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THE OBSERVATION OF PICKINGS IN A MANUAL SORTING PLANT OF SELECTIVELY COLLECTED MIXED PACKAGING WASTE FROM HOUSEHOLDS

ABSTRACT

In Hungary the most frequently applied technology for pre-treatment of selectively collected waste is manual waste sorting. In our research we studied the picking rates of the sorting staff, and also the rates of different materials placed in the drop zones and into bags. The observation was carried out on two picking belts, in two shifts, in three timebands per shift. The material was placed on one of the belts by direct loading and on the other one through a trommel. Based on the analysis, it can be considered that the rate of the materials put into the drop zones and into the bags was around 80% and 20% on both picking belts. The pickers did about 4000 pickings per hour on average, that means more than one picking per second; and about 60% of that was made up by PET bottles and LDPE foils. The results show that the operators standing on the first spot picked the most waste.

INTRODUCTION AND AIM

The material recovery facility serves the pre-treatment of municipal solid waste; after the separate collection of the different waste components, it is the place where reusable waste is further selected in order to increase the efficiency of its use in the production process. No waste of biodegradable organic material can be treated in the material recovery facility, except if the operator performs the further selection of the recyclable fraction after having done the mechanical separation of the biodegradable organic fraction - specially with the help of an x-ray equipment or an optical separator. [1]

Waste collection systems differ from country to country but they all share a common design concern and operational objective: the collection and transportation of waste from the inhabitants to the treatment plant where, after the best possible environmental and economic treatment, the recovery and disposal of the material takes place. Several different methods are used for the collection of the selectively collected packaging waste. The most widespread solution in Europe is kerbside collection where waste is taken directly from the site where it is generated. In the case of selective waste collection points, the producer of the waste has to take it to a common site where the waste is collected from. There are also methods where the producer of the waste is paid for the different types of materials in order to urge them to more homogeneous and cleaner waste collection. Some companies take back products free of charge so that the waste ends up at the right place. These are often companies selling electronic products that take electronic waste back, or home furnishing chain stores ensuring the re-commercialisation or proper disposal of used furniture. [2]

The collected reusable waste is taken to material recovery facilities where, in general, the sorting of the waste is mainly done manually. [3] Within the cabins, the waste being sorted is transferred on a conveyor belt, and there are people standing on both sides of the belt picking the waste that go to recovery. [4] The recyclable waste is identified and sorted according to

the types of material on the basis of visual inspection. The size and composition of the material being picked, the thickness of the waste mixed on the conveyor belt and also the speed of the picking belt affects in the process. [5] [6] The advantage of the manual sorting lines is that different types of recyclable material can be sorted simultaneously and they can be separated into relatively clear streams. The waste is sorted on the basis of the material type, or the elements are removed that can reduce the performance of other processes. [7] The manual sorting is based on the identification codes indicated on the packages; this enables the exact and clear sorting of the different types of material, but the possibility of human error should not be neglected. [8] The fluctuation of the composition of solid waste is of minor importance for the purposes of waste categorisation, but the amount of some categories of waste can increase or decrease as a result of certain situations or events. [9]

Simulations were performed by individual researchers in order to look into how the changes of waste fractions taken at the different workstations effect performance. The results show that the first workstation sorted only 72.3% of the given type of waste. The remaining waste is taken by another workstation. Despite the fact that this amount is only 27.6% of the maximum quantity of the waste capacity of the workstation, a certain part of the waste is still carried on to the next workstation. The analysis also shows that there are no grounds for the sorting of the same waste fraction on more than two workstations because it leads to a worsening performance of the employees who concentrate on the further waste fractions. The dramatic growth of the waste stream would not enable them to reach the maximum sorting capacity either. This was confirmed also by the fact that the irregularity of the stream significantly affects the result of the sorting line. [5] [6]

In the light of the research results, we can state that manual sorting is not cost-effective, but automated systems are sensitive to contamination, and for the purpose of seeking high purity they result in great losses. [8] The manual sorting systems can be partially or even completely automated through machines arranged in a specified order. [5] The ideal choice can be a combined technological process, because these types of procedures combine the low cost but ineffective methods with the expensive but effective procedures, this way creating a more cost-effective situation. [8]

MATERIALS AND METHODS

In our research we examined the performance of the manual sorting plant of the Regional Waste Management Center of Pécs-Kökény. During our observations, we used a 14-day-period as a basis. The records of the security camera of the cabins were used for the analysis, so that the pickers do not get frustrated by our presence. Three times 15 minutes were observed in two shifts per day on two parallel working picking belts. When choosing the intervals shown in Table 1, we took into consideration the start and the end of the working-time and also the breaks: this way we could get representative samples at the beginning, in the middle and also at the end of the shifts. There is one camera in each cabin placed at the beginning of the conveyor belt; because of the location and the picture quality of the camera, we could carry out the observations only to the 4th spot, since picks were not clearly visible on the two last spots.

Table 1.

Observed timebands.

Shift 1		**Shift 2**	
Timeband 1	6: 50-7:35	Timeband 4	14:55-15:40
Timeband 2	10:30-11:15	Timeband 5	18:30:19:15
Timeband 3	12:30-13:15	Timeband 6	20:30-21:15

Reusable waste (paper, cardboard, different plastic, metal, combined packaging material) collected in one container is taken to the material recovery facility. In the given area, the different types of reusable waste are collected in one common container not only at kerbside collection but also at the collection points.

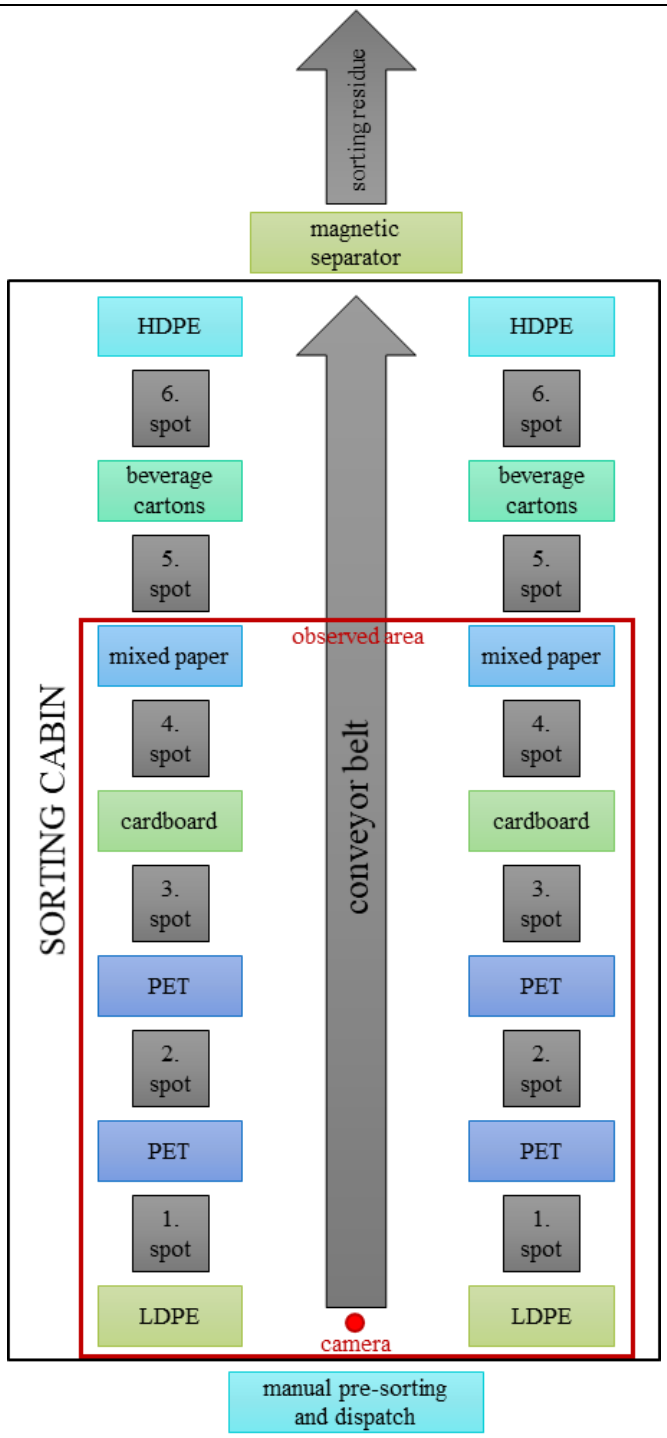


Figure 1.

The position of materials thrown into the drop zone.

The structure and operation of the two sorting cabins is identical. There is a slight difference in the material arriving at the two cabins, since the material stream getting to cabin No. 2. goes through a trommel having a particle size boundary of <80 mm, in order to separate the fractions that are small and difficult to pick and that are not recyclable, and this way making the job of the pickers easier. The speed of the picking belt is the same in both cabins, 0,3 m/s. In cabin No. 1, the mixed selective waste taken from the collection points is loaded directly on the belt without a trommel. In cabin No. 2, the waste stream of households collected through the kerbside collection system is carried, and it goes through a trommel first and then it is loaded to the sorting cabin. In the course of the sorting, there is a person standing between two drop zones, dropping the selected material into the drop zones or putting it into bags according to the type of the material. Reusable waste materials occurring in small quantities and hazardous waste get into the different bags separated. The design of the cabin ensures the smooth operation of the plant even if one of the operators leaves their spot. The layout of the cabin and the order of the materials to be sorted are shown in Figure 1.

RESULTS AND DISCUSSION

On the basis of our observations, the rate of materials put in the drop zones and in the bags is on average 80% and 20%. LDPE foils, beverage cartons, mixed plastic, aluminium cans and hazardous waste materials are sorted into the bags. Two of these, LDPE foil and beverage cartons are also thrown into the drop zones. Big pieces of LDPE foils get into the drop zone, but it is easier and faster to sort the smaller pieces into bags once the PET is selected, and this way the quantity of separated material can be maximized. Because of their size, some of the beverage cartons (combined packaging materials) are selected into bags sooner than their drop zone. Mixed plastic and aluminium are sorted into bags only, since our practical experience has shown that their amount collected per shift does not require a separate box.

The sorting residue is transmitted to the mechanical-biological waste treatment plant, so the removal of other interfering material is also essential. Having removed, they are put into special containers and bags, and they are utilized or disposed by external entrepreneurs according to their material.

It can be clearly seen in Figure 2 that there is no significant difference in the picking rates of materials put in the drop zones or in the bags between the cabins, the pickers on the right or left side, or the times of day.

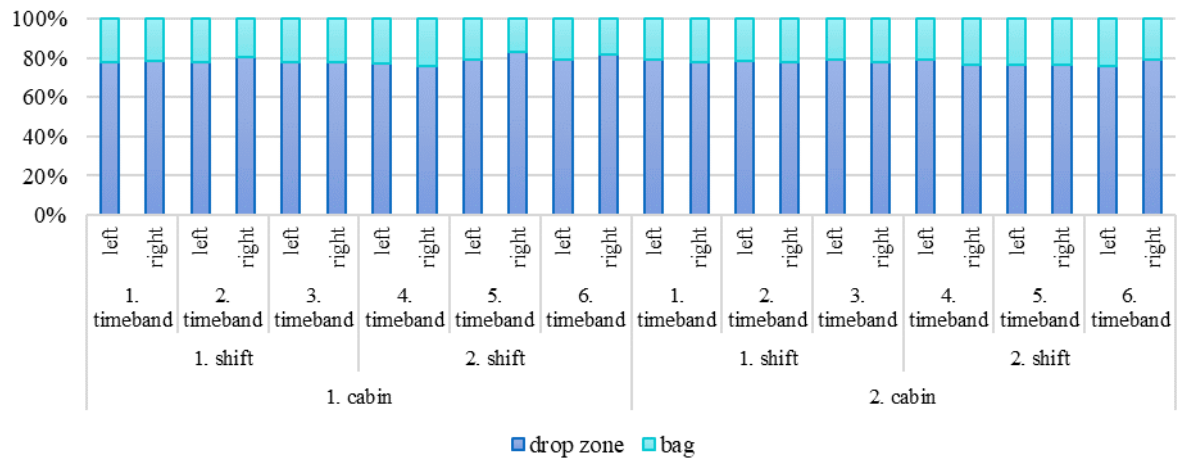
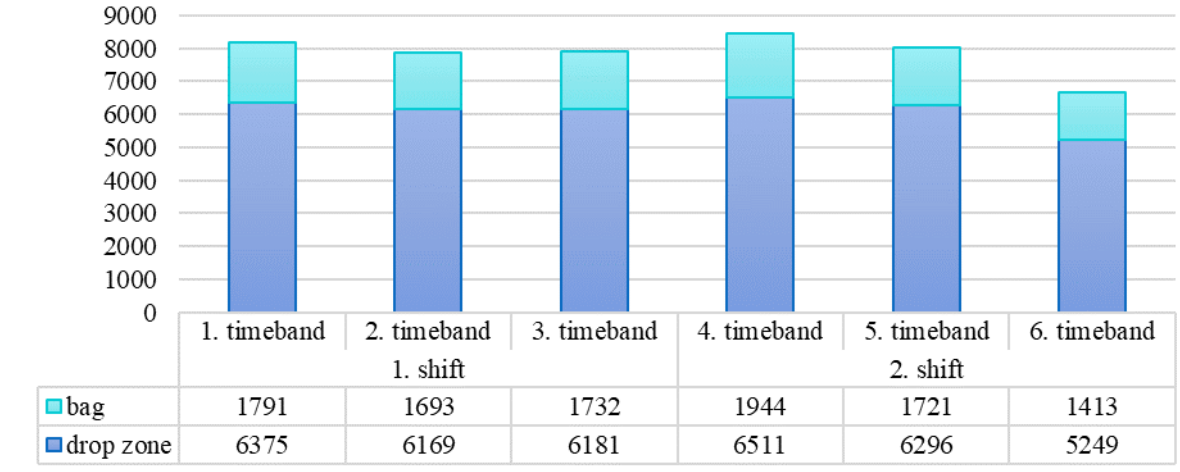


Figure 2.

Rates of pickings per cabin, per time of day, on both sides of the belt in the appointed timebands. [%]

It can be stated about Figure 3 that the first 5 timebands do not show remarkable differences but the number of pickings significantly declined in the 6th timeband. This is the last timeband and to top it all it is in the evening; this means the employees are probably the most tired at that time, they have longer response time and that can contribute to the reduced number of pickings.



	1. timeband	2. timeband	3. timeband	4. timeband	5. timeband	6. timeband
	1. shift			2. shift		
bag	1791	1693	1732	1944	1721	1413
drop zone	6375	6169	6181	6511	6296	5249

Figure 3.

Average number of pickings per hour. [pcs]

PET bottles make up 41% and mixed paper 21% of the pickings in each hour, and these together add up more than half of the total pickings. Other materials of significant number of pickings are LDPE foils making up 14%, mixed plastic, aluminium, beverage cartons and cardboard together giving 14%, and unfortunately interfering materials of 10%.

The selection of the latter is necessary because the sorting residue is treated in the mechanical-biological waste treatment plant where these materials would endanger the functioning of the technology, and they could be problematic considering incineration. In addition, some of these materials can be inflammable and explosive, and that means the

employees carrying out the mechanical treatment would also be endangered. Figure 4 shows the average number of pickings per hour and their percentage allocation.

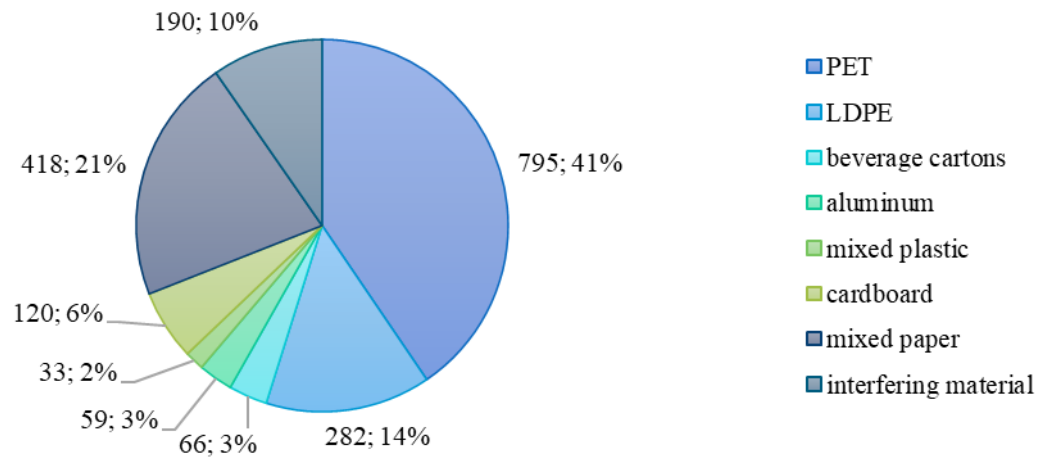


Figure 4.

The average number of pickings per hour and their percentage allocation. [pcs]

Based on the analysis of the number of pickings, it can be considered that the operators standing on the first spot at the picking belt, who pick both PET and LDPE and put beverage cartons, aluminium and mixed plastic into bags, generally produce 35% of the pickings. The pickings of the operators standing on the second spot between two PET drop zones and putting LDPE foil, mixed plastic, beverage cartons and aluminium into bags make up 20% of the total pickings, whereas the operators on the third spot picking PET and cardboard and putting interfering material into bags produce 18% of that. The pickers on the fourth spot, selecting cardboard and mixed paper and putting the remaining interfering material into bags, do 27% of the pickings on average. The results also show that the operators standing at the first and fourth spots pick the most material that get into the drop zones. The rates of pickings per spot and timeband are shown in Figure 5.

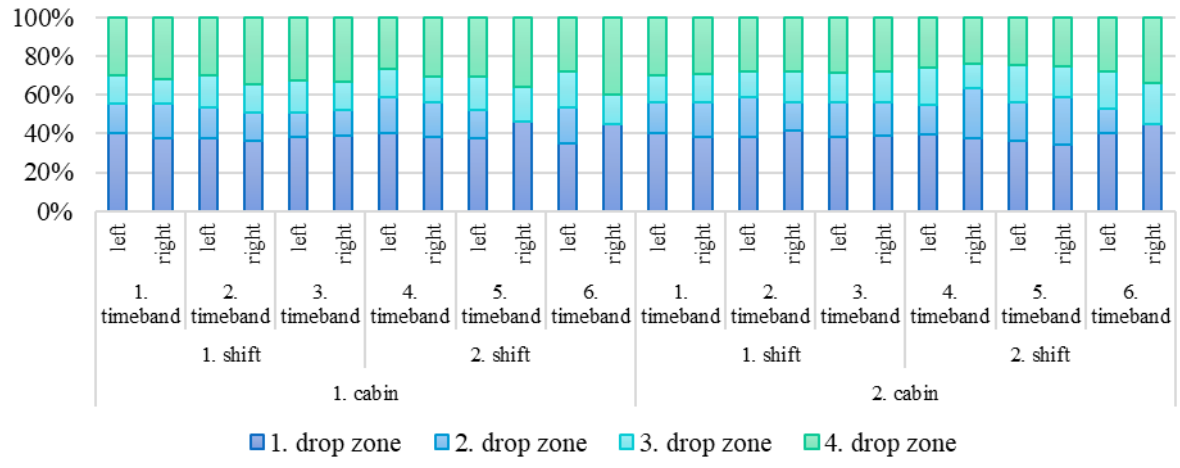


Figure 5.

Rates of pickings. [%]

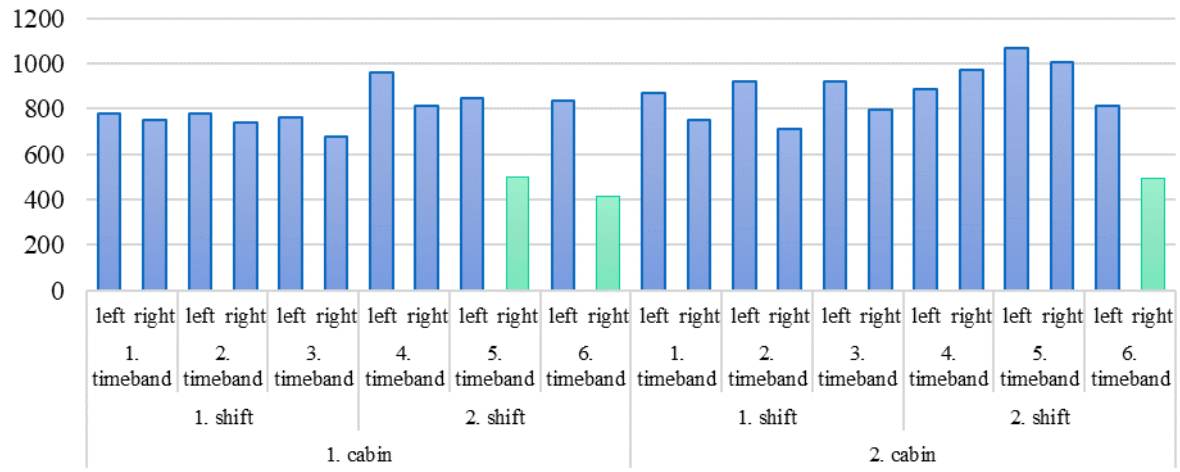


Figure 6.

The number of PET pickings per hour per drop zone. [pcs]

According to our observations, on one side of the conveyor belt three pickers had on average 800 PET pickings per hour. During the measurements, there were no pickers in the second shifts on the 2nd spot of the right side of the belt at the PET drop zones in Cabin 1 in the 5th and 6th timebands and in Cabin 2 in the 6th timeband. The result of it can be clearly seen in Figure 6: on the side where only two people dropped PET bottles in the drop zones, the number of pickings fell significantly below the average number.

CONCLUSION

Based on our analysis we concluded that in the manual sorting plant of Kökény, the average rate of materials dropped into the drop zones and into the bags was around 80% and 20%. No significant differences were found between the sorting rates and the pickings of the 1. and 2. Cabins, in the 1. and 2. shifts and in the first 5 timebands, but the picking number of the 6. timeband was regularly lower that the others. The reason for this is likely to be found in the fact that it is the late evening timeband, when the cumulative tiredness of the staff - regardless of the time spent in the shift - has a detectable impact on their performance.

The rate of pickings in each hour is made up as follows: PET bottles 41%, mixed paper 21%, LDPE foils 14%, mixed plastic, aluminium, beverage cartons and cardboard together 14%, and interfering materials 10%. We concluded that the pickers standing on the first and fourth spots pick proportionally the most of the material dropped in the drop zones; it is therefore appropriate to put the employees with an ability to sort the material at a higher speed in these spots. The same is true, when there are spaces left out between the picking spots owing to the lack of available workforce. In this case it is also appropriate to put the pickers who are better at sorting in these spots.

It can also be observed, that if a place is left out on one side of the picking belt, it is not the person opposite who is loaded by the material to be sorted, but the ones standing after the empty spot. By contrast, when examining the pickings of PET bottles, we found that the performance of the picker standing on the next spot did not change significantly compared to the situation when the number of the staff was complete. This also means that the pickings of the person standing on the second spot cannot be made up by the next person, and so this amount gets in the sorting residue.

ACKNOWLEDGEMENT

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