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Analysis on effectiveness of separate collection system by using GIS

○Shinya Suzuki*, Shigeo Oka**, Yasushi Matsufuji*, Michiko Yokoyama***, Kazuo Yamamoto***
*Department of Civil Engineering, Faculty of Engineering, Fukuoka University
**Taiseikanrikaihatsu Ltd.
***Environmental Science Center, University of Tokyo

1. Introduction

In Japan, there are many separate collection systems for 3R (Reduce, Reuse, and Recycle), which are being conducted by various kinds of method. However, most collection systems are standardized in each municipality, few systems take detailed "waste source" characteristics into account. But in fact, the recovery rate differs widely between each waste source. For example, in Tokyo's 23 wards, recovery rate of waste paper from large-scale businesses is sufficiently high; on the contrary, the rate from medium and small-scale businesses is low.

GIS (Geographic Information System) is one of the most useful tools on solid waste management, which contributes to the system improvement by integrating various kinds of data. So in this study, the analyses of 2 separate collection systems were conducted.

- Local collection system in Fukuoka city was analyzed by using the GIS data itself.
- Economical analysis of aiming at waste paper collection project for medium and small-scale businesses in Tokyo's 23 wards was conducted by using the analytical function of GIS.

2. Local collection system in Fukuoka city

Methods

Data on the amount of collected waste for disposing and recovering in every small district were examined respectively. Based on these data, "the factor of contribution to recovery" was introduced, and inputted on the map as one of the geographic information by using GIS software.

As for local collection, such as the local activities by one of the local communities or PTA, each local resident manages this collection system. Each waste producer carries newspaper, magazines, metals, glasses etc. from each household to the collection station. So this collection system

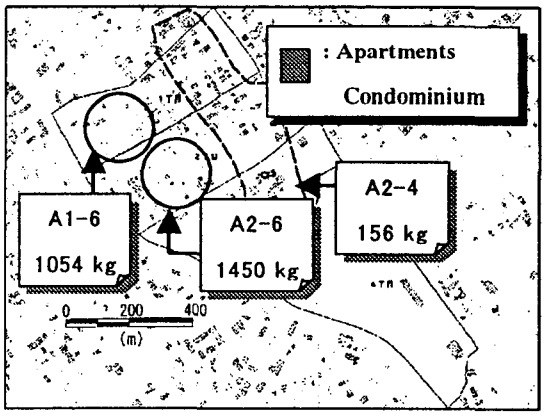

Fig.1 Influence of local characteristics on local collection

Shinya Suzuki: Department of Civil Engineering, Faculty of Engineering, Fukuoka University, Japan
8-19-1 Nanakuma, Johnan-ku, Fukuoka, 814-0180, Japan
TEL: +81-92-863-8238 FAX: +81-92-863-8248 E-mail: ssuzuki@fukuoka-u.ac.jp

was analyzed by introducing the data on the types of buildings "apartments, condominium, or bungalow" in order to understand more detailed local characteristics.

Results and Discussions

The amount of collected waste differs according to the districts. Fig.1 shows the amount of separate collected waste for recycling at "A district" in Fukuoka city. The values of A1-6 and A2-6 districts are about 10 times larger than that of A2-4 district. The ratio of apartments or condominium in A2-4 district is higher than those in others. As a general, in apartment houses, young people live single. The result clarifies that it is difficult for single people to cooperate the present system.

3. Waste paper collection in Tokyo

Methods

Collection fee is currently set cheaper than waste disposal charge, but the number of participants is very small. So in this study, we took "indirect cost" into account. 3 kinds of indirect costs were analyzed, such as "haulage cost", "hauled container's space cost", and "sorting work cost".

Comparison between "FF (floor to floor) method", waste paper is collected from every floor, and "1F (1 floor station) method", waste paper is collected from the station in 1 floor, was conducted. Major factor of cost of waste paper collection is collection and transportation cost in Japan. It depends on collection efficiency. The definition of collection and transportation time is shown in Fig.2. Transportation times were analyzed by using GIS software, which can detect the shortest route.

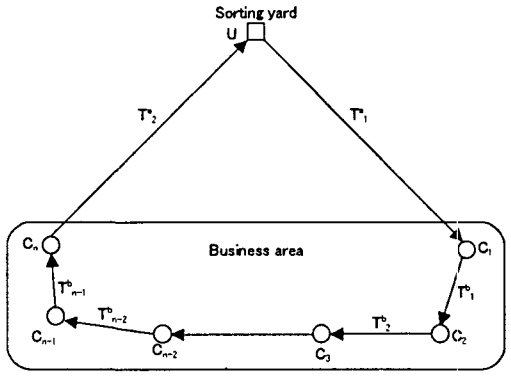

Fig.2 Definition of collection and transportation time

Collection and transportation time = $T^a + T^b + C + U$

$T^a=T^a_1+T^a_2$; Transportation time (a)

$T^b=T^b_1+T^b_2+ \cdots + T^b_{n-1}$; Transportation time (b)

$C=C_1+C_2+ \cdots +C_n$; Collection time

U; Unloading time

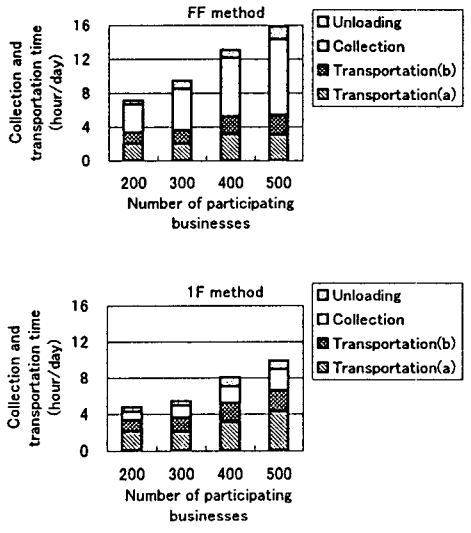

Fig.3 Difference of collection and transportation time between "FF (floor to floor) method" and "1F (1 floor station) method"

Table 2 Difference of the number of collection vehicles

Number of businesses	200	300	400	500
FF method	1	2	2	3
1F method	1	1	2	2

Results and Discussions

Fig.3 shows the difference of collection and transportation time between FF method and 1F method. The difference of method affects collection time, which makes the number of collection vehicles different between 2 methods. (Table 2)

Fig.4 shows summation of cost of waste paper collection, container's cost, and indirect costs (haulage cost, hauled container's space cost, and sorting work cost). When the numbers of participants are 300 and 500, cost of waste paper collection differs between 2 collection methods. In case of 1F method, total value of costs of waste paper collection system and haulage cost are higher than waste disposal fee regardless of the number of participating businesses. In case of FF method, costs of waste paper collection systems are higher than those of 1F method because of lower collection efficiency, but the difference decreased according to the increase of the number of participating businesses. Container's cost and hauled container's space cost also decreased according to the increase in the amount of collected waste paper from each business. So optimal method differs in every business. It is essential to prepare 2 collection methods so as to give incentive to business establishments in the same area.

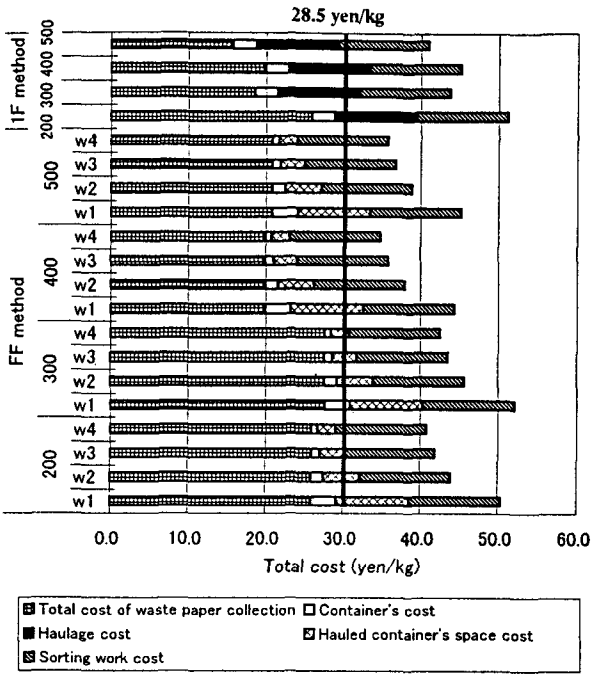

Fig.4 Summation of cost of waste paper collection, container's cost and "indirect costs". (w1; 100kg/business・month, w2; 200kg/business・month, w3; 300kg/business・month, w4; 400kg/business・month)

4. Conclusion

Analysis on effectiveness on separate collection system was conducted by using GIS. As a result, the use of GIS data itself and the analytical function of GIS are both helpful to improve the separate collection system. In Japan, as one of the services, public information gets open to the public. GIS is the effective tool for helping solid waste management develop by connecting the Internet web page. And it is also practicable for proposing the policy concretely and constructing its evaluation methods.

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