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Introduction of a New Waste Sorting and Collection System at a University

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Abstract. Nowadays the usage of source separation waste collection system is essential for all organisations. This paper describes a case of introduction of such a system at a university of applied sciences (UAS) in Tallinn. The project started in September 2015. The main goals of the project were to reduce the number of garbage cans in the UAS, reduce the amount of unsorted household waste and inform the school community about the significance of waste sorting and relevant environmental matters. The first step of the project was to execute a full waste audit in UAS to identify precise waste quantities which occurred on daily basis. During the week the environmental technology students weighed and sorted all the waste in all premises of the UAS. Based on the collected data, the new system comprised of 19 waste collection points with sorting instructions and adequate volume. The total number of garbage cans was reduced by 46% and mixed household garbage cans by 72%. The final step was to analyse the efficiency of the new waste collection arrangements. Results showed that the new system was well accepted and 80–85% of waste was sorted and collected in the new waste collection points.

Keywords: source separation, food waste, higher education, sustainability.

Conference topic: Environmental protection.

Introduction

Nowadays, the waste collection and management issues are important in all European Union countries. Every day large quantities of waste are also produced in Estonia, most of which is burned for energy or small amount is taken to landfills. However, a relatively large proportion of the burned or landfilled waste could be recycled instead. Therefore the development of efficient and environmentally friendly waste separation and collection systems is important. The separation should be done by the waste producers and such systems should be implemented in various institutions – offices, schools etc.

Efficient waste collecting systems can be established only if there is complete understanding of the composition of a waste stream and the activities that determine its generation (Farmer *et al.* 1997). In every examined area the waste composition can vary, depending of its generating source (Tchobanoglous *et al.* 1996; Armijo de Vega *et al.* 2008: S21–S26).

Ways of how to identify/explore waste streams of an organisation can vary, for example: visual waste assessments, reviewing waste management records, interviewing waste producer or waste management staff and extrapolating data from other institutions or from statistics. The best and the most effective way is to organize a direct waste analyses/studies, during which the exact amount and composition of the waste is measured (Dahlén *et al.* 2007: 1298–1305; Mason *et al.* 2003: 257–269; O 'donnell 2002; Smyth 2008).

To date there are many studies analysing household waste content and quantity (e.g. SEI Tallinn 2008; SEI Tallinn 2013; Ripa *et al.* 2017: 445–460; Aphale *et al.* 2015: 19–28; Liikanen *et al.* 2016: 25–33; Burnley *et al.* 2007: 264–283), fewer studies have been conducted in various institutions (e.g. Trung, Kumar 2005: 109–116; Pirani, Arafat 2014: 320–336; Radwan *et al.* 2010; Fagnani, Guimarães 2017: 108–118) and relatively few studies examine the waste management in higher education institutions (Ramírez Lara *et al.* 2017: 1486–1491; Armijo de Vega *et al.* 2008: S21–S26; Mason *et al.* 2003: 257–269; Smyth *et al.* 2010: 1007–1016).

In Estonia waste sorting by type has been implemented for example, in the following institutions Ministry of Environment, University of Life Sciences and Tallinn University. Of which only the first one was successful in implementation of the new system.

The main goals in UAS were development of waste collection system, reduce the number of mixed household garbage cans, reduce the amount of unsorted household waste and inform the school community about the significance of waste sorting and relevant environmental matters. Saladié (Saladié, Santos-Lacueva 2016) in his article indicates that informing is necessary. It was important to set up understandable, visible and easy to use waste collection points in different floors of UAS.

With the creation of the new system was intended to guide the students and universities staff to use new waste collection system to become eco-friendly school and a pioneer to other educational institutions. The vision to plan a new system was to collect all the waste what will be produced on a daily basis separately and deliver them for recycling.

Materials and methods

Study took place at the TTK University of Applied Sciences (UAS). The UAS is situated in the centre of the Tallinn city, has over 2,500 students and about 190 staff members. UAS has five faculties – Faculty of Architecture and Environmental Technology, Faculty of Clothing and Textile, Faculty of Construction, Faculty of Mechanical Engineering and Faculty of Transport – with 13 different 4-year study programs. UAS offers study programmes for daily learners, distance learners and in-service training courses in the Open University (TTK UAS 2016).

The study consisted of two fases – a waste audit (I study) and the analysis of the efficiency of the new system, which was repeated twice (II and III study). Before creating the new separate collection of waste system, the audit was needed to evaluate the composition and the quantities of the waste produced on a daily basis. The audit took place in September 2015 and lasted for one week. The audit examined the generated waste quantities and composition of household waste in all waste pins available (except toilets). Method used to collect essential waste data during all studies was divided into four actions:

- viewing the percentage of fulfilment of storage in each mixed household garbage can,
- sorting the waste (paper, packaging waste, biowaste and other) as described in Table 1
- weighing the waste,
- making notes of waste which was laid into a wrong part of the waste sorting. This was done only during II and III study.

Table 1. Sorting instructions used by the students

Category	Description of representative material
Paper and cardboard	printer paper, magazines, catalogues, coloured paper, envelopes, newspapers, corrugated cardboard
Packaging waste	Tetra packs, single-use tea and coffee cups, plastic beverage containers, plastic bags and packaging, metal cans, glass bottles, polystyrene disposable food packaging
Biowaste	Raw vegetables and fruits, coffee grounds and tea bags, food waste, bones, bread, tissue paper and other compostable material
Other	Textiles, clothing, pens, dirty packages, chewing-gum, cleaning rags, non-recyclable

After the new separate collection of waste system was put into practice the methodology described above was used again (spring and a year after the system was created) to check if the system works or need's improvement. It was also used to assessed how many mixed household waste pins where left in the university premises and how much waste was in them. All the data collection was done with the help of UAS students.

The new waste sorting system was created in accordance with the results of the first study results. The sorting guide and pins were designed and their dimensions calculated by the environmental technology and environmental management forth course students (Fig. 1).

Fig. 1. Designed waste collection point with sorting instructions

For the new waste collection points location was originally placed in every faculty and in the halls between faculties. Because the purpose was to give up small mixed household waste pins from the class rooms and offices. The new waste collection points had to be easily accessible and highly visible. New collection point's locations are shown in the Figure 2.

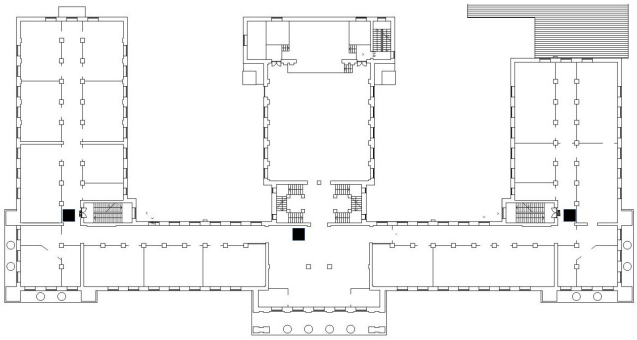

Fig. 2. New collection point's locations

During waste collecting system change there were different ways to inform students and staff for the upcoming change. It started with the European Week for Waste Reduction during what, there were held different environmentally friendly events such as promoting recycling clothes, quiz with prizes and movie night. The last and most important step of informing students and staff was sending a notification through UAS Study Information System.

In the court yard of the University there were containers for paper and cardboard (0,8m^3), mixed household waste (4.5m^3) and for bulky waste (4,5m^3). After the new system was created there were added new containers for packaging (1,1m^3) and biowaste (0,24m^3).

Discussion

During the first study we counted 286 garbage cans all of which were used to collect waste as mixed household waste. After the introduction of waste sorting system the number of garbage cans dropped as did the number of cans used to collect garbage as mixed waste. The 2th study results revealed that the number of 16 litre cans reduced to 155. Only 35 garbage cans from those 155 were used for separated collection of bio-, paper- or packaging waste and 120 were used for mixed waste. During the 3rd study there were 138 garbage cans in total, of which 104 were used for mixed municipal waste, 21 for paper waste and 13 for biowaste. Detailed figures of remaining garbage cans by floor are outlined in figure 3. 10% of mixed municipal waste garbage cans were used in classrooms and the rest in the offices. Considering that the university has about 190 employees, every third employee still has a mixed household garbage can under the table. Many employees are not willing to give up their garbage cans because they are used to having their own garbage can or they don't consider it necessary to collect waste separately. One possible solution for that could be to replace personal garbage cans with a set of united garbage cans (paper, packaging waste, biowaste and household waste garbage can) in each office. Therefore the amount of the garbage cans would not depend on the amount of the people who work in offices. This would decrease the amount of remaining garbage cans significantly.

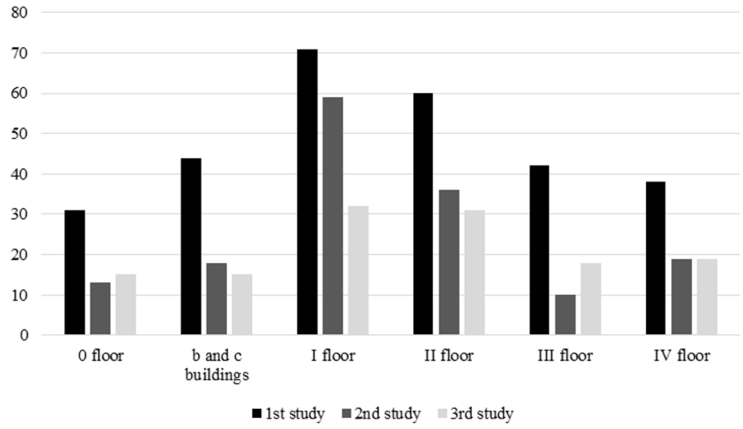

Fig. 3. Number of garbage cans in UAS by floor

The amount of waste produced at the university during the 1st study period was approximately 7500 litres, all of which was collected as mixed household waste into small garbage cans. The second study showed that after introducing the new waste sorting system, the amount of waste that was collected into the mixed household waste cans dropped to roughly 900 litres. Meanwhile waste collected into the new waste collection points was approximately 4200 litres. The higher total waste amount during the 1st study can be explained by the fact that the first waste audit took place during the autumn, when the school year just started and more students are in the house. 2nd study took place in the spring, when the last course students mostly work home and third course students are out of the university in their internship.

In overall the results were postitive. Around 80% of all the waste produced at the university during 2th study and 85% during the 3rd study was collected into the waste collection points and hence sorted. The waste laid into the wrong part of the sorting container (mostly packaging waste in municipal waste and other way around) was remarkably small.

Comparison of waste generation by floors show's that second, third, and B-unit generated a similar amount of waste during all studies. The quantities of waste in second and third floor remained in the range of 9–12 kg per week, and each study showed that the use of sorting containers increased. In B-building already 95% of produced waste is collected to waste collection points.

The most waste in UAS was generated on the 1st floor (Fig. 4), where the entrance to the building is located, so most people will use this floor. Additionally, there are many administrative offices on the floor which employees work on a daily basis. During the 1st and 2nd study the quantity of waste generated per week was around 30 kg, but decreased during the 3rd study by 45%. On the 1st floor, there was also a decreased in the number of cans for mixed household waste, but it cannot be the only reason why the mass of collected waste is reduced. On 4th floor the waste quantities decreased after the 2th study, but 3th study results showed 55% increase in the mass of waste. The reason is probably the timing of the 3rd study. It took place at autumn, a period when to the fourth floor of university was brought a large number of apples. Since autumn 2016 were very rich by apples, then both employees and students led apples to the university and thus increase the amount of biodegradable waste and the entire waste mass quantities.

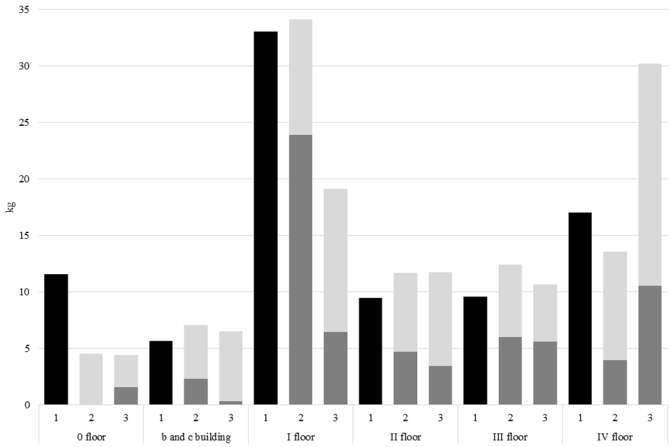

Fig. 4. Waste generation in different floors and during studies (black – mixed waste cans during first study, dark grey – amount of waste collected as sorted, light grey – amount of waste collected as mixed waste)

Meanwhile on the 2nd to 4th floor of the university, there was similar volume of the waste during first 1st study (around 700 litres) but a large difference of the waste volume on 2nd study. Most waste in spring was collected on the 2nd floor (approximately 900 litres in waste collection points and 200 litres in remained garbage cans), less on the 3rd floor (roughly 560 litres in waste collection points and 70 litres in garbage cans) and least waste collected, on those three floors, was on the 4th floor (approximately 400 litres in waste collection points and 70 litres in remained garbage cans).

At the basement floor (0 floor), there were two waste collection points placed (in library and e-learning centre) and the remaining garbage cans were taken in use as sorting bins. Also the canteen (where the most waste was collected during all studies) which is located on the basement floor went through a huge change. It withdrew small garbage cans and is now using large sorting bins to collect biowaste, household waste and packaging waste.

Lot of waste in UAS is generated in cafeteria. The biggest problem there is the high proportion of biowaste, which according to the 3rd study is around 20 kg per day. Most of the biowaste generated was food waste. Figure 5 shows that biowaste quantities have been particularly high during the 1st study. By the time of 3th study the biowaste quantities in the canteen has reached a kind of equilibrium and is generated in equal amount through out the week. 1st study coincided with time period when a new company took charge of the canteen management, and large quantities of food waste might be caused by the fact that the company did not yet take into account what is the number of consumers and customer preferences for food. Most of the raw material which reaches to the canteen is pre-treated – vegetables are peeled and meat products are cut and packaged. Thus, the majority of biowaste which proceed are the food which is left on the plate or overly prepared food. Amount of the food waste would reduce the higher quality of food serving,

because at the moment there has been displeasure. Also planning the menu and the quantities in cooperation with the education department, who is aware of how many students are in the school at any given time, could help.

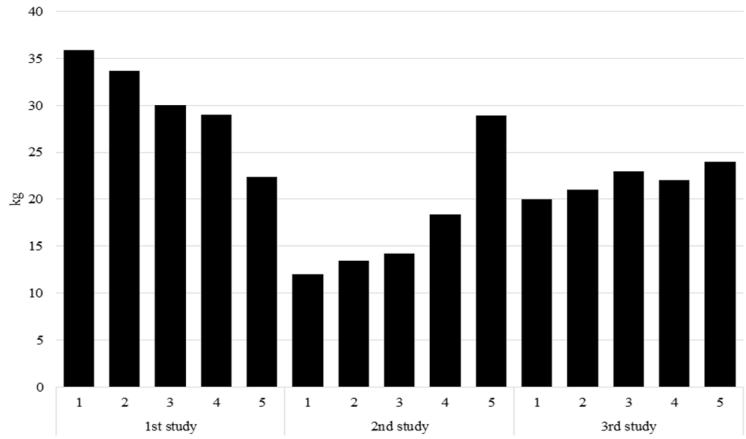

Fig. 5. Biowaste quantities in different study periods (numbers 1 to 5 shows the day of the study)

Conclusions

By the results of the first study a sorting guide and waste collection points were designed and dimensions calculated. The work was done by the 4th course students of environmental technology and environmental management. Waste collection points locations were choosen according to the habits of the school family. After the installation of waste collection points, students and employees were informed of the new arrangements.

The 1st study revealed that the largest numbers of garbage cans are and the most waste is generated on the first floor (excl cafeteria). This may be due to the administration and offices, where the daily work, and the lobby location at that floor.

The introduction of the new system has decreased the number of garbage cans in university from 286 to 138 pieces. The proportion of waste generated daily, which gathered on 2th and 3th study to waste collection points formed 80–85% of the total waste volume, which were produced in UAS. This is a very positive result in view of the new separate collection of waste system has been introduced only a year ago.

On the basement floor of the university a large part of mixed household waste garbage cans were abandoned. After the 1st study there was placed two waste collection points (in library and e-learning centre) and the remaining garbage cans were taken in use as sorting bins. Also the canteen went through huge change. Meaning it withdrew small garbage cans and is using big sorting bins to collect biowaste, municipal waste and packaging waste.

However, there is still a lot of biowaste in the canteen, which is mostly food waste. It is necessary to reduce that quantity. Providing better nutrition and preparing the menu considering how many students are in the university at specific time could be helpful.

The collected waste quantities in different study periods are different; the most stable are the amounts on the second and third floor and on the B-building. Large quantitative differences are on the fourth floor, with the last study, the waste quantities were increased almost 55%. On the first floor the 1st and 2nd study results of waste amount were similar, but during the 3th study the production of waste was 45% reduction.

Food waste and package waste represent two of the most significant material types for targeted waste reduction. The result presented in this paper shows the challenges that educational institutions may face when they want changes the institutions waste management more sustainable.

Disclosure statement

Authors declare that they don't have any competing financial, professional, or personal interests from other parties.

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