Waste Management Analysis on the Example of a Leading University: VŠB-TUO (VŠB – Technical University of Ostrava)

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Abstract

The paper concerns an analysis of waste management at VŠB – Technical University of Ostrava (VŠB-TUO). The paper focuses mainly on mixed municipal waste, and paper and cardboard waste, which make up the largest part of all waste generated at this university. The results of analyses of these three types of waste are presented. The analyses were carried out to determine the actual raw material composition of the contents of the collection bins and to determine how full they were on collection days. The studies were carried out within the framework of national waste legislation in line with European Union legislation. The results of these analyses served as the basis for the development of a waste management concept at the university.

Keywords: *waste management, municipal solid waste (MSW), mixed municipal waste (MMW), combustible waste, mixed municipal waste analysis, biodegradable waste (BDW)*

Introduction

Today's developed societies continue to struggle with a huge amount of waste generated, resulting in significant difficulties in waste disposal. The increase in waste generated seriously threatens human health and the environment. In order to promote efficient waste management, it is important to design and implement new tools that allow users to reduce the amount of waste generated and improve waste treatment. [1]

Today's universities can be compared to “small cities” with large areas and a wide range of human activities affecting the environment. State and international institutions require these universities to integrate sustainable strategies into all their activities in order to positively influence the social, economic, and environmental well-being of both their immediate surroundings and the wider environment. [2] The importance of universities in promoting sustainable development has been emphasised in various groundbreaking declarations including the Talloires Declaration (1990), the Halifax Declaration (1991), the Kyoto Protocol (1993), the Swansea Declaration (1993), the Copernicus Charta and others. [3]

VŠB – Technical University of Ostrava (VŠB-TUO) is a large university with an extensive campus and modern facilities. The total number of students is approximately 11,000. This number of students translates into the volumes of waste generated at the university. The purpose of this paper is to analyse the waste generated at VŠB-TUO and the current methods of waste disposal in a university environment. Particular attention is paid to mixed municipal waste and so-called combustible waste, which make up the largest part of waste generated at this university. The data obtained from the waste sampling process has been used to create a concept defining how the university will manage and treat waste. In practice, this means that, based on a study of the types and quantities of waste generated by the university, a proposal was developed for a strategy to manage waste in an efficient and environmentally-friendly way, and to minimise its impact on the environment and promote sustainability.

Current status

VŠB-TUO generates approximately 600 tonnes of waste annually [4,5,6,7,8], which is generated during the daily activities of students and university staff, or visitors to the area. According to Decree No. 8/2021 (Journal of Laws) on the catalogue of waste and the assessment of waste properties (Waste Catalogue), as amended [9], this waste is designated as "Other waste" (O), which is the largest amount in the university area, and "Hazardous waste" (H).

The largest part of the remaining waste is mixed municipal waste (hereinafter “MMW”) with the catalogue number 20 03 01, combustible waste which is listed under catalogue number 20 01 01 and bulky waste with catalogue number 20

Tab. 1. Observed SKO fractions depending on the classification level [15]

Tab. 1. Zaobserwowane frakcje SKO w zależności od poziomu klasyfikacji [15]

Poziom I	Poziom II	Poziom III
Paper	Packaging	Cardboard
		the remaining
	Not packaging	Magazines, leaflets, and similar papers
		Newspaper and office
	Other	
Plastics	Packaging	Foils
		Hard plastics
		PET colorless
		Colored PET
		PS
		the remaining
	Not packaging	
Bio	Kitchen	Fruits and vegetables
		Plant, fruit and vegetable remains
		Other foodstuffs
	From gardens and parks	
Wood	Only modified	
Glass	Packaging	
	Not packaging	
Metals	Packaging	Ferromagnetic
		Aluminum
		The remaining
	Not packaging	Ferromagnetic
		The remaining
Textiles	Clothes	
	Other textile materials	
Composite and beverage cartons	Beverage cartons (four-packs)	
	The remaining	
Electrical equipment		
Batteries and accumulators		
Other waste	Diapers and hygiene waste	
	Mineral waste	
	NO-other potentially hazardous waste	
	Composite products	
	Other	
Share less than 400 mm		
Share below 20 mm		Ash
		Other organic substances
Share less than 10 mm		Ash
		Other organic substances

Tab. 2. Collection dates and sample weights of 20 03 01 – Municipal solid waste (container)

Tab. 2. Daty odbioru i masa próbek 20 03 01 – Stałe odpady komunalne (pojemnik)

Date	19.05.2023	01.06.2023	13.07.2023	04.08.2023	13.09.2023	11.10.2023
Mass [kg]	18.7	39.1	24.5	17.1	61.6	45.2

Tab. 3. Collection dates and sample weights of 20 01 01 – Combustible waste (container)

Tab. 3. Daty odbioru i masa próbek 20 01 01 – Odpady palne (pojemnik)

Date	19.05.2023	01.06.2023	13.07.2023	04.08.2023	13.09.2023	11.10.2023
Mass [kg]	18.7	39.1	24.5	17.1	61.6	45.2

Tab. 4. Sampling period and total mass of 20 01 01 – Paper and cardboard (bag collection)

Tab. 4. Okres pobierania próbek i masa całkowita 20 01 01 – Papier i tektura (odbiór worków)

Date	24.05.2023	14.06.2023	12.07.2023	04.08.2023	19.09.2023	04.10.2023
Mass [kg]	17.3	27.4	18.4	17.9	38.3	46.5

Tab. 5. Sampling period and total mass of 20 03 01 – Municipal solid waste (bag collection)

Tab. 5. Okres pobierania próbek i masa całkowita 20 03 01 – Stałe odpady komunalne (zbieranie worków)

Sampling period	September – October 2023
Total mass [kg]	13.36

03 07. This waste is generated continuously throughout the year. Irregularly generated waste includes, for example, construction and demolition waste, and biodegradable waste from environmental maintenance. [10]

Waste management at VŠB-TUO is subject to the Waste Management Directive TUO_SME_05_005 version H [11], which sets out the obligations of waste producers at the university. Decision No. 194/22/OH, reference number SMO/804179/22/OŽP/MA, dated 30.11.2022, issued by the City of Ostrava (MMO). [12]

The decision approves the waiver of selective waste collection at VŠB-TUO. The decision could have been issued on the basis of § 30(5) of the Act No. 541/2020 on Waste [13] and is currently in force until 30 November 2026. [11,12] The omission applies to the following types of waste [11]: VŠB-TUO is obliged to classify mixtures of waste into the

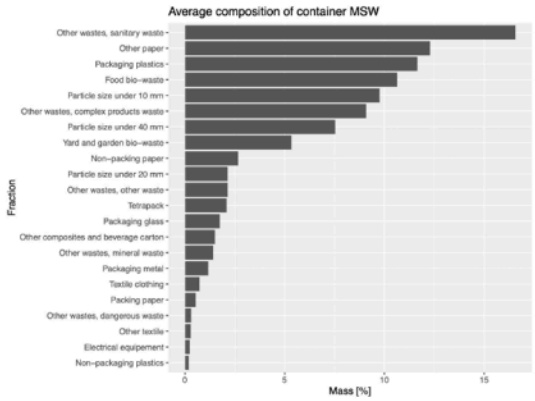

Fig. 1. Average raw material composition of mixed municipal waste in containers
Rys. 1. Średni skład surowcowy zmieszanych odpadów komunalnych w pojemnikach

predominant type of waste for record-keeping purposes and to classify the remaining mixture of unusable waste into the second category under the catalogue number 20 03 01 Mixed municipal waste". [11]

University waste management system

Within the university (e.g. in the Rector's building), waste is collected by staff and students in waste bins of different capacities (e.g. 50 dm³ or 25 dm³), which are placed in corridors, teaching rooms, offices, and lecture halls. The bins are labelled according to the type of waste that is collected in them (e.g. as "municipal" (MW) or "paper+plastic" (PP)).

From the waste bins located in the university buildings, the cleaning service staff collect selectively into three-ply paper sacks, which are then put into the bins according to the type of waste. These sacks are reused multiple times for their intended purpose. From the sacks labelled as paper and plastic, cleaning services staff segregate clean packaging paper and plastic waste, which is collected separately in a paper bin and a plastic bin. The remaining contents are stored in bins labelled as combustible waste, where smaller wood waste is also stored. It is this combustible waste and MMW that will receive the most attention in this paper. [14]

A total of 100 bins for waste types 20 01 01 and 20 03 01 [14] are available at VŠB-TUO in Ostrava-Poruba: 53 1100 dm³ bins for MMW, 2 240 dm³ bins for MMW, 7 120 dm³ bins for MMW, 37 1100 dm³ bins for combustible waste, 1 240 dm³bin for combustible waste. The remaining bins on the site are for clean waste, i.e. 8 240 dm³ bins for plastics and 8 240 dm³ bins for paper and cardboard. [15]

The contents of the MMW and combustible waste bins are collected from the university campus three times a week. The combustible waste (20 01 01), once collected from the site, is further processed (crushing, homogenisation) and used as certified fuel, which is burned in e.g. cement plants. MMW is no longer used and is landfilled. [15]

As part of the optimisation of waste management at VŠB--TUO, the project Supporting the Environmental Aspects of University Operations was implemented in 2022, which is in line with the university's strategic plan. As part of this project, an analysis of the production of all types of waste at the university over the past five years was carried out, with a particular focus on MMW and combustible waste, which account for the largest part of annual production. The results of the project identified deficiencies in waste segregation and deviations in waste records. The data from the continuous records are reported by an employee of the maintenance services to the Integrated System for the Performance of Reporting Obligations (ISPRP), set up by the Ministry of the Environment. The system is managed by the Czech Environmental Information Agency (CENIA) and its task is to provide administrative support, coordination, and development of this information system. Data is therefore managed in the ISPRP system, and the results from this data then allow the development of the production of individual types of waste and changes in waste production over different periods of time to be monitored. Forecasts of waste generation can then be made using mathematical models. [5]

In 2023, VŠB-TUO participated in the student grant competition for the Waste Management Optimisation project, which is based on the project Supporting the Environmental Aspects of University Operations and focuses on the analysis and optimisation of waste management at VŠB-TUO.

Methodology

Ministry of Environment (MŽP) methodology for determining the composition of MMW, MW

The methodology for determining the composition of MMW, MW is issued by the Ministry of the Environment (MŽP) in order to obtain and then statistically process information on individual components of MMW. [16] "The purpose of the methodology is to establish procedures that allow comparability and reproducibility of the results of field surveys aimed at determining the composition of MMW, but also of other types of MW (separately concentrated MW components)". [16]

The methodology divides the selected waste into three levels, from basic classification to detailed waste. The methodology identifies the first and second levels of sorting as mandatory. It then divides the waste into different fractions depending on the material. The waste is sorted on welded sieves with a mesh size of 40 × 40 mm, 20 × 20 mm, and 10 × 10 mm. Waste with a diameter greater than 40 mm is sorted by fraction and then shaken on individual sieves. The individual oversieve, intersieve and subsieve fractions are weighed and their weights recorded. [16]

The purpose of the waste sampling at the university was to determine the quality of sorting of individual components of

Fig. 2. Fraction of construction waste in a container for SKO
Rys. 2. Frakcja odpadów budowlanych w kontenerze dla SKO

municipal waste, and then to assess the possibility of proper waste management on the VŠB-TUO campus. The sampling process was carried out according to the methodology described above for determining the composition of MMW, MW. The sampling concerned 20 03 01 MMW, 20 01 01 Combustible waste and 20 01 39 Plastics.

Samples were taken in the area of the university's Rector's building, where waste is mainly generated in offices, meeting rooms, corridors, and toilets. This area is home to the largest container yard, where the majority of waste from university buildings is collected and taken away.

Staff and students separate their waste into bins labelled "municipal waste" and "paper and plastic". In the morning, the cleaning person segregates this waste into paper sacks, which are then taken to the outside containers. The sacks labelled "paper and plastic" are put into the combustible waste bin.

Sampling of the mixed municipal and combustible waste that was taken from the containers took place between May 2023 and October 2023 at monthly intervals. A total of six MMW containers with a total weight of 206.20 kg and six combustible waste containers with a total weight of 165.8 kg were sampled. In addition, MMW and paper and cardboard waste samples were taken from the sacks on an irregular basis, prior to being placed into the containers.

Sampling results

The figures for individual bin collections and their weights are shown in Tables 2 and 3. The number of retrievals from paper sacks for MMW waste, and paper, and plastics and their total weight are provided in Tables 4 and 5.

Figure 1 shows graphically the determined average raw material composition of the contents of the MMW bins. These average values were calculated from the six analyses carried out of the total weight of 206.20 kg of waste. Figure 2 clearly shows that the composition was dominated by the following: other waste (mainly sanitary waste), contaminated paper waste (mainly contaminated office paper), packaging plastic waste, biodegradable waste, and finer mesh fractions. The larger share of the remaining waste fraction was due to the presence of mineral waste (building materials, plaster, bricks), which, however, should be placed in large-capacity bins.

The largest part of the subsieve fraction consisted of smaller pieces of food, tea bags and paper up to 40 mm in diameter. The fraction up to 20 mm mainly contains soiled paper and smaller pieces of food, while the fraction up to 10 mm mainly consists of bio-waste such as coffee beans and dust. The samples also contained electrical equipment, including extension, and connecting cables, and wire residues.

Figure 3 shows graphically the determined average raw material composition of the contents of the combustible waste bins. These average values were calculated from the six analyses carried out of a total weight of 165.8 kg of waste. As can be seen from this sample, wastes were found that should not be placed in the 20 01 01 waste bins. These were specifically: glass, bio-waste, and electrical equipment (cables) and from the other waste group (minerals): waste, composite products such as shoes and bags, sanitary waste, ND). [16]

Figure 4 shows the average MMW raw material composition in the sacks before being put into the containers. The subsieve fraction was mainly of biological origin and included coffee beans and smaller pieces of food. The paper and cardboard fraction was mainly contaminated paper, including shredded office paper. The weight of this sample was 21.68 kg.

Figure 5 graphically shows the average raw material composition of the paper and cardboard waste collected from the sacks prior to being placed in the combustible waste bin. The total weight of the sample was 13.61 kg. Unlike the sample from the bin, it does not contain glass fractions. The sample consisted mainly of the paper and cardboard fraction, where shredded office paper predominated. The second largest component was plastic waste, consisting mainly of packaging material. Smaller pieces of bio-waste, coffee beans and pieces of paper from shredders were also present in all the subsieve fractions.

Figure 6 graphically shows the raw material composition of the waste collected from the plastic waste bin. The total weight of the sample was 13.81 kg. As can be seen, this sample included waste that should not be put into the plastic waste bins 20 01 39. These were in particular: composite products, soiled paper, biodegradable waste, metal waste, glass, wrapping paper and textile waste. The subsieve fractions mainly contained smaller pieces of bio-waste and coffee beans.

From the figures above, it can be seen that all MMW samples are dominated by the paper and cardboard fraction as well as plastic waste. In the paper and cardboard fraction, there was paper from shredders, ordinary office paper and wrapping paper. Although this type of paper is recyclable, by being concentrated in the bins designated for MMW, it is mixed with other fractions such as the bio-waste fraction, resulting in contamination and making it non-recyclable. There was also a significant proportion of the plastics fraction, which could be segregated appropriately into bins designated for plastic waste. There was a glass fraction in almost all samples. Glass should be disposed of separately in the glass waste bins located in the corridors of the University. For the MMW samples and combustible waste from the containers, waste elec-

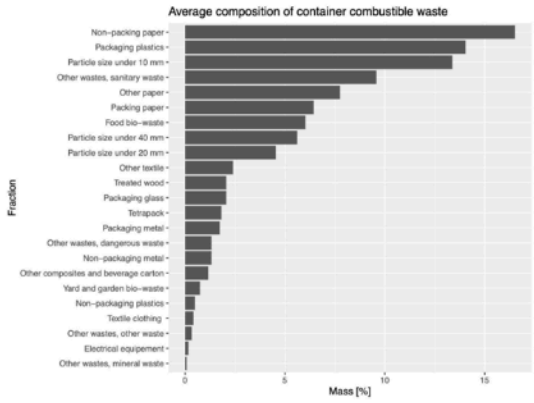

Fig. 3. Average raw material composition of combustible waste in containers
Rys. 3. Średni skład surowcowy odpadów palnych w pojemnikach

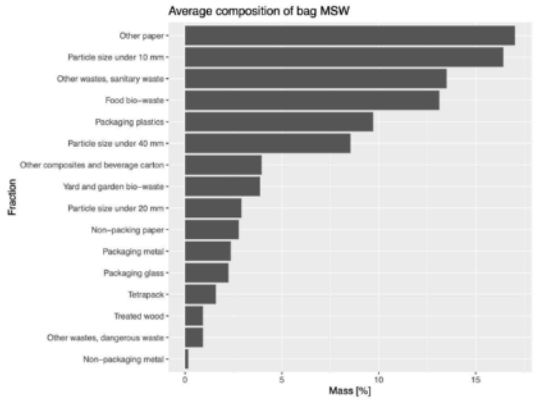

Fig. 4. Average raw material composition of mixed municipal waste in bags
Rys. 4. Średni skład surowcowy zmieszanych odpadów komunalnych w workach

trical equipment was found, including connection and power cables. These should also be separated for proper disposal or recycling. A one-off sampling of a plastic waste bin detected undesirable waste fractions, especially other waste, especially composite products, but also paper, metal, glass, textiles, and biodegradable waste.

The analyses also revealed that the containers are not filled effectively and are disposed of incompletely. Data from OZO Ostrava a.s. shows that the average weight of waste in a 1.1 m³ bin is 54 kg for mixed municipal waste and 27 kg for combustible waste. The Czech Agency for Environmental Information (CENIA) reports [18] that the specific mass of mixed municipal waste is 160 kg per 1 m³. In addition, it can be seen from Table 5 that during sampling carried out at VŠB TUO as part of the Waste Management Optimisation project at VŠB TUO, the average weight of waste in 1.1 m³ bins on the day of collection was 34.4 kg for MMW and 30.2 kg for combustible waste.

From the above data, it can be concluded that the filling of bins is not optimal. The optimal solution would therefore be to obtain underground containers with a larger volume, equipped with a hydraulic press. This would lead to the export of filled containers and, at the same time, and to making the space on the VŠB-TUO campus more visually attractive.

Conclusions

The result of the analysis was that waste segregation at the university was not effective. Action has been taken to avoid these shortcomings. Inconsistent labelling of the collection bins is also a problem.

During sampling, it was found that the contents of the waste bins partly do not correspond to the composition of the waste that should be placed in the bins. Electrical equipment was found in the containers for MMW, which should be put in the bins intended for electrical waste, and mineral waste, which should be collected in large-capacity bins. A similar case was also found in the bins for combustible waste, where electrical waste was found. In addition, it was noted that there was a significant component of paper and cardboard in the MMW containers, including contaminated office paper. If this paper had been placed separately in the bins designated for paper and cardboard, it would not have needed to be mixed with other MMW components.

Proposals for measures to improve waste management at VŠB-TUO

- Increased education of operational services staff, university staff and students in the field of waste management.
- Switching to an underground bin system equipped with a hydraulic press as part of making the university grounds more visually attractive and in cooperation with the waste collection company. The advantage of underground containers is primarily to save space. Although they look like small rubbish bins at the top, their volume under the surface is usually

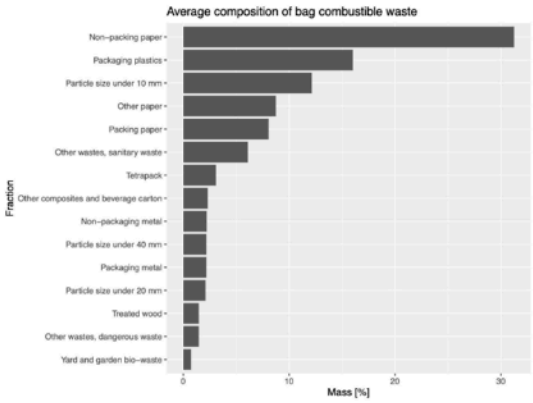

Fig. 5. Average raw material composition of combustible waste in bags
Rys. 5. Średni skład surowcowy odpadów palnych w workach

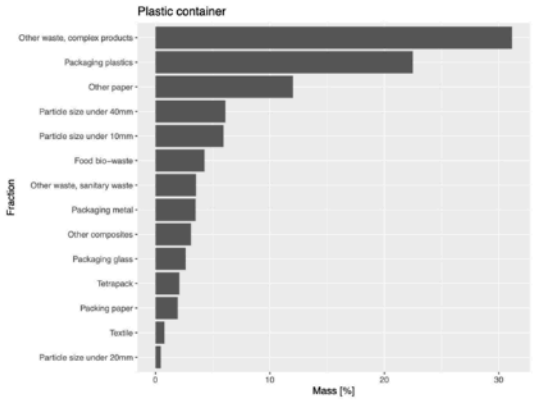

Fig. 6. Average raw material composition of plastic waste in a container
Rys. 6. Średni skład surowcowy odpadów tworzyw sztucznych w pojemniku

Tab. 6. Average mass of MSW and combustible waste in container (1m3) on the day of its export
Tab. 6. Średnia masa MSW i odpadów palnych w kontenerze (1m3) w dniu ich wywozu

Data origin	OZO Ostrava a.s.		Data obtained by sampling	
Types of waste	MSW	combustible waste	MSW	combustible waste
Average mass [kg]	54	27	34.4	30.2

three times that of a regular bin. Another advantage is undoubtedly making the surroundings more visually attractive, which consists primarily in the elimination of rubbish lying on the surface, but also in the minimisation of unpleasant odours, especially during the summer months. Due to their large volume, as well as the lower temperatures underground, they do not need to be emptied as often as classic above-ground containers.

- Ensuring selective collection of selected municipal waste (paper, plastics) preferably by 2025, but by 2030 at the latest. [14]. The transition to selective collection will therefore be smooth and there will be sufficient time for this.

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Analiza gospodarki odpadami na przykładzie wiodącej uczelni – VŠB-TUO

Artykuł dotyczy analizy gospodarki odpadami na Uniwersytecie Górniczo-Technicznym w Ostrawie (VŠB-TUO). W artykule zwrócono uwagę głównie na zmieszane odpady komunalne oraz odpady z papieru i tektury, które stanowią największą część wszystkich odpadów powstających w tej uczelni. Przedstawiono wyniki analiz tych trzech rodzajów odpadów. Analizy przeprowadzono w celu określenia rzeczywistego składu surowcowego zawartości pojemników zbierających oraz określenia stopnia ich zapełnienia w dniach odbioru. Badania przeprowadzono w ramach unijnego prawodawstwa dotyczącego odpadów. Wyniki tych analiz posłużyły jako podstawa do opracowania koncepcji gospodarki odpadami na uczelni.

Słowa kluczowe: *gospodarka odpadami, stałe odpady komunalne (TKO), zmieszane odpady komunalne (SKO), odpady palne, analiza zmieszanych odpadów komunalnych, odpady ulegające biodegradacji (BRO)*