Management System Model for Charged Household Waste Disposal

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Abstract: This report summarizes the results of a survey study of charged household waste disposal which is said to promote the reduction of the disposal amount. In particular, the actual condition of charged collection due to charging for household waste was carried out from 2008 to 2011, and its management system is reported. Although previous studies and discussions have reported on the various creative methods of the charged collection by local government bodies, the actual condition has not been clearly identified systematically. In this report, management systems are classified and material which is useful for designing an information system of charged collection management is prepared. Especially, in the collection management system using authorized bags which are commonly introduced in recent years, is targeted. Furthermore, the operation conditions of the information management system which has developed based on the system designing of this study, is confirmed and its usability is verified.

Key Words: Household waste, Disposal charge, Charging management system, System modeling, Entrusted management and Implementation method, Waste reduction.

1. Introduction

The reduction of the household waste is an important issue of municipal government in Japan. As in other developed countries, many local governments in Japan introduced producer responsibility regulations for the household waste. Producer responsibility principle also applies for industry sectors, such as home appliance disposal and returnable packages, and so on.

For the charge of household waste, there are two major methods, i.e., fixed charge rate for every family and variable charge based on the waste quantity. For the second charge methods, many local governments introduced an idea that every family must purchase authorized waste bag for their household waste disposal. However, monitoring purchasing of authorized waste bag is not easy. It requires careful matching of information, therefore an elaborated information system is required.

In this paper, we investigate real cases and provide knowledge for environmental management information system. Through analyze data from the newly built management information system based on our investigation and analysis, we found problems in the system tracing the household waste, and evaluate the management information system.

2. Charged Collection by Authorized Waste Bags

There are different ways to charge for household wastes, we focus on two types of charge method in this paper, i.e., fixed charge system and variable charge system. Japanese government released a new Waste Management Law in May 26, 2005, which is known as “The basic policy towards the comprehensive and systematic promotion of measures for the appropriate management in the reduction of waste”. Based on the Article 5-2 (1) of the Waste Management Law was revised and described as follows: “in order to promote the control of general waste disposal using an economic incentive and encourage recycling, as well as promote impartiality in payment according to general waste disposal and to further increase awareness by the residents, conversion to a charge-based general waste disposal system should be considered”. This has led to the promotion of a charge for amount of general waste disposal as a basic environmental policy on household wastes. Furthermore, according to “The Charge for General Waste Disposal Guide” issued in June 2007 by the Ministry of the Environment, a system using a fair rate charge to the amount disposed was set to be the basis for the environmental management system. Thorough our investigation, we found that most municipal government introduced amount base charge system instead fixed charge system.

As shown in Figure 1, there are various types of charges depending on the amount of household waste. For example a simple charge based on amount, a set charge for waste in excess of a base household waste amount, a multi-step rate where charge rate increases as the amount of household waste increases, and a graduated set charge.

Table 1 shows instruments of the charges. As shown in Table 1, there are two major instruments for charging household wastes, i.e., bags and stickers. Stickers are purchased and attached to trash box, bags or directly on the wastes such as used home appliances and other big size wastes. Charge sticker is easier to produce it than produce trash boxes or bags for those big size household wastes. They can be produced locally, without consuming fossil resources, hence less emissions. Stickers are easier to separate management for manufacturing and distribution, and charging. However, adapting a charge system which uses stickers instead of authorized bags have difficulty on real faire charge because of the difference of the waste bags.

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Table 1 Tools for Charged Accounting

Main Media for Charging		Management Target	Metered Charge	Charged Accounting
Bag	Sticker			
Undesignated bag	1 sticker / 1 bag	Stickers and stores	Difficult	Separation of bag manufacturing, distribution, and charging is possible
Designated and authorized bag	1 sticker / 1 pack of bags	Bags, stickers and stores	Easy	Separation of bag manufacturing, distribution, and charging is possible
Authorized bag	Not in use	Bags and stores	Easy	Designated price with bag distribution costs and charges are unified

Fig. 1 Structure of Charged Collection

In some local governments, stickers and designated or authorized bags are used in parallel. Waste bags distributed and used in the local communities are classified in types such as burnable or unburnable trash, recyclable or not recyclable, big size or small size, hazardous substances, home appliances, and etcetera. This allows manufacturers, wholesalers, and retail stores to produce and distribute waste bags satisfy municipal regulations. Those bags can be sold with different price at different retail stores. Stickers are purchased at convenience store and putted on the designated or authorized bags when dispose household wastes. Bag prices fluctuate based on market demand and supply, specifically quite much affected by oil price for the case of authorized or designated waste bags. Parallel using of the stickers and authorized waste bags enables separate management of household waste recycle, hence stable income for the household waste management. Incidentally, if retail stores sale the waste bags with stickers same time, then residents can save time for purchase waste bags and stickers separately at different stores. This tiny idea makes sense in terms of real field operation, and increase personal social environmental responsibility significantly.

Currently, the most common method is the distribution of authorized bags. Designated bags meet specific local standards and used in local household wastes collection. The authorized bags acts as revenue stamp, therefore production and distribution must be under control according to national or municipal tax system. In this paper, we focus on this authorized bags management system.

We argue that an integrated management of charge on house-

hold waste disposal and authorized waste bags may reduce total management cost, including waste collection and operation of two type management system, the physical flow of waste bags and the monetary flow of charge for household waste. Furthermore, the integrated management may increase convenience of residents household waste disposal, introducing designated bags, residents must purchase the bags in order to dispose of household waste, same time they also requested to purchase stickers or any similar type of revenue stamps. An authorized waste bag enables the integration of physical household waste collection and charge for household waste disposal. If we introduce several types of the authorized bags considering types of household waste, then it may further increase efficiency of the reverse logistic operation eliminating the operation of sorting after or during household waste collection.

Introduction process of charge for household waste

Small: comparatively small. Large: comparatively large.
?: not easily described due to regional characteristics and concepts.

Fig. 2 Structure of Share Cost of Residents for each Process to Charged Accounting

For residents, the introduction of authorized bags may be considered to be the same being charged for their household waste disposal. However, there is some differences. Figure 2 demonstrates the difference of cost burden of residents before and after introducing authorized waste bags. In figure 2, (Small) represents comparatively small cost burden, (Large) represents comparatively large cost burden, and (?) represents not easily described due to different conditions, ideas, efficiencies in each municipal household waste management. Introduction of authorized bags requires the residents (polluters) must

take responsibilities on their household waste disposal cost. An independent management of waste bags and charging system may increase total cost and burden to residents because of the double expenses on manufacturing, retail, waste collection service, and expenses for revenue stamps, and other management costs. In the next section, we construct an integrated household waste management system and evaluate it based on real case.

3. Classification of Management Method and System Design

In this study, the difference in the costs of distribution and management from one region to another was considered. Then, based on actual survey on local government's management was carried out., and from the viewpoint of business processes such as management-related tasks and implementation-related tasks, we classified management methods of charging introducing authorized bags for household wastes.

In this study, based on management organization and bag distribution methods, we categorize the household waste management system into three types as shown in Table 2. These three types are, (1) the direct management and direct implementation method where the entire operations of management and implementation are handled by the local government, (2) the direct management and entrusted implementation method where management tasks, such as accounting, are handled by the local government, and implementation of distribution tasks, such as inventory and delivery of the bags, are entrusted to a private organization, and (3) the entrusted management and entrusted implementation method where management tasks, such as accounting of charges, and stock and inventory of bags, and implementation of distribution tasks, such as delivery, are both entrusted to a private organization.

Table 2 Classification of Charging Method

Method Category	Content
Direct management and direct implementation	The local government handles all tasks such as accounting, inventory of bags, and delivery.
Direct management and entrusted implementation	The local government handles charges and accounting, and private organizations handle distribution tasks such as inventory, delivery, etc.
Entrusted management and entrusted implementation	Private organizations, etc., handle all accounting, inventory, and distribution tasks such as delivery, etc. The local government supervises all the tasks.

In this study, based on this classification, we constructed a management system for the household waste, and we are going to configure the system in detail. First, role of each organization in the system is described as shown in Table 3.

In local communities, the local government acts as center of the household waste management system. Bag manufacturing companies make the authorized bags based on a contract with the local government. Wholesalers handle management tasks such as receiving bags from the bag manufacturing companies, shipping, and inventory management. Logistic companies use their geographical superiority in local communities to handle

Table 3 Subject and Role in the Management System

Target	Role
Local government	Centering on implementation of general waste disposal in the local community
Bag manufacturing company	Manufacturing of priced authorized bags
Wholesaler	Inventory and shipping of priced authorized bags, and their management
Delivery company	Delivery in the local community and its management
Retail store	Bag sales to local residents and its management

bag delivery tasks. Retail stores handle sale of bags to the local residents and other bag consumers, same time receive payment from customers and make payment to manufactures. The retail stores also handle bag inventory management, and collect opinions from residents with respect to the management system. Furthermore, according to the survey of actual situation, for all methods we found a case that the disposal fees could be collected from retail store before the bag is sold out.

1) Direct management and direct implementation

As shown in Figure 3, in the direct management and direct implementation, the local government directly manages the receipts and expenditures, including the quantity of authorized bags and the service fee, inventory of the authorized bags, and delivery. The local government concludes a contract with each company (wholesaler) and retail store. The local government takes the initiative and plays central role in an integrated information management system, and handles associated management and accounting. They also handle bag inspection tasks, inventory management, shipping tasks, collection of money, and etc.

Red lines in Figure 3 represent daily tasks with high work frequency. Black lines represent tasks performed a few times a year. Solid lines represent flow of authorized bags and payment, and dashed line represent flow of data, such as sales slips, reports, invoices, etc.

First, in flow of daily tasks, a retail store handling the bags put an order to the local government. Local government receives order, and delivers the bags to the retailer. Then, the retail store handles sales management for the bags. In addition, the retail store deducts a sales commission fee and pays for bags to the local government, and the payment includes the environmental service fees.

Next, flow of the bags, money, and data will be explained. Based on annual consumption of the local community, the local government provides instructions for shipping of the bags to the wholesaler A for several batches. Based on the instructions, the wholesaler A arranges for the manufacture of the bags from the bag manufacturer and delivers the bags to the local government. Then, based on the delivery slip and invoice, the local government pays for the bags to the wholesaler A. In some cases, the wholesaler A and bag manufacturer described in Figure 3 are same company.

As for management related tasks, the retail store handles inventory as well as sales to the residents, and the wholesaler A handles manufacturing and inventory. The local government

Fig. 3 System Structure of Direct Management and Direct Implementation Method

handles shipping and warehouse inventory, and important tasks such as management over receipts and expenditures and overall distribution management. As shown in Figure 3, the local government is directly involved in manufacturing, wholesale, and retail.

2) Direct management and entrusted implementation

As shown in Figure 4, in direct management and entrusted implementation, the local government handles management of receipts and expenditures including the number of authorized bags and the service fee, and private organizations handle inventory and delivery of the authorized bags. The local government concludes a contract with each company A (wholesale), company B (delivery), and the retail stores, and control all process in the management system, handles information flow and accounting, pays service fees to company B, and entrust the company with bag receiving, inventory, delivery, etc.

The local government handles management of receipts and expenditures as well as overall distribution. Company A handles manufacturing and inventory. Company B handles delivery and warehouse inventory. The retail store handles sales and stocks. Compared to the direct management and direct implementation method, this method is characterized by designation of the delivery company and an entrustment contract is concluded. The local government traces and manage the physical flow from manufacturing company to retail stores, rather than directly handle and deliver the bag to retail stores. The local government focuses on management of bag distribution based on shipping reports and delivery completion reports from company A and B, and entrusts distribution (implementation-related tasks) to the private organizations.

3) Entrusted management and entrusted implementation

As shown in Figure 5, in the entrusted management and entrusted implementation method, the local government entrusts management on receipts and expenditures, including the num-

ber of bags and the service fee, as well as management on inventory and delivery of the authorized bags. The local government concludes contracts with management organization C, company A (wholesale), company B (delivery), and the retail stores, then confirms reports, and do necessary audits for these entrusted entities. According to our survey results, there are many cases in this method where the management organization C and company B (delivery), or company A (wholesale) and company B (delivery) are independent or dependent companies.

Now, we explain daily tasks of the method. A retail store which sells bags to residents put an order to the management organization C. After receiving the order, the management organization C ask company B (delivery company) to deliver the bags. Next, company B delivers the bags to the retail store and receives a receipt. Company B then submits the delivery completion report to the management organization C with according to the receipt. The management organization C sends an invoice to the sales retail store for the bags, and receives the payment. This differs from the other two methods in that there is no direct transaction between the local government and the retail stores for the bags or payment. The management organization C handles all daily tasks instead of the local government.

Next, an example of the flow of bags, payment, and data will be explained. Like the other two methods, shipping instructions are given to the wholesaler A, several times a year. Company A (wholesaler) ships the bags to company B (company of delivery) according to the shipping instructions, and receives a receipt. Company A sends the shipping report to the management organization C, and at the same time, sends an invoice to the local government. The management organization C submits a monthly report and the collected money to the local government. After confirming reports and invoices from company A and the management organization C, the local government pays a management fee to the management organization C, and make payment to the manufacture, delivery, and management of the

Fig. 4 System Structure of Direct Management and Entrusted Implementation Method

bags to company A. Company A make payment to the company B, and the manufacturing costs to the bag manufacturing company. The balance is the handling charge for company A.

Regarding management-related tasks, simple management on receipts and expenditures is a main task of the local government. The management organization C manages overall distribution and payments instead of the local government as seen in the other two methods. Company A handles manufacturing and plant inventory, and company B handles shipping to the retail store and warehouse inventory. The retail store handles sales to residents and inventory at store. A major characteristic of this method is that overall distribution management of receipts and payment are entrusted to an outside organization. The local government focuses on implementation relating to household waste handling and charging, and mainly handles management on receipts and expenditures. Emphasis is placed on supervision and oversight of outside organizations. Recently, more local governments including those have already introduced charging system are considering to implement this method. Figure 6 shows the system structure.

4) Cases of Ideas which show Local Advantage

Figure 7 shows a case categorized as entrusted management and entrusted implementation, where resources of the local community are used. This case is in Tamura City, Fukushima Prefecture, where a progressive approach toward charged household waste management system was taken. Compared to the general entrusted management and implementation

method as shown in Figure 5, a flow of simple tasks with less exchange of bags, payments, and data can be seen.

First, in daily tasks, a retail store purchases bags from the management organization D and sells them to residents.

Next, like other methods which have been already discussed, the local government provides shipping instructions to company A (wholesaler) for the bags. Company A requests bag manufacturing company to manufacture the bags according to these instructions. After manufacturing, the bags are delivered to the management organization D. Company A receive a receipt from the management organization D, and submits an invoice to the local government based on the receipt. The management organization D submits a task completion report and the payment from the retail store for the bags to the local government. The local government confirms the report and invoice submitted by the management organization D and company A, and pays the management organization D a management fee and company A the manufacturing fee.

This case is based on the entrusted management and implementation method shown in Figure 5, where resources in the local community are effectively used. In this case, as shown in Figure 7, company B (delivery company) does not appear as the task usually assigned to the local business association which has a community own logistic service. The local business association has a close relationship with the local retail stores and trusted by local community. This case has advantage with the utilization of the local business association's power. This en-

Fig. 7 System Structure of Cases of Ideas which show Local Advantage

4. Verification of the Information Management System

In this study, a household waste management system was introduced, and we made confirmation if an information management system developed based on the system. The verification case of Tamura City, Fukushima Prefecture, Japan is shown in Figure 7. Tamura city is jointly involved in the household waste management system with neighboring Miharu and Ono towns. Waste is classified in five categories. Ten kinds of authorized waste bags with different size were provided. The information system to support the management system is shown in Figure 8.

The local government, management organization, and manufacturer of the authorized bags are linked to their respective clients via the Internet, and communication is encrypted. Encryption is carried out using currently confirmed technology, a commercially available encryption application or encryption device is not required. Furthermore, each client carries out multiple processing for encryption in real time, and secure communication pathways are possible even for communications on the same LAN.

In Tamura City, the authorized bags for household waste were introduced, which is simple and characterized by utiliza-

tion of the business association as the management organization. Tamura City entrusts sale of the authorized bags to the retail stores in five areas, Funehiki, Ogoe, Miyakoji, Takine, and Tokiwa. The number of retail stores in each locality, as of the end of December, 2011, was 97 in Funehiki, 24 in Ogone, 19 in Miyakoji, 41 in Takine, and 36 in Tokiwa. Retail stores which sell authorized bags in Tamura City are registered (members), and then they can purchase the authorized bags at any one of the local business association.

Each local business association receives purchase orders from retail stores for the authorized bags at the reception desk, and exchanges the authorized bags with money. An acknowledgement of acceptance and payment receipt is issued at this time, and "bag category" and "quantity" are entered into the information system. This system reflects the number of bags transferred to the retail stores in its inventory records after issuing the acknowledgement.

In Tamura City, the number of bags sold by commerce and industry associations to retail stores is calculated as transaction achievement. Data can be outputted in Microsoft Excel format, in consideration of the effective use of the data by data managers at Tamura City.

It should be noted that in this study, an on-site survey was

Fig. 8 System Structure of case study

Fig. 9 Use of registration document which gave bar code

carried out prior to implementing the information management system. In order to simplify paperwork required by the commercial and industry associations and retail stores, an interface using a barcode at the reception desk of the commercial and industry associations was implemented. Retail stores wishing to handle priced authorized bags apply for sales permission, and receive registration certificate as an authorized store. At this time, as shown in Figure 9, a printed barcode is provided and attached to the registration certificate. When purchasing from a commercial and industry association, basic information of the retail store is collected from the barcode and prompt processing is achieved without inputting error. The information management system was thus customized.

At the verification site, a detailed information system was constructed using authorized bags as certification stamps to support a charged household waste disposal and was confirmed. Furthermore, the information system functioned as an integrated management tool for the region, consolidating a wide area of the targeted local communities.

Unfortunately, statistical analysis and results of the system assessment cannot be shown in this paper because of the confidentiality. All the data on the server contains information regarding companies and corporations as well as information re-

garding public funds, such as service fees and certified stamps. Since all this information is bound by confidentiality, analysis and assessment of the data cannot be cited in an open document.

The following quantitative assessments were received from users. Management tasks in public offices are handled by an extremely few number of staff. Confirmation of orders and inventory on the information system is carried out multiple times each day. Through this system, inventory at all local business associations can be confirmed, and surplus of one association can be transhipped to another association, with proper update of inventory data. In this way, we reduced total expenses of the city balancing inventories in different business associations. By introducing the information system into the business associations, original data were transferred between organization therefore reduce duplicated data input, and associated mistakes. Furthermore, compare to collect inventory information individually, the integrated information system can share inventory information between different organization, therefore increased efficiency and reduced bag inventories.

5. Conclusion

In this report, forms and implementation methods of charged household waste disposal were classified based on an on-site survey of the local government, organization and companies. Based on the survey, we constructed a household waste management system and developed an information system to support this management system identifying major flow of tasks and system configuration.

In particular, a survey was conducted in 2009 on a charging system which took advantage of regional resources, and the local merits and ideas were highlighted.

System design and coding was carried out on a charging system using the entrusted management and implementation method. The first management system using the achievements of this study was introduced in Tamura City, Fukushima Prefecture, Japan in February, 2011. In this study, a survey was conducted to confirm effectiveness of the introduced system, from the viewpoint of efficiency of the household waste management system and waste bag inventory reduction. We still working on the extension of the system toward commercializing, and the diffusion of our system to other local government household waste management system could be interesting research topic in the practical viewpoint.

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