system and action plan that can not only draw attention to environmental issues but also reduce growth in plastic waste were suggested.

Summing up what has been said, our concept offers the action plan based on the circular economy with waste recycling, emission minimization, renewable energy sector and environmental friendliness rating.

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