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ASSESSMENT AND DEVELOPMENT OF THE SELECTIVE WASTE COLLECTION AT THE UNIVERSITY OF MISKOLC

MÁRTON GULYÁS[1] - PÉTER VERES[2]

Abstract: *The importance of a selective waste collection system cannot be underestimated in today's economy. It can be seen as a principle of individual and social responsibility to reduce some of the pollution caused by over-consumption. Selective waste collection is an important pillar of circular economy, but there are still many sceptics and unwillingness to do so in Hungary. There are many ways to reduce this phenomenon, but without physical selective collection points, the system will unfortunately not work. The aim of this publication is to assess the location of these collection points in the University of Miskolc and to propose ways to improve their distribution.*

Keywords: *circular economy, recycling, selective waste collection, University of Miskolc*

1. INTRODUCTION

Everyone should and would recycle to some extent. Creating a more environmentally conscious, sustainable lifestyle can be difficult at first, but it can become a routine later. We can even try small things at first: instead of plastic bags, ask for paper a bag at the shop or bring your own, or use your own cup at a drinks machine. We can also save paper by paying bills online, use energy-saving light bulbs, drink tap water to reduce the number of plastic bottles going to waste, take notes in mobile apps and save paper. We can opt for zero waste shopping if it's feasible or start collecting litter selectively in our homes [1]. The latter requires minimal knowledge to participate effectively in selective waste collection, thus achieving a new usage of waste as secondary material, that have been wrongly thrown in our bins anyway. The essence of this collection is recycling, which can save a great deal of material needed to produce items. In many cases, this requires less energy than the extraction, transport and processing of raw materials and the creation of new products. Recycling also reduces soil and air pollution, as waste does not end up in landfills. The landfill's "temporary storage" or incineration facility significantly increases in the carbon footprint, as large amounts of greenhouse gases are released into the atmosphere. This is why we need to reduce the amount of waste going to landfill, thus curbing global warming [2]. In fact, people produce a lot of waste in their lifetime, which is difficult discard in the modern developing world. Many people don't know this, but most of the waste we accumulate can be recycled as secondary raw materials. It's a good way to reduce ground- and air pollution, reduces the depletion of the Earth's resources, and also to conserve primary renewable resources such as wood. This is not a fashion or a trend, but a common goal for all of us to contribute to the protection of the Earth, whether we do it as individuals or as companies. By doing so, we are creating a more sustainable, cleaner world for the next generation [3].

[1]BSc student., University of Miskolc, Institute of Logistics, Hungary
gulyasmarton00@gmail.com
[2]PhD., University of Miskolc, Institute of Logistics, Hungary
peter.veres@uni-miskolc.hu

2. RECYCLABLE WASTE AND THEIR TYPES

Composting is the most common form of recycling of organic waste in garden buildings, as most organic waste can be used as a soil conditioner to make the soil more fertile and nutrient-rich, for example under the vegetable garden [3].

Paper and cardboard boxes can also be easily recycled. Newspapers, leaflets, envelopes, office paper can all be used to make a new paper-based product. Wood is another material that can be recycled indefinitely with little excess [3].

Glass is one of the easiest materials to recycle: by remelting and moulding. Basically, any glass product can be recreated, just be careful of the 'impurities' already in it, such as colouring. It can also be crushed to produce glass asphalt or glass wool, so whatever form it takes, it will always be recyclable [3].

Various metals such as cans, soda cans, aluminium products and much more can also be recycled indefinitely. Their production, involves significant environmental risks and burdens, so there is an even greater emphasis on selective collection, which is a shared responsibility of all people. From another perspective, aluminium packaging is less harmful to the environment than plastic. While 75 percent of the aluminium cans ever produced are still in circulation today, only 13 percent of the PET bottles put on the market for consumer use in a year will be recycled. For glass bottles, the figure is 59 percent [4].

Plastics are everywhere today and surround our lives - they are one of the most damaging materials to our environment and should be replaced by more environmentally friendly materials. Plastics pollute Earth both during production and usage, and most of the time they do not degrade to natural elements over centuries. It is also polluting when the raw materials are extracted, because it is made from fossil fuels (oil and natural gas), and the extraction of these fuels releases and emits a significant amount of greenhouse and other harmful gases (benzene, carbon monoxide, hydrogen sulphide). According to Greenpeace, the global production and disposal of plastics is equivalent to the air pollution from 189 coal-fired power plants in one year [5]. Their use also releases harmful substances that can also have adverse effects on the human body. According to a study presented by the WWF (World Wide Fund), we consume 5 grams of plastic per week, which is equivalent to the weight of a bank card [6].

The use of plastics also plays a major role in climate change. This harmful substance is already in our water and soil, causing irreversible damage to flora and fauna. Millions of tonnes of plastic are released into the environment every year, mainly through human irresponsibility. Another appalling fact is that more than 90 percent of the plastics once produced have never been recycled. The biggest blow to our environment is single-use plastics [3].

The aim is to keep in mind that different types of selective waste are sorted into different groups and then disposed of in the appropriate colour (blue, yellow, grey, green, white) selective collection bin according to their material. This is a more environmentally friendly way to get rid of the waste that accumulates every day. We can take the following types of waste to the containers placed around the city at any time:

- paper (without coating or food and greasy contamination),
- plastic (drinking, household and packaging plastics with the recycling symbol, mostly: PET, HDPE, LDPE, PP),
- metals (mostly cans and bottles),
- white glass (mostly drinking and daily usage bottles),

- coloured glass (mostly drinking and daily usage bottles).

Hazardous waste (batteries, accumulators) is prohibited and dangerous to dispose in these containers, which can only be deposited in waste collecting yards or designated places. This also includes styrofoam, which is not yet recycled and cannot be thrown away in any waste bins [3].

3. WASTE COLLECTION SYSTEM

In the field of logistics, especially external logistics, organising and operating collection systems can be a high priority and can lead to significant cost reductions. Besides direct route collection systems, there are multiple form of organized multi collection point systems, such as collection/distribution depots, internal milkrun routes, postal and courier services, as well as for waste collection.

The core tasks of logistics management, reuse and recycling, can be covered in logistics systems:

- shaping product and production design and development concepts,
- developing system management plans,
- designing the organisation of the system,
- system operation,
- system design, system planning, system design, system operation, and system monitoring.

The logistics tasks in the reuse and recycling problem area can be basically divided into three subsystems:

- products used by users,
- products used by users that fail within the warranty period,
- waste and scrap from the manufacture and assembly of used products.

Within the subsystems, basic logistical tasks are distinguished:

- collection and sorting is important for used goods,
- disassembly and dismantling,
- repair and reuse of dismantled items,
- the delivery of the new manufactured product to the user.

The collection-distribution processes play an important role in logistics systems, which are already very complex from an operational point of view. The design and creation of these systems involve a number of optimisation tasks, the implementation of which involves complex mathematical problems. The aim of the analyses is therefore to simplify the collection process into sub-assemblies, making the mathematical description problem easier to understand, while ensuring that the values obtained can serve as a basis for further analyses of multi-level systems. The aim is to define the optimal number and placement of the parts of the collection process (receiving centres, collection centre) for a two-stage collection system, given a set of basic data [7].

In general, it can be said that the collection tasks of the end-of-life products that arise in practice (as well as many other non-recycling collection tasks) form a system in which the collection of end-of-life products is done in two steps. For this reason, a two-stage

collection system should also be taken as the basis for our analysis. The first stage is the transfer from the users to the collection centres and the second stage is the transfer from the users to the collection centre [7].

3.1. Selective collection in the area of the University of Miskolc

In Table I, we can see the complete list of selective collection bins and containers in the area of the University of Miskolc.

Table I.

Selective collection bins and containers in the area of the University of Miskolc

Current state									
Building	**Building segment**		**Currently available**					**Not required (optional)**	**Relocation (if necessary)**
			Glass	**Paper**	**Plastic**	**Metals**	**Mixed**		
A/1	Ground floor	Front of the gallery						–	–
	Upper ground foor	Gallery side stairs						Each bins into Institutes	–
		Lecture hall 32–33					4	–	Middle staircase
		Bar buffet						–	–
		Corridor					1	–	–
	1st floor	Gallery side						–	Gallery side
		Corridor					2	–	Middle staircase
		Side staircase of	It is not necessary, it will be located to the stairs from the institute of building A/3.						
	2nd floor	Gallery side						–	Gallery side
		Corridor					2	–	Middle staircase
		Buffet side Institute						Paper and metal bins	–
		Buffet side	It is not necessary, it will be located to the stairs from the institute of building A/3.						
	3rd floor	Gallery side						–	Gallery side
		Middle staircase						–	–
		Buffet side	It is not necessary, it will be located to the stairs from the institute of building A/3.						
Between A/1-A/5	Lecture hall 3						2	–	–
A/2	Chemisrty							–	Lecture hall 2
A/3	Instituite in upper ground foor							–	Placement to the A/1 stairs
	Instituites 1st floor							–	
A/3	Instituites 2nd floor							–	Placement to the A/1 stairs
A/4	5 floors			each floor	each floor	each floor	4	–	To elevators
A/5	Ground floor							–	To staircases
	1st floor							–	Middle of Institute
	2nd floor							More paper	
	3rd floor							–	
A/6	Ground floor						4	–	To elevators
	1st & 2nd floors		There is none and it is not necessary.						
Main entrance	Foregoround						3	–	To bathroom
B/1 & C/1	Ground floor							–	–
	1st floor	Next to Fornetti						–	–
		Corridor						More paper and metal bins	–
	2nd floor							–	To staircases
	3rd floor							More paper	To staircases
	3th floor							–	To staircases
B/2	Porter's lodge							–	–
B/3 & B/4	Porter's lodge							–	–
C/2	Workshops		There is none, but we can take it to an external container from here since it will be						
IT building	Entrance							–	–
	Next to elevator								
Applied Earth	Porter's lodge							–	–
Innocenter, TÜKI	Front of building		Container	Container	Container	Container		–	–
Between A/1 and	Parking lot		Container	Container	Container	Container		–	–
Between B/1, C/1	Parking lot		Container	Container	Container	Container		–	–
Dormitories	Fornt of E/4 & E/5		Container	Container	Container	Container		Bins for each type	Dormitory entrances
	Uni-Hotel parking lot								

In Table, I we can see the bins and container's approximate location of each building and outside area. There are 5 categories of collecting selective waste: glass, paper, plastic, metal and mixed. The mixed collection is a little white bin where we can put any kind of selective waste. The green filling shows that there is such a collector bin in that area, where the red shows that there is none and it would be necessary. If it remains empty (white), then there are no collectors, but we do not consider it necessary to put that type of bins there. The yellow line means, that the area doesn't have bins or containers, but there is no necessity for other reasons.

3.2. Problems with the current system

Location: As we can see in the table, the entire university area is not completely covered with selective collection units. Furthermore, if they are displayed, they are not always in the right place, which makes it difficult to use them easily. If they are not in sight, the person, how wants to use them will not even know they exist. This can also be seen from the last column of the table, which also shows where they should be placed/moved. The bad positioning is mainly typical of the "A" buildings, where we can hardly find some of them when walking in the corridors. Most of the time, they are found in institutes, often at the end of them as seen from the entrance or the corridors.

Design: Their application is further complicated by the fact that they do not have a uniform design. From almost every bin, we found at least two different designs, which in some cases even have different colours, which only complicates the seemingly simple use even more. These can easily confuse people, and the standard design and appropriate colour marking are the ones that attracts more attention and facilitate the application.

The "white" mixed bins: It is not a bad idea to collect selective waste in one container, as they require less material to produce. The advantage is that you don't have to think about how much can accumulate, the total mass or volume is enough, and the users don't even have to pay attention to throwing the garbage in the right bin. Despite all this, we still do not think they are necessary because of their hindering factors. Their disadvantages stem from their advantages. Since everything is collected together, it becomes necessary to build a sorting system before recycling, which entails costs. Of course, they will fill up sooner, but if we use more or larger ones, the material saving will no longer be an advantage, maybe to a minimal extent, but it is already negligible. Less attention will not be completely true either, since the types that can and cannot be inserted are precisely defined at the top of these, which must be observed.

Outdoor containers: This should be the centres of collection points where selective waste is taken out of buildings and to transport. They are located in the places named in the last four rows of the table and there is no problem with their positions, however, there should be more in frequent palaces and there should be more options (types/colours), because at two points, only glass collectors exist.

4. SOLUTIONS AND VISION FOR THE DEVELOPMENT OF THE SELECTIVE COLLECTION SYSTEM

Physical elements (bins, containers, labels, signs, etc.) must be replaced, installed, or improved systematically. The goal is to cover the entire building network, in addition to re-examining the current collectors and containers and replacing units that do not meet the

standards. There are cases where relabelling can help. Continuous testing would be necessary based on, for example, saturation and traffic. Location errors can be fixed, with collecting data of the busiest nodes of the buildings. In the future, when we have a functioning collection network, the frequency of delivery to external containers will be planned and implemented based on the saturation tests. However, in order for this to be used properly, awareness is needed on the part of all students, employees, guests of the university and, if possible, all outsiders who come here. Of course, this is a bigger challenge for guests and outsiders coming here. For university employees and students, it is a much easier task to introduce and get them to apply this conscious thinking and action, since the management has a lot of tools at its disposal to communicate information. These include, for example, messages, advertisements, posters, conferences, publication by teachers in classes or the online space, which is perhaps the most suitable of all. Since there the invitation can be guaranteed to be delivered to all citizens of the university. An easily transparent map of the established network can be useful, as until people get used to it, these can make it easier to find the storage facilities for those who are less aware of the structure of the university. Of course, by displaying these smaller maps, we can also make the work of outsiders easier. In contrast to larger containers, it is not common for smaller collectors to be marked with everything, only the most necessary. Even though people think they know what can and can't be done, there are special cases when the given waste can be misleading. This applies mostly to plastics and paper. Therefore, we would also consider it useful to label the indoor units in this way.

All in all, this is not an impossible goal to achieve, and even with more serious determination, it can be done within a shorter period of time. Perhaps the most difficult task is convincing the students, but with the right will and persistence, it is not impossible, it just takes more time.

5. SUMMARY

In this article we present the importance of selective waste collection for achieving a more sustainable economy and way of life of the University of Miskolc. Everyone in the World has to do their part for this, and the citizens of the University of Miskolc are no exception. We assessed and explained the selective waste collection options on the campus and although the situation is not as bad as we thought, there is no logic or standardization. These should be included in a system, from which a responsible staff and a system plan should be used to determine the location of the collectors, regulate the standard size and colour, replace the "white" mixed bins and upgrade the outdoor containers.

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