Household Recycling in order to Build a Sound Material-cycle Society

-A case study in Minamata City Kumamoto Prefecture Japan-

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Abstract: Waste management as one of the key factors for sustainable development has caught more and more attentions both from governments and researchers all over the world in recent decades. Began with "Basic act on establishing a sound material-cycle society", Japan also released several laws these years to encourage material circulation. After nearly 20 yearly efforts, Japan has achieved a relatively high recycle rate of industrial waste. However, the recycle rate of municipal waste is still around 20%. This research focuses on household garbage, which has around 70% share of whole municipal waste. By encouraging recycling household garbage, the total recycle rate of municipal waste will be improved. Minamata City, the top eco-city of Japan was once suffered from Minamata Disease. To recover from the disease and improve the bad image of the environment, Minamata City has started a series of environmentally friendly activities from 1992. Household recycling is the very beginning one. It has been already done for more than 20 years since Minamata citizens started to separate their garbage into more than 20 categories in households. The purposes of this research are to examine the effectiveness of household recycling on reducing the waste amount and increasing recycle rate and to investigate the feasibility of household recycling. By quantitative study using the data of daily per capita garbage and recycle rate for 2 decades, and qualitative survey targeting on 90% of all citizens in Minamata City of satisfaction on household recycling system, the results show a significant effectiveness of household recycling in Minamata City. The participation and satisfaction rate of citizens are also surprisingly high. The Minamata's case shows a high feasibility of household recycling.

Keywords: Household recycling, Reduce waste generation, Recycle rate, Qualitative survey, Minamata City

1. Research Background

1.1 Social Background

1.1.1 International Background

Sustainable development is the concept indicated firstly in 1987 by United Nations World Commission on Environment and Development in its report "Our common future". In 1992, United Nations Conference on Environment and Development adopted "Agenda 21" and the concept of sustainable production and consumption catches a lot of attentions from all over the world. Recently in 2015, "Transforming our world: the 2030 agenda for sustainable development" which was adopted by United Nations general assembly, proposed 17 sustainable development goals in which

the 12th goal is "Ensure sustainable consumption and production patterns". Also, in the same year in 2015, European commission released "Circular economy package" and showed an idea of shifting to circular economy from traditional linear economy. All of these movements show that material circulation and waste management have been more and more important for sustainable development.

1.1.2 Domestic Background

Japan also follows this trend and has started working on material circulation and waste management from 2000 by publishing "Basic act on establishing a sound material-cycle society"[1]. Based on this act, the Japanese government has released "Containers and packaging recycling law", "Home appliances recycling law", "Food recycling law", "Construction material recycling law", "End-of-life vehicles recycling law" and "Small home appliances recycling law" to encourage material circulation. Nearly 2 decades passed since these recycling laws have been released, the results of recycling resources and reducing the waste amount are significant (Figure 1).

The total garbage generation amount decreases around 10 million tons compared to the peak year. It was around 55 million tons in 2000, however, the current amount is only 44 million tons per year. The recycle rate also changes a lot. It was only around 12% in 1998, and surprisingly it has been almost doubled within 20 years. The latest data shows the recycle rate in 2015 was over 20%. Compare to only depended on incineration and landfill decades ago, Japan is shifting

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[1] In "Basic act on establishing a sound material-cycle society", it defines
1. "Sound Material-Cycle Society" is a society in which the consumption of natural resources will be conserved and the environmental load will be reduced to the greatest extent possible,
2. "Circulative Resources" are useful things among wastes,
3. "Cyclical Use" is reuse, recycling, and heat recovery,
4. "Recycling" is the use of circulative resources in their entirety or in part as raw materials.

to a sound material-circulation country by applying reduction, recycling and reusing.
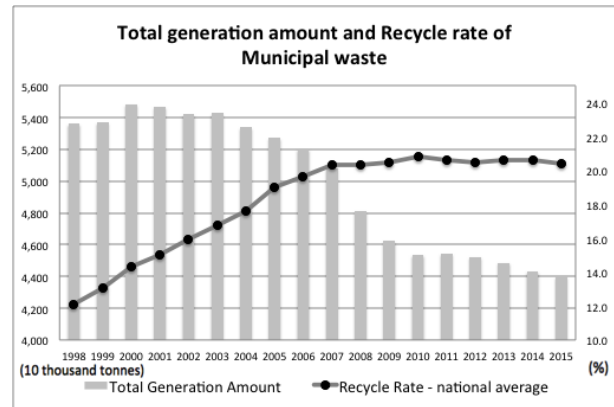

Figure 1. The waste generation amount and recycle rate

Even though the recycle rate of municipal waste has been increased a lot, there still is a big gap between industrial waste and municipal waste (Figure 2). Compare to the high recycle rate around 50% of industrial waste, municipal waste has only around 20% of recycling rate. Thus, working on municipal waste recycling is highly demanded in the current situation and will definitely contribute to build a sound material-cycle society.
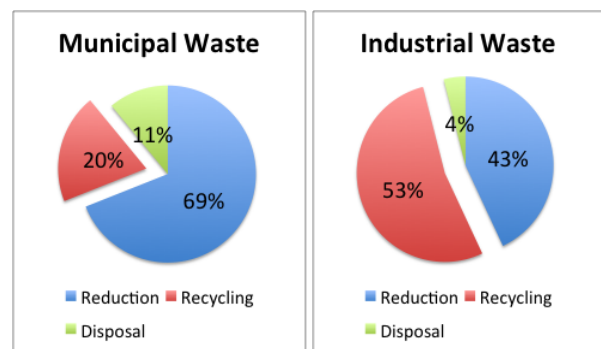

Figure 2. Treatments of municipal waste and industrial waste

1.2. Academic Background

The recycling of household garbage can be divided into two kinds. One is by third parties, another one is within households. The studies about recycling by third parties such as recycling facilities mainly focus on technology aspect. On the other hand, the researches about recycling within households by citizens mainly

attempt to examine its effectiveness and to assess variable factors affecting on the participation such as Azilah M. Akil (2015), Christina Knussen (2004), Francis C. Bergeron (2016).

In S. Miafodzyeva (2013), Sviatlana Miafodzyeva classified variables affecting the recycling behavior of householders into four theoretical groups: socio-psychological, technical-organizational, individual socio-demographic and study-specific.

Many research belong to technical-organizational group are related to cost such as Berglund, Ch. (2006), there are some about the collection schemes such as Domina, T (2002). Those researches indicate the close correlation between technical-organizational variables and household recycling.

The studies on socio-demographic variables are also popular. Many researchers agree with that gender, age, living style, incomes, and education level influence on household recycling. However, Anni Huhtala states, "Preferences play an important role in, and may outweigh the impact of income on, willingness to contribute to a public good. (…) Even though a high level of education and positive attitudes towards the environment are often correlated with high income, it does not mean that high socio-economic status translates into positive environmental actions and that low-income people display less interest and effort when it comes to environmental concerns (Anni, 2010).

Most researches infer socio-psychological variables. As Jurate Miliute-Plepiene and Mikolaj Czajkowski mentioned, attitudes to environment and recycling are very important and will affect on household recycling directly (Jurate Miliute-Plepiene, 2016, Mikolaj Czajkowski, 2014).

In Japan, the research related to household recycling is also popular. Some researchers think household recycling is difficult according to the negative attitudes to do the separation even though people knows the importance of recycling (Shinoki, 2011, Sugiura, 1999). On the other hand, other researchers hold rather positive opinions. "Mottainai" as one of the most famous Japanese concepts means "What a waste".

Based on the Mottainai emotions, Japanese people are relatively cooperative to household recycling (Kurokawa, 2012).

2. Research Objectives

The objectives of this research are 1) to examine the effectiveness of household recycling on reducing the waste amount and increasing recycle rate, 2) to investigate the feasibility of household recycling.

3. Research Area
3.1 Introduction of the area

This research took Minamata City as the research area. It is located in the south part of Kumamoto Prefecture Kyushu next to Kagoshima Prefecture (Figure 3). The area of Minamata City is $163.29m^2$ populated with 25,276 people (May 2017). The west side of the city is Yachiyo Sea and the east side is mountains.

Figure 3. The location of Minamata City in Japan

Although the industry grew rapidly since Chisso Corporation entered to Minamata City in the beginning of 20th century, one of the most serious environmental problems, the Minamata Disease occurred. It had stopped the economic development and also deprived many lives. The maximum population of Minamata City was over 50,000 people at that time, however, after the Minamata Disease, the population has been decreased and nowadays only around half of the

population remains there.

To recover from the Minamata Disease, the Minamata City government published "Declaration on environment and development" in 1992 to show their decision to revitalize the town by doing eco-friendly activities. There were series of activities

spent high cost. As the results, Minamata City took ISO14001 in 1999, has been elected as one of the 26 Environmental model cities in Japan in 2008, and in 2011, Minamata City obtained the title of "Japan's top eco-city" (Figure 4).
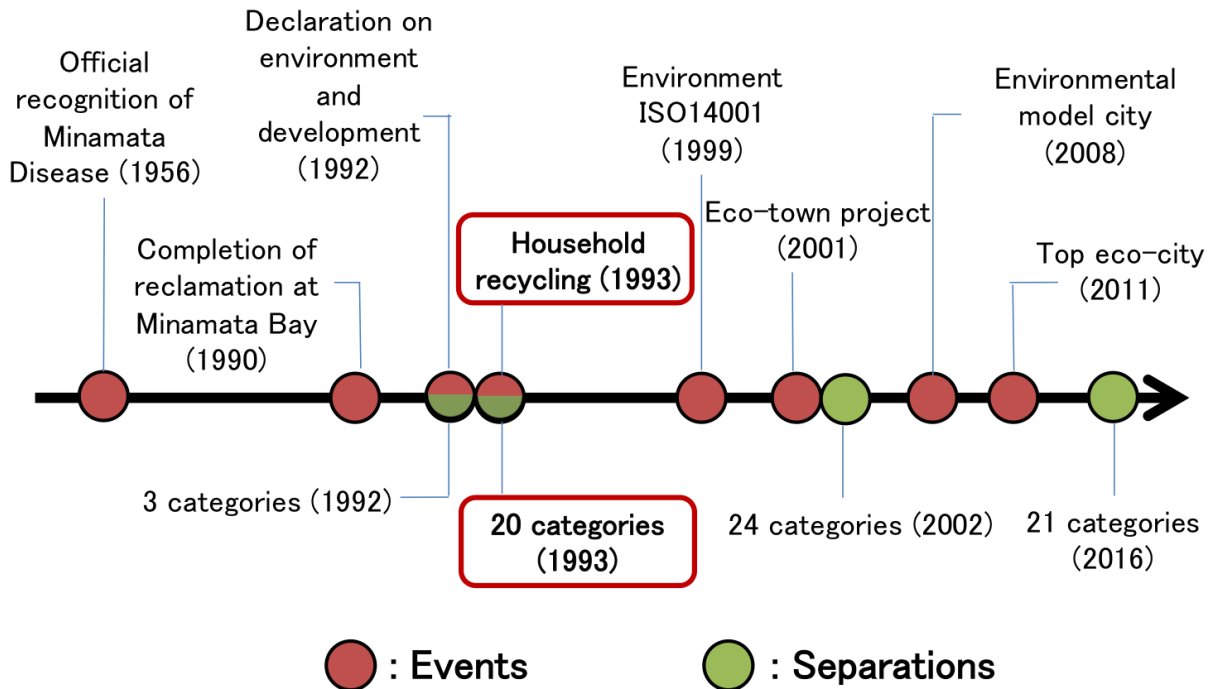
Figure 4. Several major events and number of garbage separations in Minamata City

3.2 The system of household recycling

After "Declaration on environment and development" in 1992, Minamata City started to apply household recycling in 1993. Citizens were asked to separate household garbage into 20 categories from 1993 while it was only 2 categories until 1992 (Figure 4).

Household recycling in Minamata City is a set of activities that start from doing separation in households and then bring the specific categories of garbage on a specific day to specific garbage stations. The date and the place to throw garbage have been decided by communities.

There are around 300 garbage stations for burnable and organic garbage and around 300 garbage stations for recyclable garbage in the city. Around 50 to 100 households share one garbage station. Kitchen garbage and burnable garbage are collected twice a week, plastic package is once a week, bottle and paper are twice a month and other recyclable garbage is once a month. In total, there are 6 garbage trucks collect all garbage from around 700 garbage stations in the city from Monday to Friday. Citizens can also bring their garbage to Minamata Environment Clean Center by themselves on weekends if the date to throw garbage is inconvenient for them.

4. Research Methodology

This research consists of 2 steps. Firstly, to examine the effectiveness of household recycling on

reducing the waste amount and increasing recycle rate, quantitative data from 1991 to 2015 published by the Ministry of Environment Japan and the Minamata City government has been used. According to waste treatment flow (Figure 5) and

Ministry of Environment Japan, the indicators of daily per capita garbage (DCG) and recycle rate (RR), which directly show the effectiveness of household recycling in Minamata City can be calculated as below (Figure 6).
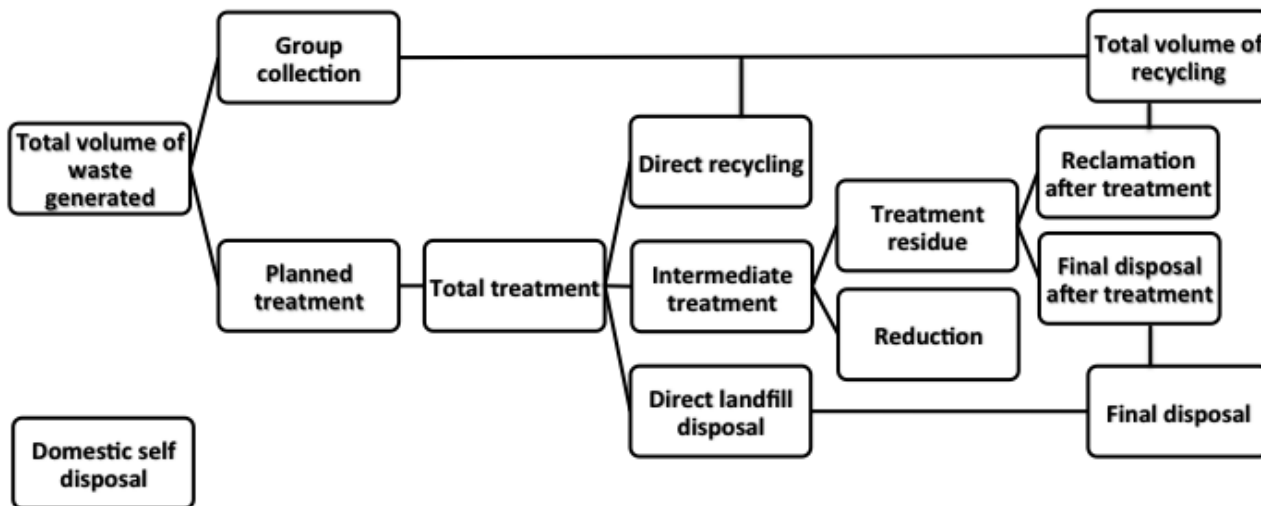

Figure 5. Waste treatment flow

$$DCG(g) = \frac{\{\sum(P + G)\} \times 10^6}{Population \times Days}$$

where, DCG: Daily per capita garbage (gram)

    P: Planned treatment (ton)

    G: Group Collection (ton)

$$RR(\%) = \frac{\sum(D + R + G)}{\sum(T + G)} \times 100$$

where, RR: Recycle rate (%)

    D: Direct recycling (ton)

    R: Reclamation after treatment (ton)

    G: Group collection (ton)

    T: Total treatment (ton)

Figure 6. Calculation of DCG and RR

Secondly, to investigate the feasibility of household recycling, a qualitative survey has been used. The questionnaire consists of 8 categories of questions, which are "Daily life", "Health and welfare", "Education and culture", "Industry", "Disaster and crime prevention", "Environment",

"Community", and "Basic information". It has been distributed to all households join to the local communities in 2016, which covered around 90% of all households in Minamata City. The ratio of the valid answer of this survey is around 40% (Figure 7).
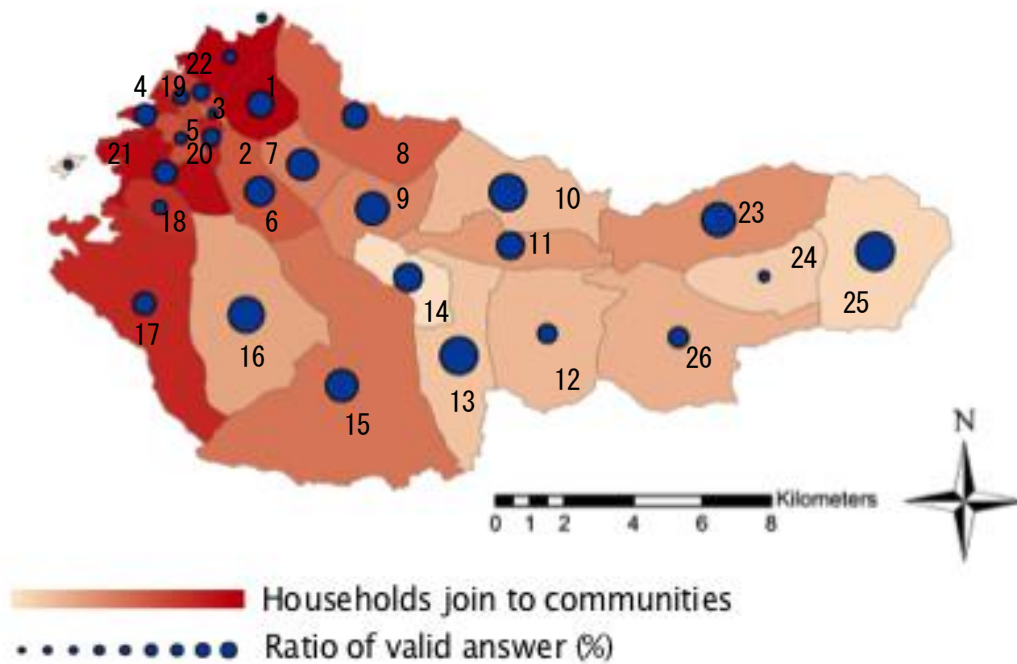
Figure 7. Qualitative survey collection result

5.   Results and Discussions

5.1 The Effectiveness of Households Recycling

Nearly 24 years passed since the Minamata City has started household recycling. The result of reducing the waste amount and increasing recycling rate is significant. The daily per capita garbage in Minamata City is around 800 grams. This is very low compared to the national average which is around 1000 grams (Figure 8).

On the other hand, the recycling rate in Minamata City rocketed twice and it now maintains almost as double as the national average for many years though there are some slight changes (Figure 9). The first drastically increasing was in 1993, the year that Minamata City started to apply household recycling. Another marked changes of recycle rate was from 2002 probably because Minamata City started kitchen garbage separation in that year.
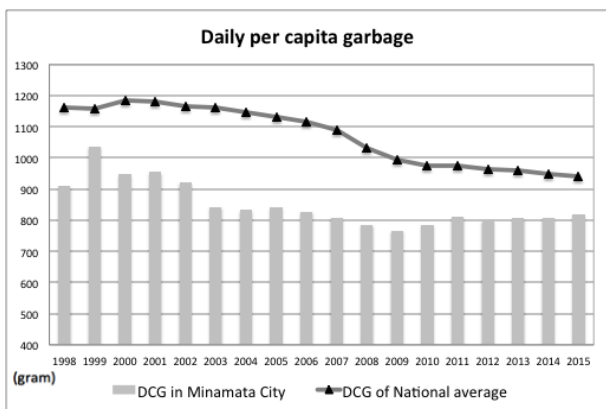

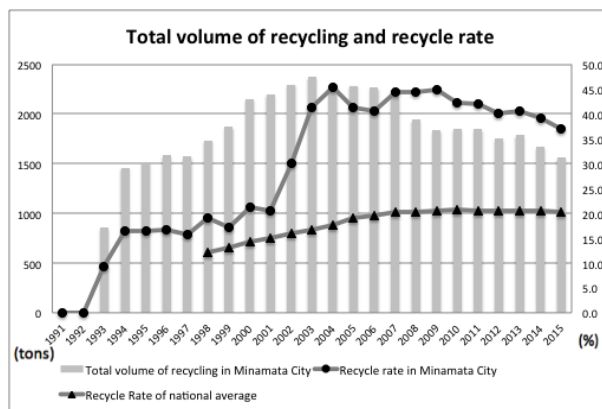**Figure 8. Daily per capita garbage**

Figure 9. Total volume of recycling and recycle rate

5.2 The Feasibility of Household Recycling

One of the questions in the questionnaire was about the satisfaction of households recycling. The level of satisfaction included 5 aspects, "the number of separation category", "the distance from home to garbage station", "the rotation recycling promotion system", "the total labor of throwing garbage" and "the cost of throwing garbage", were examined with this question. The results are surprisingly great (Figure 10).
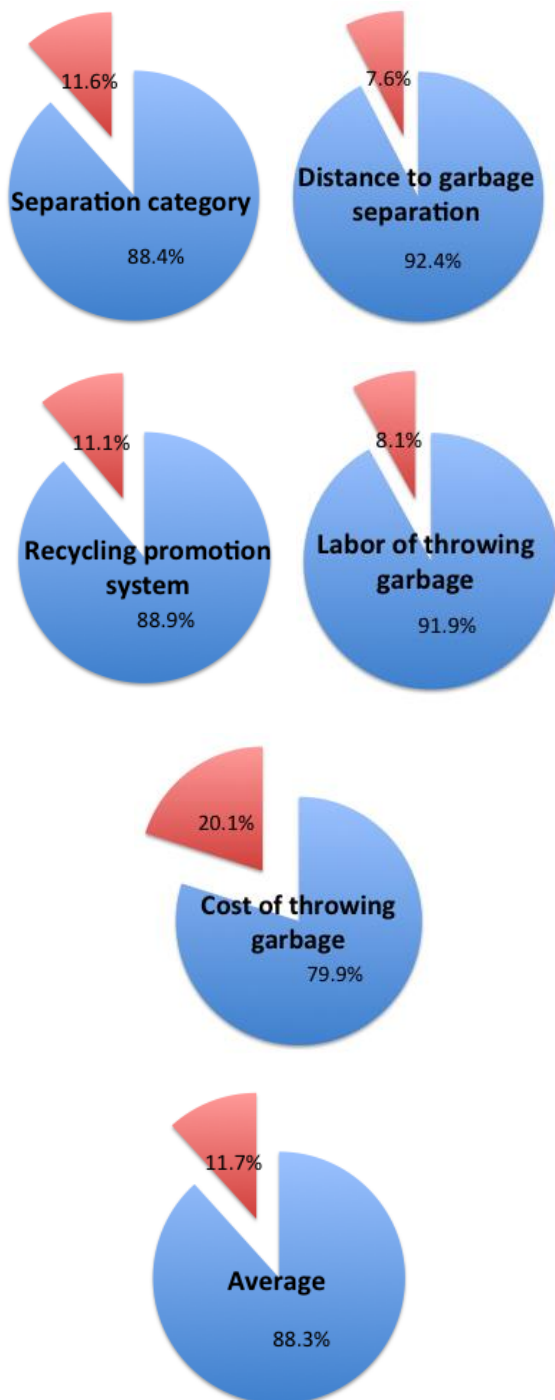
■ Satisfied   ■ Unsatisfied

Figure 10. Satisfaction of household recycling

Averagely only 11.7% of all responders presented unsatisfied attitude to household recycling according to this questionnaire. The one with highest unsatisfied rate is the cost of throwing garbage. At about 20.1% people showed a negative attitude when it comes to the cost of throwing garbage. The unsatisfied rates of the other 4 aspects are around 10%. A high acceptance of household recycling in Minamata City can be seen from this qualitative survey.

5.3 Considerable reasons of high recycle rate

The Minamata City government has organized more than 300 orientation meetings for calling participation of households recycling since 1993. After gained the comprehension from citizens, it released a lot of policies to be followed-up and to encourage households recycling.

The most powerful policy in increasing recycle rate was the recycling of kitchen garbage started in 2002. The Minamata City government introduced a biodegradable bag for kitchen garbage so that kitchen garbage can be recycled as fertilizer. The amount of kitchen garbage that is recycled every year is around 1,000 tons. During 1993 to 2001, it can be seen as the first stage of household recycling in Minamata. In this stage, it was the recyclable garbage such as bottles, papers, and cans are recycled. The recycling rate was around 20%. Kitchen garbage recycling started in 2002 boosted Minamata City into the second stage. In this stage, the recycle rate is around 40%. Furthermore, by recycling kitchen garbage, the volume of burnable garbage has been decreased and it becomes drier.

Another policy that effectively maintains Minamata's recycling rate at a high level is the rotation recycling promotion system. Several recycling promotion members help to prepare and tidying up garbage containers and to separate garbage when others bring to garbage station. The

recycling promotion members are decided at the beginning of every year as a rotation. Everyone whomever youth or adult, elderly, is asking for participation. Besides to recycling in the household, a double check by recycling promotion members is the key point of precise recycling in Minamata City. It is a place for citizens to confirm their separation and to recognize the importance of recycling.

5.4 Some follow-up to household recycling

There are also many policies that are not directly related to household recycling but contribute to enhance the awareness of reducing garbage and doing recycling. These policies can be considered as a good follow-up of household recycling.

One unique policy calls "*Gommunication*". It made from "*Gomi* (garbage in Japanese)" and "communication". On specific days of throwing garbage, junior high school students go to elderly people's place to help them do separation and to carry the garbage to the garbage station. During the separation, young people can have an opportunity to talk with elderly people.

The "My-my" movement is a campaign to encourage people carrying "my chopsticks", "my bottle", and "my bag" so that the needs of disposable products are diminished and the amount of garbage generation can be maintained at a low level. The participants of this campaign are not only Minamata citizens but also visitors such as students or travelers. The targets are chopsticks, water bottle, bags, toothbrush and lunch boxes which are mainly related to lunch.

The Minamata City women's liaison conference on waste reduction has been established from 1997 to achieve a better result of reducing garbage. The main purpose of these 16 female members is to propose the implementations of avoiding wasteful things brought into the house. They have been successfully reduced disposable food trays and containers in retail shops and supermarkets and also calling for carrying own reusable shopping bag in order to reduce the use of plastic bags.

Furthermore, there is a service called "Tea stand", people can refill their bottle and do not need to buy beverages from vending machines. The "Minamata City rare metals recycling study group" set several collection boxes to collect used small household appliances. "*Mottainai* box (reuse corner)" is a dashboard for citizens to exchange the information of various goods they do not need or they want.

These policies are very helpful on spreading household recycling to the whole city. With these policies, household recycling becomes easier. The policies also contribute to deepening the connection within the community so that household recycling becomes something with a lot of fun.

6. Conclusions

Household recycling can seem as a successful attempt in Minamata City. The effectiveness of household recycling on reducing the waste amount and increasing recycle rate was gradual and stable. Minamata City local government was steady from the beginning and shows a cooperative attitude to citizen groups on waste management. All the policies taken in Minamata City related to waste management are very close to daily life and relatively easy to be achieved. The environmental education in Minamata City might be another key factor of successful household recycling.

Minamata City shows a successful example of household recycling. Both local government and citizens are benefit from household recycling. Though it takes time and needs tons of efforts, according to Minamata's case, the feasibility of household recycling is undeniable.

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