



MORPHOLOGICAL CONTENT AND RECYCLABILITY OF SEPARATE COLLECTED PACKAGES: A CASE STUDY FOR KAUNAS, LITHUANIA

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Packaging material can arise from a wide range of sources, and they are commonly used for food, medicine, household appliances, items to enclose or protect products during distribution, storage, sale, delivery, and use. Which material (paper, plastic, glass, wood, metal, multi-layer or other packaging) will be used, depends on the type and properties of the product, the purpose of the packaging and the price.

The most common packaging waste is made from paper and cardboard (40,9 %), in the second place is plastic package waste (19 %), glass packaging waste accounts for 18,7 %, woods – 16,1 %, metal – 5 % and 0,3 % – other package waste (see Figure 1) (Eurostat, 2020). However, to sort waste into these fractions is not enough in order to ensure high rate recycling and recovery of materials because of different properties of materials.

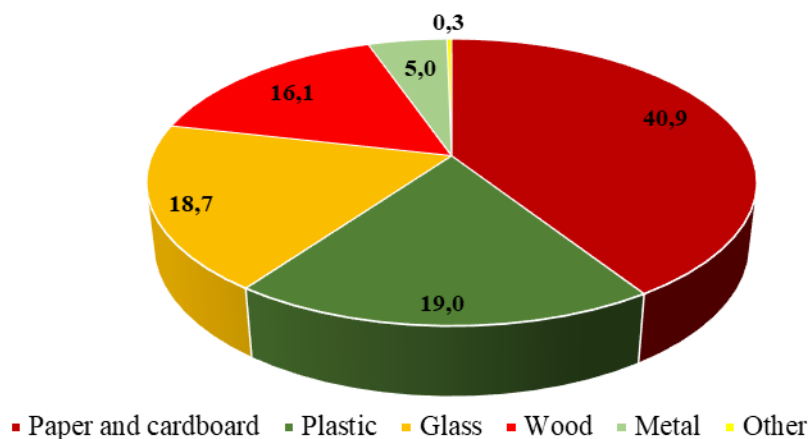


Figure 1. Packaging waste generated by packaging material (%), EU-27, 2018 (Eurostat, 2018)

Plastic is becoming more widely used material in packaging due to its properties such as low density and thermal conductivity, chemical resistance, transparency, lightness, cheap manufacturing process, easy moulding, more simple technological recycling, etc. Most common used polymers for package are thermoplastics, which covers almost 85 % of overall plastic market demand (such as polyethylene terephthalate (PET), high density polyethylene (HDPE), low density polyethylene (LDPE), polyvinyl chloride (PVC), polypropylene (PP), and polystyrene (PS)), while the thermosets

account for 15 % overall plastic market (duroplast, polyurethane (PU), polyester resin) (Hestin et al., 2017).

According to the reported data of Eurostat, it is known that the total quantity of generated packaging materials rose by 6,7 million tonnes from 2008 to 2018 (approximately + 9,4 %). It is estimated that in 2018 EU had 174 kg of packaging waste per inhabitant (the total volume per inhabitant from 2008 to 2018 increased by 12.4 kg). In 2008-2018 the recycling rate of packaging waste increased from 60.4 % to 66.3 % while the recovery (recycling, energy recovery and other forms of recovery) rose from 73.8 % to 80.9 % during this period. All EU countries should achieve the target to recover 60 % material from packaging waste. Although recycling is the main form of recovery in all countries, energy recovery from packaging waste still contributes significantly to the overall recovery rate.

To conserve the planet's resources, it is important to monitor and evaluate packaging waste recycling rates and analyze their potential. To reach the sustainable development goals, EU is committed to recycle 70 % of all packaging waste by 2030, in line with the priorities of the waste hierarchy (European Parliament, 2018). Based on the data of Eurostat (2018), in 2018 Lithuania recycled 60,7 % package waste and it was in the first place in EU according to the recycling rate of plastic packaging waste, (recycled 69,3 % plastic waste). Although most EU countries have already met some of the EU's packaging recycling targets projected for 2025 or even 2030, they still face with the recycling problems of wooden, aluminium (multilayer) and other plastic packaging waste. To evaluate the possibilities of increase of the package waste recyclability and recovery rates in Lithuania, this study is focused specifically on the analysis of recycling opportunities of the morphological composition of packaging waste collected separately in Kaunas city private households.

The aim of investigation is to analyse the morphological composition of packaging waste collected separately in Kaunas city private households and to evaluate its recycling possibilities. The analysis of the mixture of paper, plastic and metal packaging waste was performed in the winter and spring (one time per month) in the waste management company JSC "Kauno švara".

A group of students manually sorted a randomly picked pile of packaging waste. First, the waste was sorted by different morphological fractions according to the identification marks of international standards on the packaging (1 PET, 5 PP, 6 PS, etc.) (European Parliament and Council Directive 94/62/EC). Further, each fraction was assigned to the groups: currently recyclable, can be recycled outside local businesses, theoretically can be recycled, recycling options are being investigated and not recyclable (Šleiniūtė et al, 2021).

In a morphological study carried out in the sample of 21st of January 2021, the largest amount of sorted mixed packaging waste was made up of plastic and composites – 53,5 %, mix small fraction – 13,8 %, paper and cardboard – 13 %, metal – 9,5 % and textile – 6,3 % and glass – 3,9 % (see Figure 2). In the sample of the 15th of March 2021, the same trend remained, only the percentage distribution of waste in fractions has changed, plastics decreased (44 %), increased the amount of paper and cardboard (25,8 %) and mix small fraction (18,5 %), while metal and textile fractions percentage composition slightly decreased. In the sample of the 15th of April 2021, the largest fraction of packaging waste was still plastics – 34 %, a significant increase was observed in small unsortable fraction – 30,7 %, the composition of paper remained as in March – 25,4 %, a slight decrease in metal – 7,4 and textiles amounted to 1 %. Wood was also detected 0,5 %, as well as electrical and electronic equipment – 0,5 %.

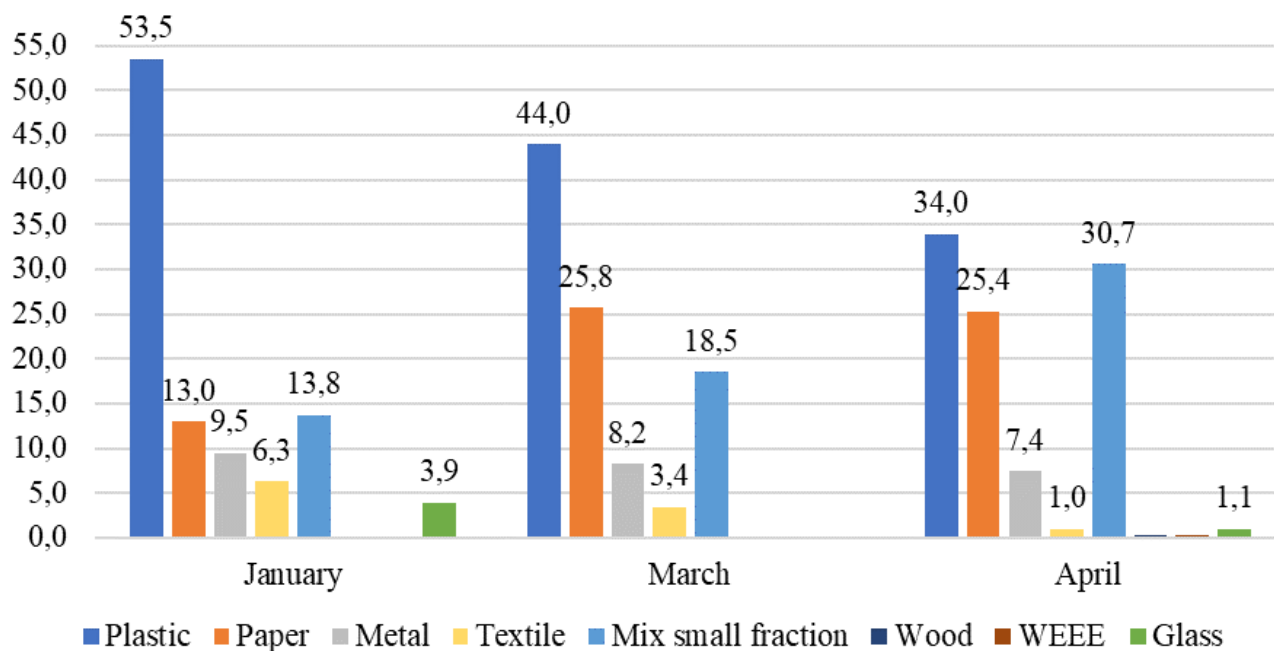


Figure 2. Distribution of packaging waste mixture in January, March, and April in Kaunas city private households, %

Observing the fractional distribution of packaging waste in Kaunas city private households in January, March and April, a tendency of decrease of plastic waste and increase of small, unsorted fractions can be seen.

More than 40 % of all package waste in the sample of January are actually recycled, including paper, PET, LDPE, HDPE packaging, tetrapacks and all metal (see Figure 3). Also, more than 15 % of packaging waste (glass, polyurethanes, polystyrene foam, part of heavy plastic) could be recycled in other Lithuanian waste recycling companies. Another 6,7 % of packaging consisting of rigid polypropylene and polystyrene packaging (containers, boxes, tools) are possible to recycle. Flexible packaging containing aluminium accounts for 2 % of packaging waste and its recycling potential is currently being investigated. 35,9 % waste (small, unsorted fraction, part of heavy plastic, textile and other flexible plastic) is unsuitable for recycling, suitable only for incineration.

A similar but slightly better situation was observed in the March and April samples. 59,1 % of all package waste in sample of March are recyclable, they can actually be recycled 4,3 %, possible to recycle 10 %, investigated for recycling 1,5 % and 25,1 % not recyclable. 49,5 % of all package waste in sample of April are recyclable, can be recycled 9,2 %, possible to recycle 4,9 %, investigated for recycling 0,8 % and 35,6 % not recyclable.

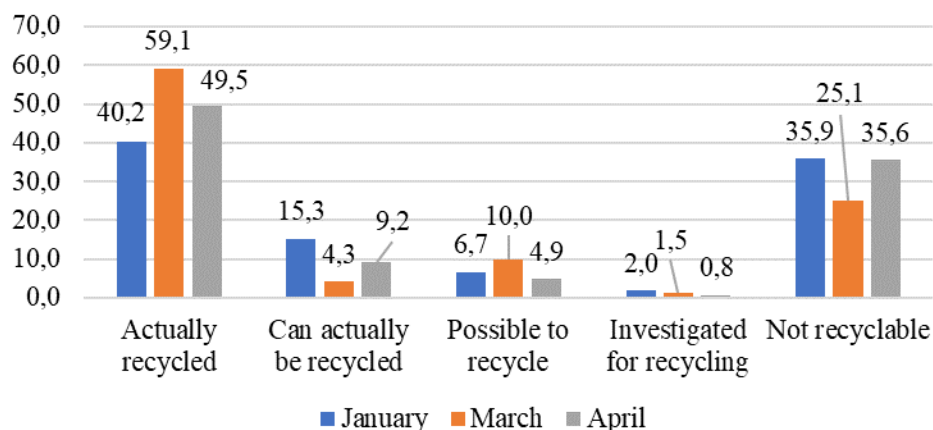


Figure 3. Recyclability possibilities of package mixture waste composition in Kaunas city private households in January, March, and April, %

Packaging waste contains various types of materials. The distribution of percentage composition in the studied samples is shown in the picture below (see Figure 4).

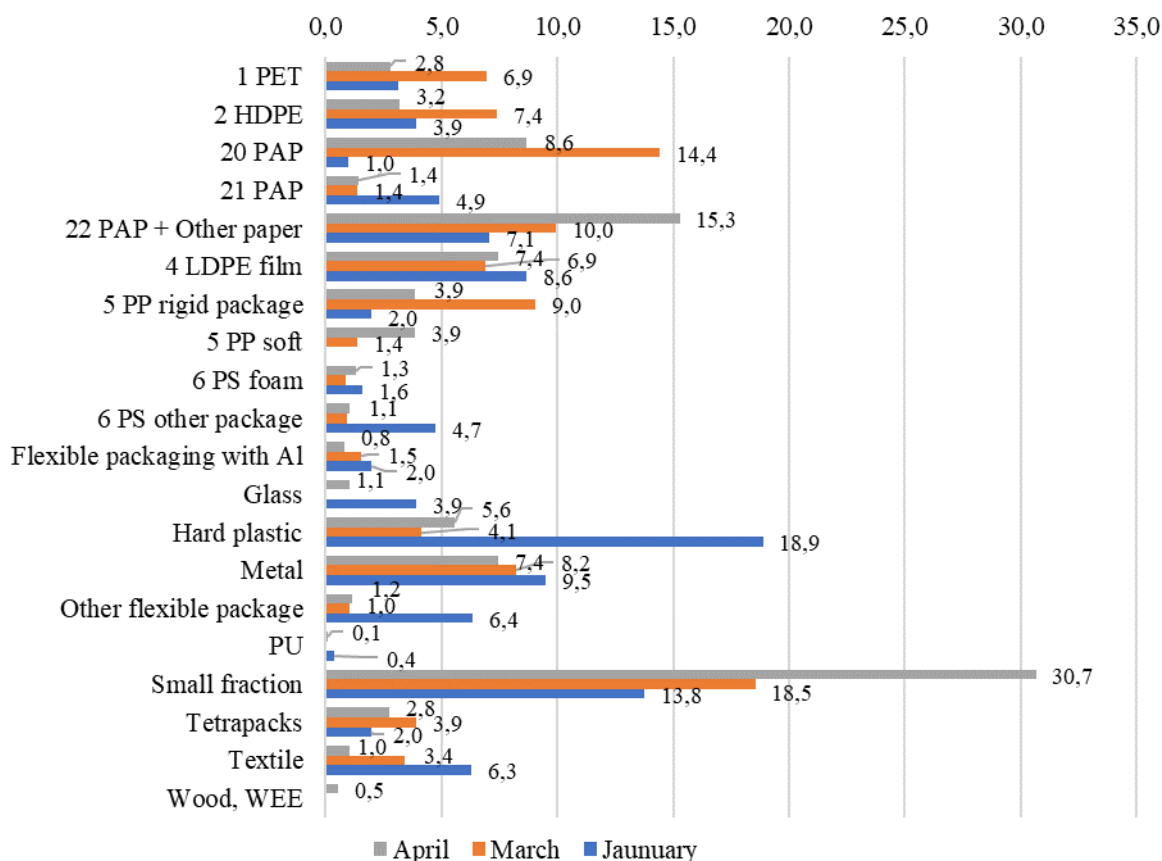


Figure 4. Distribution of packaging waste mixture in Kaunas city private households in January, March, and April, %

The composition of sorted plastic in the packaging waste mixture in private households in Kaunas city is shown in a picture below (see Figure 5). Based on the different recycling options for the same code plastic waste and the quantities, morphological fractions of plastic according to the identification marks are separated to subs fraction based on the physical properties (soft, rigid, foam).

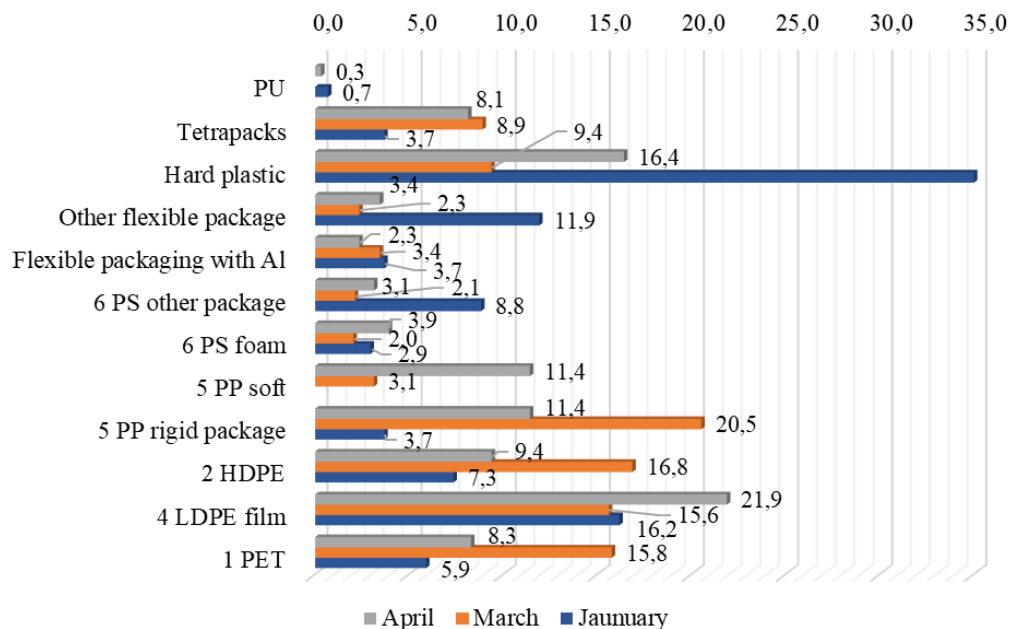


Figure 5. Plastic composition in package waste mixture in Kaunas city private households in January, March, and April, %

Assessing the plastic part in January, March and April waste samples separately, it was observed that in all samples the largest amount was of plastics that are actually recycled: 31 % of plastics in January (including 5,9 % PET, 16,2 % LDPE, 7,3 % HDPE, 3,7 % tetrapacks), 41,5 % in March (including 15,8 % PET, 15,6 % LDPE, 16,8 % HDPE, 8,9 % tetrapacks), 47,7 % April (including 8,3 % PET, 21,9% LDPE, 9,4 % HDPE, 8,1 % tetrapacks) (see Figure 6).

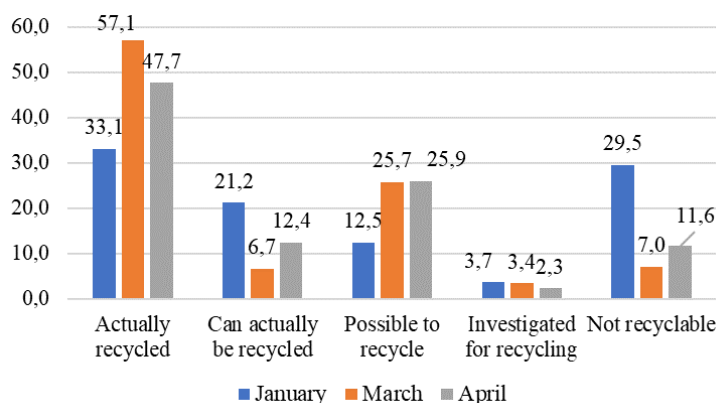


Figure 6. Recyclability possibilities of plastics waste composition by month in Kaunas city private households in January, March, and April, %

The share of plastics that could be recycled in other companies was 21,2 % in January, 6,7 % in March, and 12,4 % in April (polystyrene foam can be recycled by JSC "R&R Ideas", polyurethane can be recycled by JSC "AVAGO", Vilnius).

The share of plastics, which could theoretically be recycled and is made up of other rigid packaging, was 12,5 % in January (PP – 3,7 %; PS – 8,8 %), in March – 22,6 % (PP – 20,5 %; PS – 2,1 %), and in April – 14,5 % (PP – 11,4 %; PS – 3,1 %). Unfortunately, there are no companies processing them in Lithuania yet, but JSC "Retroplast" is a company in Vilnius district that buys these plastics suitable for recycling.

Flexible packaging containing aluminium accounted for 3,7 % of the total plastic waste stream in January, 3,4 % in March, and 2,3 % in April. The possibilities of their recycling are currently being investigated by the Department of Environmental Technology of KTU (Rimšaitė et al, 2019).

Non-recyclable fraction of plastics consists of other plastic marked number 7 and partially of hard plastics, respectively, the share of non-recyclable plastic waste stream suitable only for incineration was 29,5 % in January, 7 % in March, and 11,6 % in April.

To achieve the goals of the circular economy, the development of an efficient method of recycling waste is a favorable way to save natural resources, as the materials extracted from waste can be used as a raw material in the same or another production. The study has shown that according to the obtained result studied from Kaunas private households packaging waste, it is possible to recycle about 62-73 % of collected package waste stream depending on the morphological composition. Other non-recyclable wastes are incinerated. About 2 % of waste, which recycling possibilities are under the investigation on the extraction of raw materials, are currently incinerated. It is possible to recycle 66-90 % of plastic waste stream from package waste collected by JSC "Kaunas švara" depending on the morphological composition, about 3 % of multilayer package with aluminium are investigated for recycle possibilities.

Acknowledgment JSC "Kauno švara".

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