Design of a community composting plant for a selected civic amenities building in Slovakia

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ABSTRACT: *The work is focused on an overview of the current state of the recovery of biodegradable waste in the Slovak Republic and EU countries. It offers an analysis of specific ways on the principle of recovery of material for composting. Passes through the various levels of technology and processing biodegradable waste and assesses their impact on environmental quality. The results specify the proposal for an alternative solution for successful community composting facility amenities – University Hospital Kosice, in the form of architectural and technological studies.*

KEYWORDS – *biodegradable waste, handling, EU, legal management, architectural design*

I. INTRODUCTION

At present, the speed of waste production is much higher than the speed and possibilities of their processing. One of the types of waste produced by humans is also biodegradable waste. It is the largest component (34%) of all municipal waste in Europe, and about 60% of this waste is food. In the EU (European Union), around 88 million tons (173 kilograms per person) of food are wasted every year throughout the food chain. This corresponds to about 20% of the total amount of food produced in the EU. At the same time, biodegradable waste, including bio-waste, is a key source of greenhouse gas emissions from landfills and accounts for around 3% of total EU greenhouse gas emissions [1, 2].

General requirements of waste management, such as protection of the environment and human health, e.g. also during waste treatment, and priority waste recycling, are set out in the revised Waste Framework Directive. This directive also contains rules that apply to bio-waste (new recycling targets for kitchen waste) and a mechanism to set quality criteria for compost [3].

Composting is a biological method that mimics the processes that take place in the soil. Over time, the individual components of biodegradable waste will turn into loose soil - humus, which you will be able to use as an organic fertilizer [4, 5]. The raw material composition plays an important role in composting, especially the ratio of carbon and nitrogen in composted biodegradable waste. While soft and moist green waste (such as grass or fruit and vegetable residues) is rich in nitrogen, dry brown waste (such as branches and sawdust) contains relatively more carbon [6, 7].

According to the size and method of composting, we recognize three basic forms of composting: 1. HOME COMPOSTING - composting of biodegradable waste and the simultaneous use of compost in our own gardens. 2. COMMUNITY COMPOSTING - composting, which is performed by a group of people in a certain locality (street, garden settlement, panel block, school, municipality) in order to jointly compost biodegradable waste that is generated in a given locality. The resulting compost is used for the community's own needs. 3. COMMUNAL / INDUSTRIAL COMPOSTING - composting of biodegradable waste from a larger collection area at a central composting plant, which is carried out by a specialized company on a commercial basis. Compost can be used for personal use or put into circulation by sale [8, 9, 10].

At present, composting is the dominant way of biodegradable waste management, but anaerobic digestion in biogas production is also gradually increasing. Biogas is a source of renewable energy. Research and innovation are increasingly exploring the use of bio-waste, especially from food processing, as a new source of higher value products. These are, for example, the mentioned biofuels, but also volatile fatty acids [11, 12].

The impetus for the elaboration of a study on the recovery of biodegradable waste on the principle of composting was the request of the environmental department of the University Hospital Kosice. The aim was to

ensure the legal management of waste and at the same time reduce the amount of waste removed and thus the fees associated with it. On the basis of the provided documents, a variant solution of the composting plant in the form of an architectural and technological study was developed.

II. CHARACTERISTICS OF THE PROPOSED ACTIVITY

The purpose of the study is the recovery of biodegradable waste - collection, treatment, composting and subsequent storage on a paved area. Based on the inputs, a community composting plant was designed, which will process approximately 16.4 tons of biodegradable wastes per year. Composting will take place according to the chosen variant solution in an open system. The end product will be a stable material - compost in quantity of approx. 9.8 t per year, which will be used mainly for the purpose of fertilizing the area (park, garden) and at the same time will be offered free of charge to employees. During composting, biodegradable waste from the local sphere will be used as treated wood forest wood waste in the form of wood chips, green waste and residues of kitchen waste (not cooked food). Specific commodities are listed in Table 1 according the European Waste Catalogue [13].

Table 1. Wastes according European Waste Catalogue chosen for composting

Number	Waste
Chapter 02	WASTES FROM AGRICULTURE, HORTICULTURE, AQUACULTURE,FORESTRY, HUNTING AND FISHING, FOOD PREPARATION ANDPROCESSING
02 01 03	plant-tissue waste
02 01 07	wastes from forestry
02 03 04	materials unsuitable for consumption or processing
Chapter 20	MUNICIPAL WASTES (HOUSEHOLD WASTE AND SIMILAR COMMERCIAL,INDUSTRIAL AND INSTITUTIONAL WASTES) INCLUDING SEPARATELYCOLLECTED FRACTIONS
20 01 08	biodegradable kitchen and canteen waste
20 02 01	biodegradable waste

The aim of the proposed activity is to reduce the costs of exporting mixed municipal waste (€ 2,000 / year), to obtain quality organic fertilizer (assumption 9.8 / year) and to increase the current level of environmental quality within the proposed area.

III. LOCATION OF THE PROPOSED ACTIVITY

The locality of interest is located in the urban area of the city of Kosice (Slovakia) - South district. The proposed activity is planned to be implemented in the hospital complex in Košice, which is bordered on the northwest (Rastislavova Street) and southeast (Gemerska Street) by the main city roads, on the south and on the west by service city roads connecting the residential zone. The area is fenced around the perimeter, redistributed by rectangular access roads with entrances from the west and east side. The proposed location of the composting building is in the southern part of the area on the unused area of the potato warehouse. Fig. 1 the broader relationships of the area of interest.

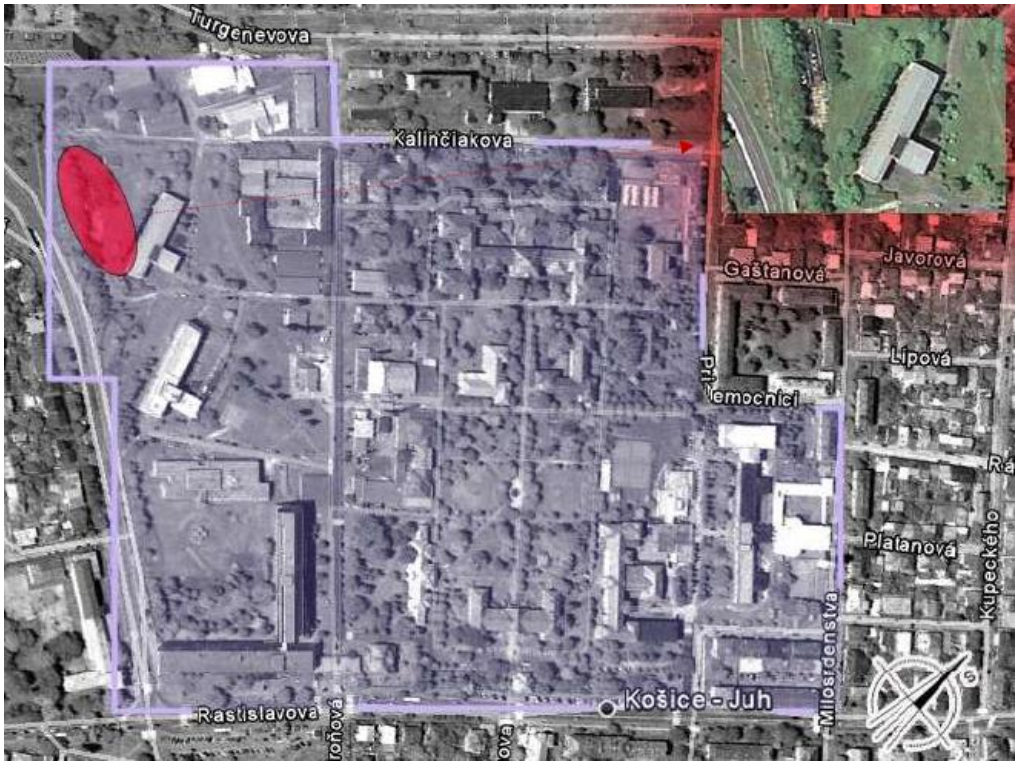

Figure1. Location of interest area (red color)

The planned location of the future composting facility consists of two parts of interest. The first part consists of a paved surface of stacked road panels measuring 3,000 x 2,000 x 150 mm with a total area of 22,000 x 12,000 mm (Fig. 2). This area is currently used for temporary storage, e.g. calamitous wood.

Figure 2. Area of stacked road panels

The second part of interest are the buildings of the vegetable and fruit warehouse, whose current desolate state does not allow the purpose of the storage space to be fulfilled (Fig. 3). The buildings are made of steel frame beams, covered with asphalt shingles attached to wooden formwork. Wall constructions are made of concrete walls and aerated concrete blocks. The floor is created by a concrete screed. Access to the building is provided by double-leaf steel doors with an opening of 3000x3000 mm.

Figure 3. Building of the vegetable and fruit warehouse interior

IV. VARIANT SOLUTIONS FOR A COMMUNITY COMPOSTING PLANT

Based on the already mentioned facts, e.g. spatial division, the design of the community composting plant was implemented in two variants (Scenario A and Scenario B), with the aim of a complex architectural and technological solution.

Scenario A - The subject of this variant is a new building in the shape of the human eye depicting the awakening of man, in the sense of re-energizing the interrupted cycle of matter by landfilling. The architectural design was created in order to bring a progressive legacy to industrial buildings.

The composting building in this scenario is designed from a prefabricated steel frame structure, anchored to the original paved surface. Biodegradable waste is processed and stored in areas with spatial boundaries (in boxes) in order to save space. Fig. 4 shows the spatial division of the individual areas of the composting plant. For favorable maturation of compost, the following areas are considered in this variant (Fig 4): Access road (1), Composting area (2), Handling area (3), Rotting place for leaves and grass (4), Area for chip storage (5), Area for temporary storage of biodegradable waste (6).

Figure 4. Spatial distribution of community composting plant - Scenario A

Scenario B - The subject of second variant is the revitalization of the site formed by the existing storage spaces and the paved area in front of them. The presented variant solutions are specified in more detail below in the text.

The place of the proposed community composting plant is divided into two parts: exterior and interior. The exterior part is formed by purposefully divided composition areas on the existing paved area. Fig. 5 shows the spatial division of the individual areas of the composting variant B into exteriors: Access road (1), Rotting place for leaves and grass (2), Area for temporary storage of bio waste (3), Reconstructed composting building (4).

Figure 5. Spatial division of the composting plant, Scenario B - exterior

The interior part consists of a building in a desolate state requiring the reconstruction of the roof cladding. The purpose of the building reconstruction would be the main processing of bio-waste. The building is made of steel frame beams, covered with asphalt shingles attached to wooden formwork. Wall constructions are made of concrete walls and aerated concrete blocks. The floor consists of a paved surface made of concrete screed, on which the redistributed areas are necessary for the favorable course of the composting process. Access to the building is provided by double-leaf steel doors with an opening of 3000x3000 mm. Areas of a community composting plant - interior part (Fig 6): Handling area (1), Composting area (2A, 2B), Chip storage area (3).

Figure 6. Spatial division of the composting plant, Scenario B - interior

V. CONCLUSION

The current state of material recovery of waste is taking the direction of nationwide and society-wide intensification. EU member states (including the Slovak Republic) are starting to take the right direction, also with the help of non-repayable financial contributions from European funds and state subsidies. This form of aid is also intended for the collection and legal management of all waste, including bio-waste.

The work was created in order to increase the material recovery of bio-waste in a selected area of civic amenities, a hospital in the town of Kosice. The main goal was to reduce the amount of waste and thus the fees for the export of mixed municipal waste. Based on the production of waste in, two variant solutions (Scenario A and Scenario B) were proposed, which differ from each other in the way of evaluating the solved area, their shape, materials used and, last but not least, the time side of implementation.

The implementation of any variant would significantly increase the quality of the environment and achieve savings in a relatively short period of time.

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