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Updating and testing of a Finnish method for mixed municipal solid waste composition studies

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ABSTRACT

More efficient recycling of municipal solid waste (MSW) is an essential precondition for turning Europe into a circular economy. Thus, the recycling of MSW must increase significantly in several member states, including Finland. This has increased the interest in the composition of mixed MSW. Due to increased information needs, a method for mixed MSW composition studies was introduced in Finland in order to improve the national comparability of composition study results. The aim of this study was to further develop the method so that it corresponds to the information needed about the composition of mixed MSW and still works in practice.

A survey and two mixed MSW composition studies were carried out in the study. According to the responses of the survey, the intensification of recycling, the landfill ban on organic waste and the producer responsibility for packaging waste have particularly influenced the need for information about the composition of mixed MSW. The share of biowaste in mixed MSW interested the respondents most. Additionally, biowaste proved to be the largest waste fraction in mixed MSW in the composition studies. It constituted over 40% of mixed MSW in both composition studies. For these reasons, the classification system of the method was updated by further defining the classifications of biowaste. The classifications of paper as well as paperboard and cardboard were also updated. The updated classification system provides more information on the share of avoidable food waste and waste materials suitable for recycling in mixed MSW. The updated method and the information gained from the composition studies are important in ensuring that the method will be adopted by municipal waste management companies and thus used widely in Finland.

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1. Introduction

The recycling target for municipal solid waste (MSW) was introduced in the waste framework directive (2008/98/EC) of the European Commission. By 2020, preparing for the reuse and recycling of MSW should be increased to 50% (European Commission Directive, 2008/98). In December 2015, the European Commission adopted an ambitious Circular Economy Package to stimulate Europe's transition towards a circular economy. The Circular Economy Package aims to boost global competitiveness, foster sustainable economic growth and generate new jobs by means of new legislative proposals on waste. By 2030, the recycling of MSW must be increased to 65%. The corresponding target for packaging waste is 75%. (European Commission, 2016.)

In Finland, the aim was to achieve a 50% MSW recycling rate by the end of 2016 (Ministry of the Environment, 2008). However, in 2014, only 33% of MSW was recycled in Finland (Statistics Finland, 2015a). Since the recycling of MSW has not increased significantly during the past two years, it is evident that the Finnish recycling target will not be reached. In order to achieve the 50% recycling target by 2020, let alone the new recycling target of the Circular Economy Package, Finland has to increase substantially the recycling of MSW in the following years.

Due to MSW recycling targets, interest in the composition of mixed MSW has increased in recent years. Mixed MSW refers to the remaining part of MSW after the source separation of different waste fractions (e.g. biowaste, paper, cardboard, glass and metal, which are typically source separated in Finland). Mixed MSW comprises a major part of the total amount of MSW. For instance, in 2014, 51% of MSW in Finland was mixed MSW (Statistics Finland, 2015a). There is a great deal of additional recycling

potential in Finnish mixed MSW. The additional recycling potential concerns particularly biowaste, cardboard and plastic since they comprise approximately 65% of Finnish mixed MSW (Finnish Solid Waste Association, 2016). Thus, more efficient source separation of these fractions would substantially increase the recycling rate of MSW.

Information on the composition of mixed MSW is needed in the planning and environmental assessment of waste management at both the regional and national level (Edjabou et al., 2015; Sharma and Mcbean, 2007). In Finland, particularly the landfill ban on organic waste from 2016 onwards and the producer responsibility for packaging waste have increased the interest in the composition of mixed MSW. Additionally, information on the composition of mixed MSW can be utilised in many other purposes which are more specific. The comparison of different waste collection systems (Dahlén et al., 2007), the determination of various combustion properties (e.g. Horttanainen et al., 2013; Zhou et al., 2014), the planning and establishment of waste treatment plants (Gidarakos et al., 2006), the life cycle assessment of waste management systems (Slagstad and Brattebø, 2013) as well as the quality control of waste (Petersen et al., 2005) are specific examples where detailed and accurate information about the composition of mixed MSW has been needed and utilised.

The composition of mixed MSW can be determined through a composition study, i.e. manually sorting waste fractions to different categories. Internationally, studies have been carried out in various methods (e.g. Aphale et al., 2015; den Boer et al., 2010; Burnley et al., 2007; Cornelissen and Otte, 1995; Dahlén et al., 2007; Edjabou et al., 2015; Gidarakos et al., 2006; Horttanainen et al., 2013; Hristovski et al., 2007; Petersen et al., 2005; Sharma and McBean, 2007; Zhou et al., 2014). The variety of methods used is due to e.g. different source separations systems, sorting guidelines, waste collection systems and information needed about the composition of mixed MSW. The European Commission (2004) has also introduced its own method for solid waste composition studies. In a review by Dahlén and Lagerkvist (2008), altogether 20 different methods for mixed MSW composition studies were identified. Even though various methods for mixed MSW composition studies exist, the use of methods has not always generalised nationally, e.g. in Finland, let alone internationally.

Due to the increased need for information about mixed MSW, a number of mixed MSW composition studies have been conducted in Finland. It has been evaluated that at least 30 mixed MSW composition studies have been carried out in Finland since 1987. The majority of these studies have been conducted in the 2000s. (Sahimaa et al., 2015.) However, studies have been carried out with different methods, which makes it difficult to compare the results. For instance, sample sizes, number of samples, classification methods and stratification practices vary substantially between studies. Therefore, it is challenging to form an overall picture of the composition of mixed MSW in Finland.

A method for mixed MSW composition studies was published in Finland at the end of 2014 by Toivonen and Sahimaa (2014) in order to improve the national comparability of composition study results. Additionally, the method and its development have been discussed in a study by Sahimaa et al. (2015). The method includes several guidelines concerning the planning and implementation of composition studies as well as the analysis of results. Because the method has been published only recently, there are no experiences of how it works in practice.

In this study, the Finnish method for mixed MSW was further developed based on the results of a survey and two mixed MSW composition studies. The updating of the method focused on the classification of waste fractions since it was estimated to need further development after surveying the information needs concerning the composition of mixed MSW and testing the method in

practice. The method's other guidelines (i.e. guidelines for stratification, sampling, statistical analysis) were not updated since they are in line with the recommendations of the European Commission (2004).

The research questions were the following:

(1) What information do different operators in the waste sector need about the composition of mixed MSW?
(2) How does the method work in practice and what is the composition of mixed MSW in two case areas, Riihimäki and Turku?
(3) How should the classification and sorting guidelines of the method be updated so that the method corresponds to the information needs about mixed MSW and is still applicable in practice?

2. Materials and methods

2.1. Description of the Finnish method for mixed MSW composition studies

The method for Finnish mixed MSW composition studies contains altogether 15 recommendations for the planning and implementation of composition studies as well as the analysis of results. The recommendations concern e.g. sampling, the number of samples, sample size, sorting, classification of waste fractions, safety and statistical analysis. (Toivonen and Sahimaa, 2014.) The classification of waste fractions is a particularly important part of the method since it defines the information obtained through a composition study. Thus, if classifications of waste fractions vary substantially between composition studies, results can hardly be compared (Dahlén and Lagerkvist, 2008).

In the classification of fractions, waste categories are divided into primary, secondary and tertiary levels. Since the levels are hierarchical (i.e. second and third level categories are included in the higher level categories), the results of composition studies are always comparable at least at the first level. At the first level, the classification is determined on the basis of waste materials (e.g. paper, wood, metal and glass). Additionally, the first level includes categories for textiles, shoes and bags, hazardous chemicals, miscellaneous waste as well as waste electrical and electronic equipment (WEEE) and batteries. At the second level, the classification is determined according the waste fractions' origin (e.g. kitchen waste) and the purpose of use (e.g. paper packaging). Thus, the total share of packaging waste in mixed MSW can be determined at the second level. At the third level, certain second level categories are further classified on the basis of certain characteristics. For instance, plastic packaging is classified to dense and plastic film packaging. The number of categories depends on the level of classification (11, 27 and 38). There is no category for hazardous waste in the classification system since hazardous waste may consist of different materials and products. Instead, different hazardous waste categories are clearly marked in the classification, and the total amount of hazardous waste can be calculated by adding up different categories' masses. (Sahimaa et al., 2015.) The classification system is presented in Table 1.

2.2. Survey on the need for information on mixed MSW

In the former development of the MSW composition study method by Sahimaa et al. (2015), the information needs of different waste management authorities concerning mixed MSW were taken into account through a survey and interviews. A survey was sent to 35 different Finnish municipal waste management companies. Nevertheless, the information needs of many important stakeholders, such as waste operators in the private sector,