

THE POSTPONEMENT AND SPECULATION PRINCIPLES ON THE EXAMPLE OF SEGREGATION PROCESS IN MUNICIPAL SOLID WASTE MANAGEMENT

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Abstract: The literature presents two principles: the postponement principle and the speculation principle applied in different areas and branches. In this article they are presented as elements of logistic processes in municipal solid waste management. It is shown in the article how these principles affect the shape of logistic processes in the municipal solid waste management.

Keywords: postponement principle, speculation principle, transport, segregation, collection.

1. Introduction

The *postponement* principle has frequently been described in economics and management literature [8]. However, it has recently been applied in logistics as well [6]. Postponement means that changes in the form or identity of a product are delayed as long as possible, i.e. until the moment when a customer order has been placed [7]. The *postponement* principle is applied to fine tune products according to customer wishes and it also allows to mass-customise products which enter the market. R. I. van Hoek differentiates between three types of the *postponement* principle:

- *time postponement*) i.e. delaying an activity until a customer order has been placed,
- *place postponement* i.e. the place where an activity is to be completed is postponed, which means that forward movement of goods to be supplied is delayed until a customer order has been placed,
- *form postponement* i.e. delaying giving a product its final form, which means that activities which determine the final form and shape of a product are delayed until a specific order from a customer has been placed [4].

The opposite of the *postponement* principle is the *speculation* principle. This principle means to move certain activities to the stages which appear earlier in a relevant production chain or in time [7].

2. Municipal solid waste segregation

A particularly good example of the area where the principles of *postponement* and *speculation* are applied is the process of segregation and collection in municipal solid waste management.

Waste segregation means separating waste from a waste stream which has the same or similar physical or chemical characteristics. Segregation is a process which can be carried out according to a different criterion and whose efficiency can vary. This process also comprises many different stages, which can be moved back and forward in time, and it may involve different participants i.e. waste management units. As far as these criteria are concerned the following ways of municipal solid waste collection can be presented:

- collecting mixed municipal solid waste, where segregation is postponed to a later stage, if any,
- separating one particular type of waste apart from mixed waste, e.g. glass,
- separating two streams, e.g. dwellers are provided with rubbish bags in two colours. They put „wet” solid organic waste in one bag and „dry” solid waste such as paper, cardboard, glass, textiles and cans in the other one. This waste will be subject to segregation on the segregation line in a sorting facility.
- separating many different waste streams, e.g. glass, paper, metal, etc.

At present it is common for the segregation process to be carried out in at least two stages:

- selective collection at source,
- at a later stage in the form of so-called post-selection, which is also called secondary segregation or sorting.

Waste segregation at the source of its generation means dividing the municipal solid waste stream into sub-streams according to an adopted formula. The adopted formula as well as segregation efficiency depend on the following factors:

- storage of waste produced in a given area,
- existing system of waste collection,
- waste disposal and recycling techniques available in a given area,
- readiness of the inhabitants of a given area to contribute and co-finance selective waste collection,
- possibilities to use waste in recycling,
- possibility to trade products manufactured in a waste recycling process [2].

One of the most common problems in segregation at source is that recyclable waste is mixed with other kind of waste. This usually results from the fact that waste generators, often due to lack of understanding, lack of information or lack of good will, place waste in inappropriate containers. That is why, having conducted a highly effective and informative waste awareness campaign, it is still necessary to carry out a final sorting of the classified and collected waste in a sorting facility. There is always a certain degree of mixed waste present which obstructs waste recycling [1].

Selective waste collection can also create certain financial problems. It requires considerable financial outlays to buy recycling banks, rubbish bags and waste collection vehicles adapted to collect sorted waste as well as to conduct appropriate informative and educational campaigns for community dwellers. Similarly, financial outlays cannot be avoided when organising a collection system of household organic waste for official compost sites [1].

Selective collection at source is highly dependable on the degree of the society motivation. Consumer's decision about how to proceed with waste gathering process depends on many factors, which is illustrated in Fig. 1 below.

As Fig. 1 shows the decision on selective waste gathering is a resultant of two forces involved, one of them being motivation to take on the effort of selective waste gathering and the other one being difficulties and workload involved in this kind of waste gathering process.

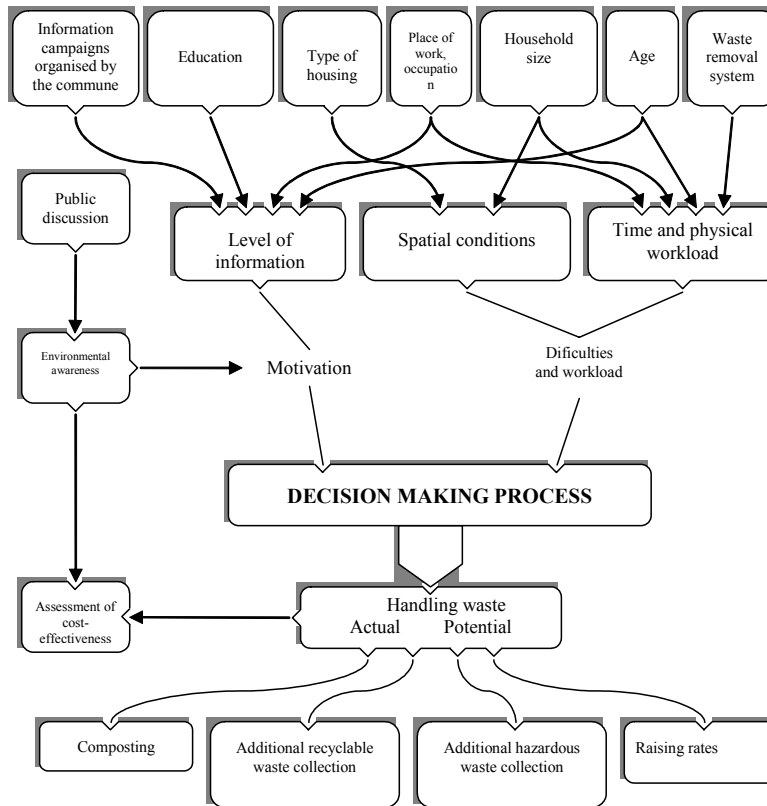


Figure 1 Factors and motivation affecting the dwellers' decision concerning selective waste gathering. *Source: [2]*

Motivation for selective waste gathering is largely determined by the level of information which waste generators have and their environmental awareness. Waste generators' level of information depends on local government's activities such as commune-run education and information campaigns which aim at showing the society benefits which selective waste collection can bring as well as waste generators' education, occupation and age.

Difficulties and workload/burden involved in selective waste gathering are a result of spatial conditions which in turn involve type of housing and household size as well as time and physical effort required. Time needed for selective waste collection depends on individual features of a waste generator (place of work, occupation, household size and age) as well as the operating waste removal system.

Moreover, the waste generator needs to be convinced that selective waste gathering can be beneficial to them, e.g. lower rates for waste removal or living in an environment friendly surrounding.

Hence, if waste generators are to make decisions which support selective waste collection, the following conditions need to be fulfilled:

- Successful operation of the system requires appropriate space,
- Waste generators need to have a certain degree of environmental awareness and also need to be convinced of the benefits that system operation can bring,
- The system needs to be user-friendly,
- The idea behind the system needs to be supported by local press and authorities [2].

Segregation proves beneficial at further stages of waste management, where the value of the recyclable waste is higher, so e.g. glass which has been separated at an early stage of the process is sorted according to color, waste paper is sorted according to specific standards and plastics according to the material used. Logistic post-selection process is often connected with a technological process, such as preliminary waste treatment process, which is meant to provide recyclables.

Such processes include plastics granulation, glass grinding, wood and bulky waste crushing and shredding. This stage of waste management is a stage where recyclable waste is actually produced in order to be sold for reutilization [1].

The post-selection process is burdened with waste contamination. Badly segregated waste material cannot be channeled for post-selection due to high contamination level. Then the segregation process becomes economically inefficient, which means that it is simply better not to segregate rather than segregate inadequately. J. Bendkowski and M. Wengierek illustrate this with an example of a waste paper collection centre in Mikołów (Poland). This collection centre takes segregated waste paper at the following prices:

- Selected cardboard on rolls: 200.00 PLN/t,
- Multi-layer paper grocery bags: 260.00 PLN /t,
- Books, newspapers: 160.00 PLN /t,
- Mixed waste paper: 100.00 PLN /t.

Mixed waste paper is treated as unsegregated waste paper and it is bought at 100.00 PLN /t. Since it has been accepted that selective waste paper collection is economically beneficial from 180.00 PLN /t, it shows that collection of unsegregated waste paper is not profitable. A similar case is that of glass containers as well as plastics [1].

The segregation process should be carried out very carefully if the material recovered from segregated waste is to be reutilised. This mainly concerns glass as different kinds of glass have different properties. That is why glass works do not take ground glass for reutilisation as they find it difficult to determine its composition. Instead they tend to take rinsed bottles, usually coming from a particular producer.

3. Municipal solid waste segregation as a result of gathering and collection processes

Waste collection system depends on the way waste is gathered. The waste segregation process has the decisive role here.

As it has been already mentioned the segregation process can be the one which opens the system – the *speculation* principle, where waste is segregated as it is being gathered, but the segregation can also take place after waste has been collected and transferred to a sorting facility. This is how, according to M. Jahre both the *speculation* and *postponement* principles can be applied in waste segregation processes [5].

With regard to when the segregation process takes place within the municipal solid waste management system two ways of waste gathering are distinguished:

- gathering waste without preliminary segregation (mixed waste stream),
- selective gathering of specific waste streams.

In case of mixed waste gathering it is assumed that the segregation process takes place at a further stage of waste channelling (according to the *postponement* principle). In case of selective waste gathering, even if it is only based on preliminary waste segregation, it is assumed that waste segregation takes place before it actually enters the municipal solid waste management system (according to the *speculation* principle).

The decision whether to place the segregation process as early as in the waste gathering process or whether to move it to further stages determines the character of the gathering process. The interrelation which arises between the way waste is gathered and the way it is collected shows that the better (the more thoroughly) the material gathered is segregated, the more complicated the collection system becomes. This is due to the fact that a greater number of types of waste streams (thorough waste segregation) means more waste stream types to be transported. In practice it means that if, while segregating waste, consumers segregate e.g. mixed-coloured glass, clear glass, paper, plastics, organic fraction and metals, then, the vehicles and refuse collection teams must be prepared to be able to collect and transport such waste streams. This also often means that different vehicles need to be sent to collect different waste stream types (a separate vehicle is sent to collect glass, another one to collect paper, and another one to collect organic waste stream, etc.).

The situation is significantly different when the number of waste streams types which need to be transported is reduced. Extreme is the situation when consumers do not segregate waste at all and they produce one waste stream. Then waste is collected with the use of one type of waste collection vehicle. Therefore, the collection process is fairly simple.

4. Conclusions

Application of both the *speculation* principle and the *postponement* principle in relation to waste segregation have their advantages and disadvantages. The most important disadvantages of the *speculation* principle include high transport costs and the necessity to adjust vehicles so that they can transport different waste stream types. This kind of solution involves also side effects for the environment e.g. car exhaust fumes. It is reported that in the city of Bonn an average of 32 waste collection vehicles pass every household on monthly basis as every waste stream requires a different type of vehicle for transport [5]. This fact presents a contradiction to the general idea of municipal waste management, in which one of the fundamental aims is environment protection. Naturally, it is possible to reduce the frequency with which such collections are scheduled, but this means more waste would have to be stored in households, which would also be undesirable. On the other hand, the most important advantage of waste segregation which needs to be mentioned is the fact that segregated waste which enters the waste management system is not as contaminated as unsegregated waste stream. It is, indeed, more difficult to separate material suitable for recycling from unsegregated stream and it is of lower value due to possible contamination, e.g. German pulp mills do not accept waste paper separated from waste stream which has not been segregated before its collection [2].

Postponement in waste sorting i.e. moving it further in time to subsequent stages and system participants, e.g. a specialist company, results in unsegregated waste transport, which results in simplified gathering process and reduced transport costs. On the other hand, however, postponing segregation and engaging a specialist company to do it results in increasing segregation costs while the consumer is supposed to segregate the waste free of charge. However, it is emphasised that the cost of segregation in a sorting facility can still be lower than transport costs in the first case as there may develop the scale effect. Postponing waste segregation and engaging a specialist company to do it may prove even more beneficial if it is taken into account that the consumer must spend time on segregation as well. Certain costs are also generated in the process of acquainting consumers with different segregation methods as well as in information campaigns aiming at popularising selective waste gathering. Moreover, postponing waste segregation is also connected with greater flexibility of the waste management process, i.e. ability to take an amount of waste material which is

different from that initially specified. This waste material can then be segregated according to the specific needs.

Then, undoubtedly, the *speculation* principle which burdens the consumer with the responsibility for waste segregation is beneficial only to a limited extent. Hence the call for lifting the burden of waste segregation off the consumer's shoulders and favouring low transport costs of unsegregated waste as well as accepting the scale effect in waste segregation performed by a specialist company [5].

The *speculation* principle and the *postponement* principle both influence the length of the municipal solid waste management process. Application of the *speculation* principle reduces the number of stages in this process as illustrated in Fig. 2.

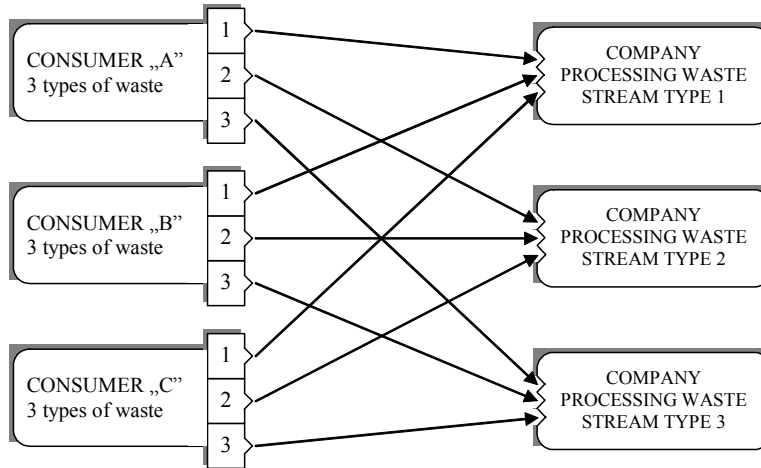


Figure 2 The opening stages in municipal solid waste management according to the *speculation* principle. Source: [5]

As Fig. 2 shows, the *speculation* principle results in early waste stream channelling and the diversification of the logistic channels since from the very moment of waste collection from the consumer this logistic channel divides into smaller channels so that each waste stream type is transported to a different destination. If the waste material has been properly segregated, it can be transported directly to the places where it is processed (e.g. steel works, plastics industry plants), thus eliminating the additional stage of the waste sorting facility and the cost of sorting waste.

The opening stages of the municipal solid waste management system look different when the segregation is postponed, which is illustrated in Fig. 3.

Fig. 3 shows that when the segregation processes are postponed and transferred from the consumer to the company, the number of stages in the process grows and its division is postponed, too. The two stage phase (the consumer and the companies dealing in waste recovery or recycling) where the *speculation* principle is applied is replaced with the three-stage phase where the *postponement* principle is applied (the consumer, the waste sorting facility and companies dealing in waste recovery or recycling).

The solution presented in Fig. 2 unfortunately has certain drawbacks. When waste segregation is done by consumers, there is a risk that consumers will not segregate the waste correctly. Appropriate segregation often requires a certain degree of expertise, which the average consumer does not have. Very few consumers have adequate facilities in their dwelling places, which are needed when segregating waste streams, notwithstanding good will and willingness. Adequate segregation requires appropriate information on the local

waste processing market, and thus appropriate knowledge concerning segregation, i.e. one needs to know whether in a given region there is a company which processes glass and whether it takes glass segregated according to its colour or not. Moreover, there are different standards and norms in different countries. Segregating waste according to the operating norms in one country may mean that the transport of given waste streams is unprofitable as the country of destination has different operating norms and they require different waste stream types.

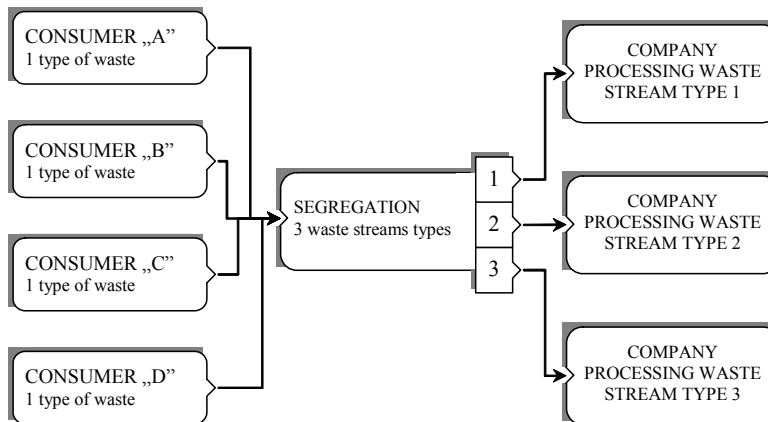


Figure 3 The opening stages of the municipal solid waste management system according to the *postponement* principle. Source: [5]

It is possible to make waste collection less complex through simplifying the collection stage. Most important here is to reduce the number of waste collection vehicles. This is achieved through using one type of vehicle adapted to collect different waste stream types – by using integrated collection methods. It is therefore possible to consider two extreme cases of waste collection, namely, when all waste stream types are collected by one waste collection vehicle and when each waste stream is collected separately by a different collection vehicle. The first case is that of so called *co-collection* i.e. integrated collection. The degree of integration can be measured and it is expressed by the following ratio:

$$\text{Integration degree} = \text{number of waste streams} : \text{number of vehicles.}$$

At present municipal solid waste is gathered and collected in different ways worldwide. In different cities and towns different amounts and waste streams are identified; there are also different types and numbers of waste collection vehicles. For instance, in the abovementioned city of Bonn waste is segregated into 5 separate waste streams collected by 5 different types of vehicles. It needs to be remembered, however, that the lower the collection integration ratio, the higher the number of vehicles and distribution channels, and hence, the more complex logistics [5].

As far as gathering, collection and segregation processes are concerned, designing a logistic system for municipal solid waste management requires solving the following logistic problems:

- it needs to be decided whether waste generated in a given region can be segregated or not, and
- it also needs to be decided whether in a given region segregation should take place already before entering the system (at the consumer's) or whether it can be performed at a further stage of the process.

This requires research into the needs of a local market concerning recyclables recovered in municipal solid waste processing. If it turns out that selective waste gathering is economically efficient, the following problems need consideration:

- deciding what waste stream types consumers should select within the waste stream they generate,
- introducing selective waste gathering methods by providing appropriate containers – deciding on the number of containers and their distribution.

Addressing these particular issues is of great importance since it allows to modify the character of municipal solid waste stream at the point where it enters the waste management system as well as shape its character in relation to the needs and possibilities which arise at further stages of the logistic channel. These, in turn, determine subsequent processes such as transport and reloading.

5. Summary

Application of the *postponement* and *speculation* principles determines segregation process in municipal solid waste management according to a specific criterion. Depending on whether the *postponement* principle or the *speculation* principle is chosen, the character of the segregation process changes. In order to enhance the commercial value of the recyclable waste, and increase the number of stages in the municipal solid waste management, the segregation process is transferred to further stages of the system – the *postponement* principle. On the other hand, applying the *speculation* principle reduces the number of the stages.

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