

2-8 Partnership Project of Solid Waste Management in Palau

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Abstract

Republic of Palau, a pacific island country, is famous as beautiful coral reef island and nice diving spot in the world. Tourists which number is over four times of the population visit the country and stay for leisure every year. Since the waste generated by not only citizens but also tourists have been piled on the landfill for a long time. Although the biggest national landfill site, M-Dock, once had a serious problem such as bank collapse, leachate water, and bad landscape, it was rehabilitated by JICA. Taking this opportunity, 3R have been promoted by government of Palau recently in order to reduce the amount of waste generation. The largest state in Palau, Koror, constructed and started to operate a recycling facility for bailing of plastic bottles, shredding cardboard and glass, and composting food waste. Preparation of waste separate collection for recycling is now going on. In the second largest state, Ailai, citizens bring their waste to a landfill site at the center of residential area because they do not have waste collection service by state authority. To promote waste reduction, reuse, and recycling, it is important to estimate the quantity of waste by waste stream.

In this project a questionnaire survey on household waste in Airai State was conducted. By analyzing the data from the questionnaire and interview survey, the characteristics in waste discharge were figured out and the strategy of waste collection by state authority was discussed.

Keywords Republic of Palau, Household waste, Questionnaire survey, Waste collection by state authority

INTRODUCTION

Location of Republic of Palau

The location of Republic of Palau is shown in Fig.1. The longitude E134 31" is almost the same of Japanese meridian E135 and the latitude N7 21" is in tropical zone. (Fig.1) Population of Palau is about 20,397 in 488 square km of 16 states. The first and second populated states are Koror and Ailai, where 70% and 13% of population live, respectively. Almost business and commercial sectors are centered in Koror state. The main industry in this country is tourism, where the tourists in number of 4 times of population visit Palau every year. Many commodities of accommodation, leisure, souvenir for tourists are imported from foreign

countries, and they turn to landfilled waste. Due to issues of unsafety and ill-landscape of landfill site, JICA had rehabilitated M-Dock, a national landfill in Koror to build Fukuoka-style sanitary landfill. Going with the rehabilitation, 3R program was launched to reduce the landfilled waste to prolong the life of landfill. Palauan central government collected ideas of 3R campaign mascot from citizens and selected the best one. The mascot „3R heroes“ in Fig. 2 enters the stage of several 3R campaigns in Palau. Fig. 3 shows a typical waste collection station equipped with some metal drums to store recyclable waste separately. Koror state constructed a waste recycling center that is equipped with glass clasher machine, baling machine for plastic bottles, paper shredder machine in main building and composting facility in other building.



Fig.1 Location of Republic of Palau

Landfill in the center of residential area

Landfill in the second largest state Ailai is located at the center of residential area. As shown in Fig. 4, the surface is covered by waste bags, cardboards, papers, plastic bottles, some garden waste, etc. A small incinerator in Fig. 5 had been donated by Japan but the operation has already been terminated afterword, it is left for a long time because the incineration capacity is quite less than the amount of discarded waste. It is worried whether leachate water from landfill is released to a small



Fig.2 Mascot of 3R



Fig.3 Collection station



Fig.4 Landfill in the residential area



Fig.5 Small incinerator paused

stream.

As comparing with Koror state, Airai state does not have waste collection service at present, and a guardian is not always in the landfill site. Ailai citizen can bring household waste to dispose at the landfill any time. In order to reduce the landfilled waste, waste collection by the municipality is under consideration. Segregated collection by waste stream of waste should be introduced. In order to make a strategy of waste collection, a survey of current waste discharge by household and a consciousness on waste collection was conducted through questionnaire.

METHODS

To estimate the amount of waste discharge by household in Aisai state, questionnaire survey was conducted in August, 2010. In the questionnaire, beginning with questions for personal attributes of the head of household, household's characteristic, awareness of waste collection, experience of participation to 3R activity or environmental protection campaign, and willingness to sort the waste in household were queried. Apart from these qualitative questions, we inquired the quantitative information of discharged waste, category by category; for example the weight of food waste per day/week, the number of waste glass bottles and cans per day/week, the weight of discarded plastic bottles, containers, and bags per day/week, and the weight of discarded paper and cardboard per day/week. Moreover, the number of discarded furnishings, appliances, and durable household waste per month/year were queried.

187 sample households were selected at random and questionnaires were handed, household by household. In some houses, we interviewed on the self-recycling or self-treatment of household waste. One week later, the questionnaires were collected by the investigator. (Fig.6)

In the analysis stage, the statistical result of each question was figured out and a structured model of current behavior on waste discharge was developed. In the final stage, the strategy for waste collection by state government was discussed.



Fig.6 Distribution of questionnaire

RESULT AND DISCUSSION

Result of questionnaire survey of household waste

The result of analysis of responder's attribute is shown in Fig.7 and 8. 101 responses, that occupy 54% of the number of distributions, were collected. As might be expected, 43% of the head of the household is 40-50 years old Palauan. Regarding sex of the head, percentage of female is higher than that of male. Since Palauan family is traditionally succeeded into the female line, the female head seems to be usual. The major occupations are professional, service, and administration. Because Palauan government is financially supported by USA, many labors work for central and state government or government-related enterprises. Also many labors provide a variety of service in sightseeing industry. The variety of the number of household members means family has many children or relative families, brothers and/or generations, live in a group. Two labors in a household are popular.

Fig.9 shows the result of physical composition (weight%) of recyclable waste to be discharged. The numbers of glass bottles, cans, and plastic bottles & others were obtained through the questionnaire survey, and afterward they were transformed to weight-basis value. The biodegradable waste, consisting of kitchen waste (21%) and yard waste (35%), occupies a high percentage (total 56%). Comparing to yard waste of Koror state, the percentage of yard waste is pretty high. Some households in two villages, Ngerusar and Ngetkib discarded much yard waste and other village does not so much. Regarding food waste, 13 households of 18 in

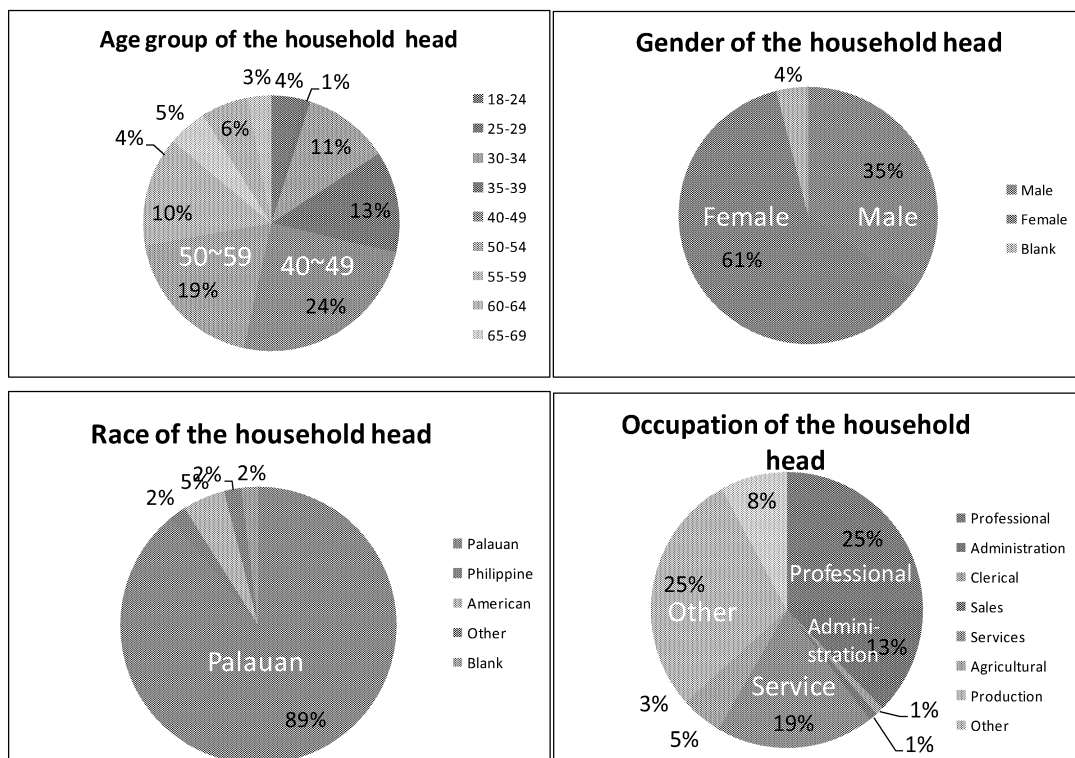


Fig.7 Profile of respondents

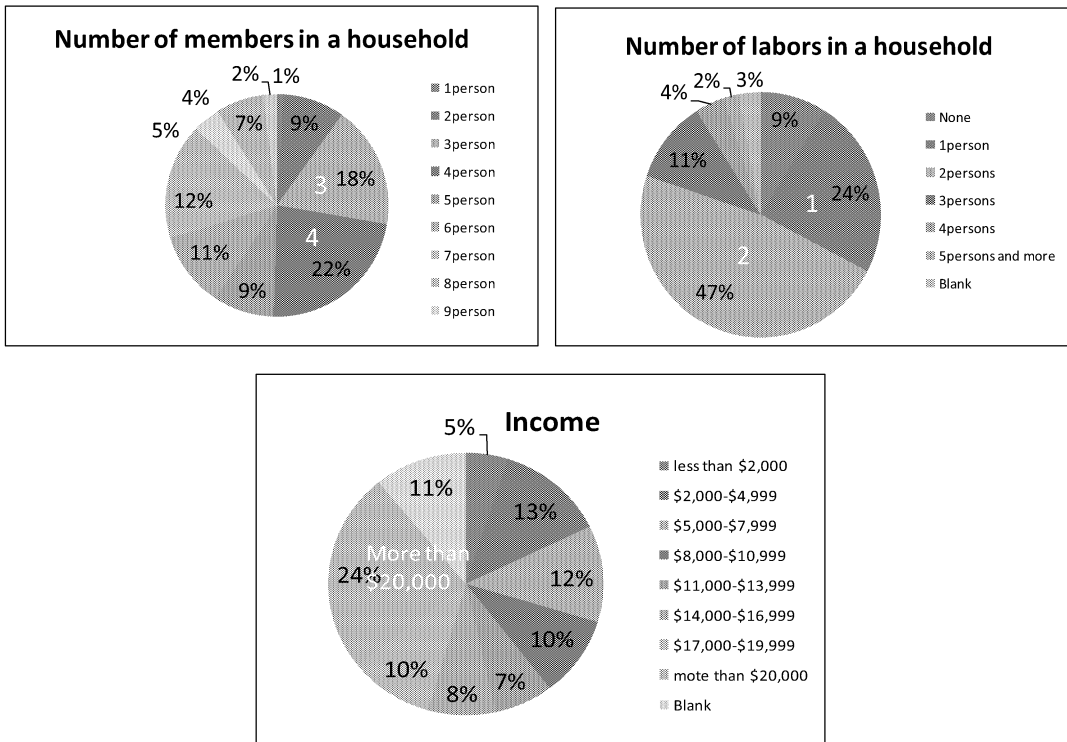


Fig. 8 Characteristics of household

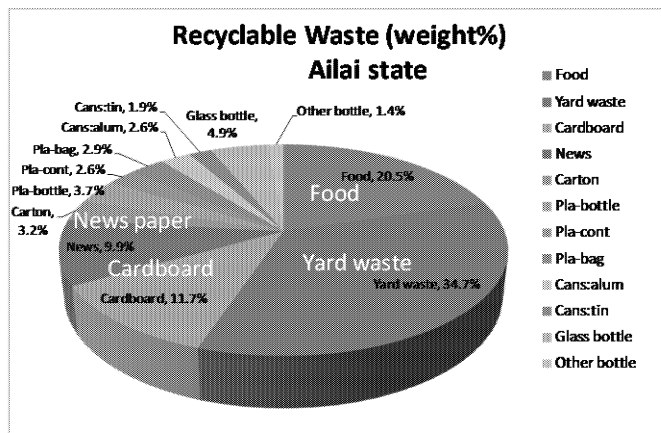


Fig. 9 Recyclable waste of Ailai state by questionnaire survey (2010)

Kesbelau answered zero discharge of food waste. Even if a small number of respondents might skip the question of the food waste, many households reduce food waste by self treatment. In interview to households, it was heard that biodegradable food waste becomes feed stuff for pets in the house or for chickens in the kitchen farm near the resident, otherwise material for composting. Actually a chicken farm truck comes to the residential area to collect food waste.

Paper waste, consisting of cardboard (12%) and news paper and magazines (10%), is the second largest. Container waste, such as glass bottle (5%) cans and tins (4.5%), plastics (9.2%), carton (3.2%), only occupies a small portion. Especially since glass bottle and cans of

beverage are collected in the recycling center and then the deposited money is refunded, every household stock the containers and recycle them.

Comparison between our survey and other waste component survey which was conducted in Koror state by state government in 2040 is shown in Table 1. Since our survey aims to investigate the quantity of recycled waste, the targets are different. The remarkable property of the waste component in Koror state is that plastic waste is greater than other waste components. The waste discharge rate of Koror state is 243 g/capita/day; on the other hand, the rate of Ailai state is 327 g/capita/day. However the total amount of Ailai's except for a large yard waste discard decreases to 243 g/capita/day, that is similar to Koror waste data.

Table.1 Comparison of discarded waste by category

	Household waste Koror(g/ cap/ day)	Recyclable waste Ailai(g/ cap/ day)
Kitchen	63.3	67.0
Yard	4.9	113.7
Paper	36.5	80.9
Textstle	4.9	-
Plastic	82.8	30.3
Leather/Rubber	2.4	-
Metals	24.3	19.5
Glass/Ceramic	9.7	16.0
Miscellaneous	17.0	-

Result of querying consciousness of waste collection

As for awareness of 3R, the experience of hearing and understanding of “3Rs” was inquired in the survey. As a result, 77% of respondents had knowledge on 3R due to several governmental campaigns of 3R. As for participation, experiences to take part in any campaign related to waste management or environmental protection and to sell or take the garbage to the recycling centre was inquired, consequently 46% of respondents had experiences of such environmental activities. Moreover experiences to minimize waste generation and to use second-hand items were inquired. As a result, 80% of respondents had consciousness of waste reduction. Finally, some questions queried the respondents about their attitudes for the willingness to separate waste in household, keeping waste in the house until collection time, and the obedience to the collection rule. Then it was found more than 90% respondents are willing to separate waste before discharging it.

Strategy of waste collection by state authority

Remarkable properties of household recyclable waste in Ailai state are summarized as follows: 1) the discharge of yard waste is high but depends on the villages. To reduce landfilled waste, such large amount of yard waste should be treated by the household themselves, 2) the discharge of household waste is similar to that in Koror state, but it is owing to waste reduction by self-treatment in some households. It seems that the convenience to discard food waste makes landfilled waste increase if the state authority starts waste collection service. 3) Due to

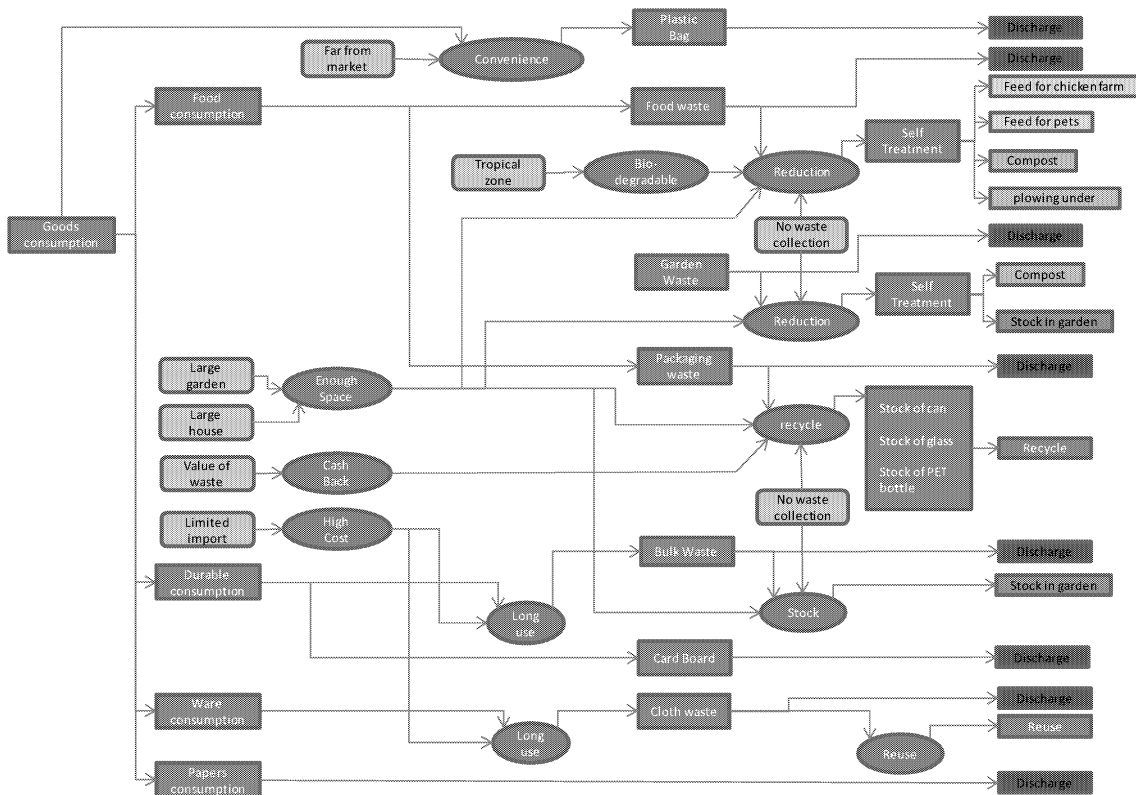


Fig. 10 Structured model of citizen's behaviors on goods consumption, waste discharge and self treatment with related consciousness (Ailai state)

the refund system for deposition of beverage bottles, self collection and transportation of glass bin, cans, and PET bottle is well going on. 4) The amount of paper waste, consisting of cardboard, newspaper, magazine, and packaging, is large. 5) We can see many plastics in the landfill in Fig.4. Plastic bag still wraps waste without being tone, resulting in slowing the biodegradation speed of the waste.

Considering these properties, a structured model of waste discharge and self-treatment is developed. This figure (Fig.10) attempts to show the motivation driving 3R actions. It is significant to predict any changes in household's consciousness and affected actions when waste collection service is introduced. In the future study, we would try to further evaluate the influence and sensitivity of 3R policy on citizen's action by using the structured model.

In the final phase of this study, a strategic waste collection policy is considered. Points of waste management policy are followings: (Fig.11)

- 1) Yard waste should be reduced by self-treatment.
- 2) Self-treatment of food waste at households should be encouraged.
- 3) Based on the refund system cans, glass, PET bottle will be collected and transported by household. However, it is needed to put a collection bin in a residence area to collect the

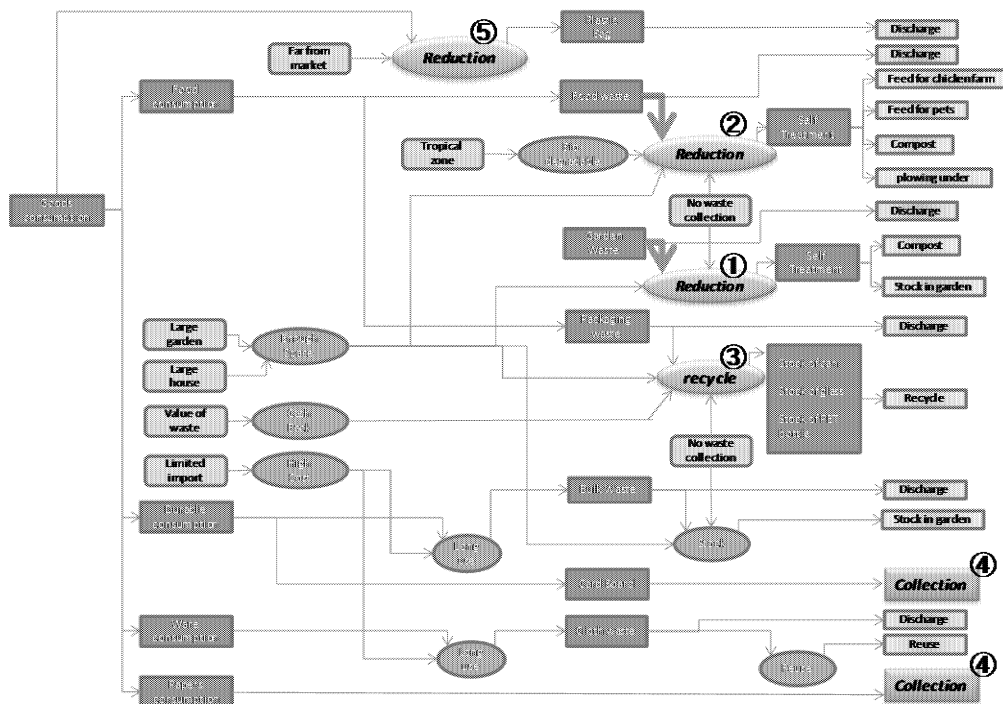


Fig.11 Waste collection policy

bottles from the household who do not want the refund.

- 4) Only paper should be collected and recycled by state authority
- 5) Distribution of plastic bags at shops should be restrained. For example, “my bag” campaign might be effective in plastic waste reduction.

CONCLUSION

Questionnaire surveys for household were carried out in Airai state, Republic of Palau. The household’s waste discharge action and consciousness were analyzed, and the quantity of household waste by waste stream was figured out. The structured model was illustrated to explain the citizen’s behaviors. Finally, the waste collection strategy was discussed and proposed. Approaches to plan concrete waste collection will be studied in future.

ACKNOWLEDGEMENT

This research was supported by the research project “Practical Research and Education of Solid Waste Management Based on the Partnerships among Universities and Governments in Asia and Pacific Countries” of Okayama University, permitted under FY2010 budget requirement to Japan Ministry of Education, Culture, Sports, Science and Technology.