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Quantitative assessment of distance to collection point and improved sorting information on source separation of household waste

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ABSTRACT

The present study measures the participation of households in a source separation scheme and, in particular, if the household's application of the scheme improved after two interventions: (a) shorter distance to the drop-off point and (b) easy access to correct sorting information. The effect of these interventions was quantified and, as far as possible, isolated from other factors that can influence the recycling behaviour. The study was based on households located in an urban residential area in Sweden, where waste composition studies were performed before and after the interventions by manual sorting (pick analysis). Statistical analyses of the results indicated a significant decrease (28%) of packaging and newsprint in the residual waste after establishing a property close collection system (intervention (a)), as well as significant decrease (70%) of the miss-sorted fraction in bags intended for food waste after new information stickers were introduced (intervention (b)). Providing a property close collection system to collect more waste fractions as well as finding new communication channels for information about sorting can be used as tools to increase the source separation ratio. This contribution also highlights the need to evaluate the effects of different types of information and communication concerning sorting instructions in a property close collection system.

1. Introduction

Source separation of waste refers to the collection of different waste fractions where the waste is sorted at the place where it is generated and where the fractions are collected in separate containers. Several different technical systems for source separation of household waste are available, all of which rely on active, efficient and correct participation at the household level (Baltes et al., 2009; Leitol, 2014; Rada et al., 2013). For example, two methods that are used in Sweden to collect separated waste are the bring/drop-off system and the property close collection system. In the bring/drop-off system inhabitants bring their sorted, dry recyclable materials to a drop-off station which may be located in another part of the city. In the property close collection system, a bin-room, which contains different bins for collection of some recyclable waste, is provided in close proximity to multi-family apartment buildings for collection of sorted, recyclable materials. In some residential areas, single family houses have multi-compartment bins for kerbside collection of sorted recyclables.

Source separation has become mainstream in Swedish waste management, increasing material recycling and decreasing landfilling of household waste, since the ordinance of producer responsibility was applied in 1994 (SFS, 1994a,b) and the ordinance about landfilling in 2001 (SFS, 2001). According to the Swedish Waste Management Association (2014), 33% of household waste was recycled in 2013. This means that a substantial amount of recyclable materials was still not recycled, but recovered in other ways such as incineration with energy recovery. The Swedish Environmental Protection Agency has suggested some objectives to increase the recycling rate of household waste and biological treatment of food waste by 2020 (SEPA, 2013). Increased collection rates of correctly sorted recyclables and a reduced amount of miss-sorted materials in the residual waste is required to achieve this goal. Therefore, identification and quantification of the factors that influence source separation of waste (called influential factors) are important. These factors can subsequently be used as a tool for decision makers and engineers to improve waste management systems.

Several researchers have investigated influential factors on inhabitants' recycling behaviour. A synthesis of research results identified consumer knowledge and commitment to recycling as intrinsic factors, economic rewards and social influence as extrinsic

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factors and frequency of the collection as an external facilitator (Castagna et al., 2013; Grodzińska-Jurczak et al., 2006; Hornik et al., 1995). Seacat and Northrup (2010) named recycling information, motivation and behavioural skills as determinants for engaging in recycling. The influence of socio-demographic variation on recycling is still under debate. In situations where recycling has become a habit and is widely spread throughout population, the demographic variable is weakly correlated to waste sorting behaviour (Del Cimmuto et al., 2014; Hornik et al., 1995). Similarly, a study in Kiruna, Sweden, found that socio-demographic factors have no effects on waste sorting behaviour (Vencatasawmy et al., 2000). This was confirmed in a recent meta-analysis study which revealed that the socio-demographic factor is a poor predictor of waste sorting behaviour, while information, environmental concern and convenience are the strongest predictors (Miafodzyeva and Brandt, 2013). In contrast, Sidique et al. (2010) found that demographic factors influence the use of drop-off centres. Similarly, several studies show that convenience in sorting, storage space at home, availability of sorting facilities, access to a kerbside collection system and distance to collection points are important influential factors that can increase the recycling rate (Ando and Gosselin, 2005; Barr and Gilg, 2005; Bernstad, 2014; Derksen and Gartrell, 1993; Folz, 1991; Garces et al., 2002; González-Torre and Adenso-Díaz, 2005; McCarty and Shrum, 1994; Sidique et al., 2010; Thøgersen, 1997). For example, quantitative analysis of a questionnaire study by Sidique et al. (2010) showed that increased distance to drop-off points is likely to decrease the number of visits. In another questionnaire study, Ando and Gosselin (2005) concluded that recycling rates would rise by 66% if doorstep collection was used instead of only using drop-off points. Similar results were obtained in a study in Sweden, which used the survey method with self-reports, where the property close collection system was found to increase collection of packaging materials compared to the drop-off system (Hage et al., 2009). Dahlén et al. (2007) used waste composition studies by manual sorting (pick analysis) to analyse collection systems by comparing the waste flow composition in six Swedish municipalities, and concluded that the availability of property close collection instead of a drop-off system increased the collection rate of sorted recyclables. They also stressed that reliable waste flow data, required for definitive conclusions, are scarce and difficult to access.

In addition to facilities close to the property, knowledge about what and where to sort the waste for recycling is an important determinant for recycling behaviour (Barr and Gilg, 2005; Hornik et al., 1995). Schultz (2002) noted that lack of knowledge is a barrier to recycling. Further, lack of information on how to implement the sorting scheme was listed as a predictor for non-recyclers (De Young, 1988; Vining and Ebreo, 1990), and the availability of information was shown to be a long-term factor that should be taken into account (Iyer and Kashyap, 2007). It is also worth noting that the complexity of sorting waste, and how information is communicated, have been named as key issues in distributing information (Schultz, 2002). For example, in a recent study in Sweden Bernstad (2014) found that written information did not increase separation of food waste significantly, but that information campaigns need to be correctly designed and proper methods must be used to spread this information. It should be noted, however, that studies which investigate the use of knowledge and information to find new ways of waste sorting differ from those that assess how these factors change existing behaviour in source separation system.

The literature review presented above shows that, among the different variables, there is consistency regarding two crucial factors for increasing participation in source separation programmes: (1) convenience such as short distance to the collection point and (2) relevant information about the recycling program. The main part of the studies discussed above has focused on behavioural aspects of the determinants, while the effects have not been quantified. That is, none of the studies quantifies the role of distance and information, separately and in isolation from other factors that can influence recycling. The overall aim of this paper is to contribute to increased and correct participation in source separation programs for household waste. The specific objective is to assess and quantify the effect of: (1) shorter distance to a collection point for packaging and (2) easy access to information about sorting of food waste.

2. Background of household waste management in Borås

This study was conducted in the city of Borås, Sweden, which has applied a source separation system for more than 20 years. The municipality provides inhabitants with free plastic bags in two different colours so that they can sort their residual waste at home into two separate fractions; food waste (black bag) and combustible waste (white bag). The black and white bags are not separated but collected in a common container, and subsequently mechanically separated in an optical sorting plant. Here, combustible waste refers to the non-recyclable, non-packaging and non-hazardous waste such as diapers and tissue. The food waste is processed for biogas production, which can be used to fuel cars and busses for public transportation, whereas combustible waste is incinerated in the city's power plant with heat and electricity recovery. Other materials, such as packaging, newsprint, batteries, hazardous waste, and bulky waste, should be collected at designated drop-off points. The waste management system in Borås, based on black and white bags, is a convenient system for the inhabitants to separate the food waste. Bernstad (2014) investigated food waste sorting in another city in Sweden where sorting equipment for collection of food waste was installed in the kitchen. The aim was to increase convenience of food waste sorting and the result was increased collected amount of food waste. The waste management system in Borås was implemented in the early 1990s and is continuously being developed. The food waste was initially collected and used for composting, and was therefore denoted the compostable fraction. It was also recommended that other waste, such as diapers and pads (all of which are called diapers in this contribution), were included in the compostable fraction. In addition, trash cans for the black bags were distributed to each household in an effort to encourage the inhabitants to sort the food waste fraction. Information about which waste should be sorted in the black bag, including diapers, was visible on the trash can. Ten years later (early 2000s) the technical system had been developed and the food waste treatment was changed from composting to biogas production. Diapers therefore had to be sorted into the white bags instead of the black bags, but the old information (recommending sorting of diapers into the black bags) remained on the trash cans. This probably caused miss-sorting of fractions in the black bags. A recent waste composition study conducted by the city of Borås revealed that the percentage of miss-sorted waste in both black and white bags was, on average, 42% for the city (Rousta and Ekström, 2013). The goals in the waste management plan for the city require that this should decrease. The research presented in this paper was initiated to measure the effect of specific interventions aimed at decreasing the miss-sorting ratio for a limited area of the city of Borås.

3. Methods and materials

3.1. The study area and participants

The study was performed in an urban residential area consisting of 208 apartments in nine eight floor buildings. The area is part of