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ANALYZING THE WILLINGNESS TO WORK AND WILLINGNESS TO PAY FOR RWH IN JAPAN

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ABSTRACT

In recent years, rainwater harvesting (RWH) was defined as an approach contributing to rainwater control and global environment in Japan, and promotion policy of citizens participation were enacted in 2014. Meanwhile, willingness to pay (WTP) was used on some studies to estimate citizens' willingness of RWH. However, it is necessary to elucidate the willingness to work (WTW) because people who prefer to participate in social contribution activities by work is increasing. Also, the participation depends on citizens' lifestyle such as age and occupation. Therefore, this study sought to examine the hypothesis that people's WTW and WTP for RWH are varying depend on their lifestyles and clarify the state of people's interest in RWH. We conducted an internet survey in August 2017(=1,794) at Japan. The survey questions addressed three areas: (1) respondents' lifestyles, (2) experience of RWH, (3) recognition of RWH activities, and (4) participation willingness in RWH including WTW and WTP. As the results, people's participation willingness is based on lifestyle, and only 10% of respondents have RWH experience. Moreover, people's recognition of RWH activities were limited to storing and using rainwater. But the citizens who have time to participate in social contribution activities, showed more interest in activities that need for time or labor. Thus, there is room to promote people to participate in those needs more time and labor to maintain RWH activities, such as planting trees and making rain gardens.

Keywords: *RWH, citizen participation, willingness to work (WTW), willingness to pay (WTP), Japan*

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INTRODUCTION

Rainwater harvesting (RWH) has a long history, with different countries and regions developing various methods for conserving and supplying water (Julius et al., 2013). In particular, RWH for agricultural production (Kumar et al., 2011), drinking (Domenech & Sauri 2011), and other purposes in countries and regions that receive little rainfall is a means of obtaining water that is important for maintaining production and life. As the climate has changed in recent years, RWH has received attention as a means of controlling runoff during periods of heavy rain (Berndtsson 2010; Feitosa & Wilkinson 2016), reducing the health impact of weather (Boelee et al., 2013), and other benefits. In Indonesia, urbanization has led to many problems, including groundwater mining, water quality deterioration, land subsidence, and increased risk of flooding (Dirks et al., 1988). Thus, it is hoped that RWH can help solve these problems (Abidin et al., 2015) and be a means of securing water after disasters (Sudiajeng et al., 2017). Further, with proper instruction, RWH is simple to manage and maintain, and could help both reduce the cost of supplying water and improve water quality (Song et al., 2009). Thus, educating the public about the harvesting of rainwater is essential.

Social background of Rainwater Harvesting in Japan

In Japan, rainwater has been used as water for daily life in areas such as isolated islands (Murakawa et al., 1986) and communities living in mountain foot areas (Naito 1950). Nevertheless, RWH is a new term defined as an approach contributing to rainwater control and global environment by the Architecture Institute of Japan in 2011 (AIJ 2011). And the RWH public participation promoting systems have been created. For example, some local municipalities offer subsidies for rainwater storage and infiltration tanks (MLIT 2015), and the Association for Rainwater Storage and Infiltration Technology (ARSIT 2016) and other groups facilitate the installation of rainwater storage tanks in single-family homes and promote the diffusion of related technology. In recent years, the heat-island phenomenon, intensifying urban flood damage, abnormal weather such as cold snaps, and water shortages due to earthquakes have increased the risk of disaster. As a means of reducing these disaster risks, efforts have accelerated to create laws governing RWH and promote citizen participation.

The Basic Water Cycle Act (MLIT 2014) and the Law on the Promotion of Rainwater Usage (MLIT 2015) were enacted in 2014. In the same year, the policy publicity office of the Cabinet Secretariat conducted a survey on household water use, which found that about 90% of respondents had an active interest in

using rainwater (Policy Publicity Office of the Cabinet Secretariat 2014). Compared to the previous survey, more respondents expressed interest in installing rainwater storage and infiltration tanks, even if state or municipal subsidies are not available. These results suggest that people are willing to cooperate with RWH activities and that future efforts to promote citizen participation in RWH could be effective. Thus, RWH in Japan has not only involved systems created by the national government to promote citizen participation, but also the formation of awareness of RWH among the public.

Research background of Rainwater Harvesting in Japan

Past research into RWH in Japan can be organized into two categories: (1) research on the effectiveness of using rainwater for disaster prevention and mitigation on building sites (Yamashita et al., 2016; Watanabe et al., 2013; Kawasaki, 2011) and lighten the environmental burden of these sites (Sakai 2012), and (2) research on residents' and households' willingness to install rainwater storage tanks. For instance, Ozaki et al. (2012) shown that residents gave high evaluation to installing rainwater storage tanks, and expressed their willingness to use stored water and participate in simple maintenance and management tasks. Alternatively, willingness to pay (WTP) is a contingent valuation method to estimate people's participation awareness which Asakura et al. (2014) used to investigate people's participation awareness of installing rainwater storage tanks, and inferred that residents who understand disaster risks and the effectiveness of RWH have a strong willingness to install such tanks. In evaluating public awareness of participating in RWH, these studies stopped at the level of assessing "the presence or absence of a willingness to participate in RWH" and "the amount people are willing to pay for RWH equipment." Moreover, when assessing citizen participation in volunteer activities related to environmental protection not limited to RWH, the mean willingness to work (WTW) value was more stable than that of willingness to pay (WTP), suggesting that this is an assessment criterion with high validity (Ohno 2001). Amid the recent growth in volunteer activities, more of the public is willing to offer their labor (Mamada 2010). Tsuchida et al. (2004) also pointed out that the participants who are highly motivated to participate in social volunteer activities are low willingness in monetary support method, so if only financial methods are used, the public willingness to participate in RWH could be insufficient.

Further, according to a survey on the citizens social contribution conducted by the policy publicity office of the Cabinet Secretariat in 2016 (Policy Publicity Office of the Cabinet Secretariat 2016), the working generation around 40s are the most frequent participants in community welfare activities, and about 50% people have ever donated money for social contribution (Policy Publicity Office of the Cabinet Secretariat 2016). When assessing people's willingness to participate in RWH, it is also important to understand the state of affairs by focusing on individual lifestyle factors, such as age and occupation. It is important to clarify the willingness of citizens to participate in RWH activities are based on their individual lifestyle factors.

Objective

The focus of this study was to clarify the potential of citizens with the different lifestyles to participate in RWH based on their willingness to work (WTW) and willingness to pay (WTP). First, we examined the hypothesis that people's WTW and WTP for RWH differ depending on their lifestyles. Second, we revealed the relationship between lifestyles and RWH activities. Third, we also examined the differences in WTW and WTP for RWH depending on whether a person had experience RWH to better understand the state of public interest in RWH.

METHODS

Survey Methods

We conducted a survey over the internet via a private company involved in online research.[14] The survey was conducted in August 2017, covering 1,800 people in 47 prefectures of Japan (1,794 valid responses). The survey was conducted so that the respondents were proportionally distributed based on the population of the eight regions, and so the male-female ratio and age group proportions were roughly equal. In the survey, the respondents were shown the definition of RWH and given specific examples of activities.

Definition of Terms

RWH is a new term and the promotion policy was formulated recently, so we inferred that the awareness of RWH of citizens is insufficient. Because of that, the questionnaire defined "RWH" as "activities for using rainwater in urban homes, parks, roads, commercial facilities, and public facilities with methods such as 'storage', 'usage', 'infiltration into the soil', and 'evapotranspiration'" prior to the actual questions. The definition also covered activities intended to conserve regular water, control drainage during heavy rains, secure water for emergency use during disasters, and maintain the ecological environment. This definition was created by referencing the "Guidance for RWH Architecture (AIJ 2011)." Specifically, these activities include (1) storing rainwater in some kinds of container, such as a reservoir, basin, rainwater tank, or jar (storing rainwater), (2) using it for things such as drinking, bathing, laundry, and flushing toilets (using

rainwater), (3) using pavement or soil to infiltrate rainwater (infiltrating rainwater into the soil), and (4) evaporating water by planting vegetation or creating water surfaces in gardens (evapotranspiration of rainwater). Additionally, we surveyed and analyzed the gender, age, occupation, housing of citizens as contents of lifestyle.

Survey Items

The survey questions addressed three areas: (1) respondents' lifestyles, (2) experience of RWH, (3) recognition of RWH activities, and (4) participation willingness in RWH. (1) Lifestyle included the questions on individual attributes and housing style. The individual attributes were gender, age group, and occupation. The housing style questions were divided between renting and owning, and single-family homes and multi-family housing. (2) For experience of RWH, they were asked whether they had any such experience. (3) recognition of RWH activities, there were 10 RWH activities to be chose. Concretely 2 storing rainwater activities, 2 using rainwater activities, 3 of infiltrating activities, and 3 evapotranspiration activities. (4) participation willingness in RWH, the questions were on WTW and WTP. The WTW question asked, "How many hours would you be willing to spend on RWH activities in a year? Please provide a number: about __ hours __ minutes." The WTP question asked, "How much money would you be willing to spend on RWH activities in a year? Please provide a number: about __JPY yen per year."

Analysis Method

The primary analysis in this study was to examine lifestyle-based differences in WTW and WTP. There were four aspects to the analysis: (1) summarizing respondents' lifestyles, (2) examining the

relationship between lifestyle and experience of using rainwater, (3) examining the relationship

between lifestyle and willingness to participate in RWH, and (4) examining the relationship between experience of using rainwater and willingness to participate in RWH. Accordingly, (1) to summarize the respondents' lifestyles, we totaled their individual attributes and housing styles. (2) The relationship between lifestyle and experience of using rainwater were examined using the

chi-square test. (3) The relationship between lifestyle and willingness to participate in RWH were examined with the chi-square test. For age group, occupation, and housing style, which had two or more items, multiple comparisons were performed with the Steel–Dwass test. (4) The relationship between experience of using rainwater and willingness to participate in RWH were examined with the chi-square test.

RESULT AND DISCUSSION

Summary of Respondents' Lifestyles

Table 1 shows the total individual attributes of 1794 sample respondents. Regarding occupation, the number of company employees (59.6%) were the most. As for employment status, the answer about workers were close to the nationwide proportion of the working people at 70.6% (Statistics Japan, 2018). In housing styles, there were 66.4% of the respondents were homeowners, also close to the ratio of homeowners in the whole country (MILT, 2010). From above results, the samples appear to be appropriate as the data to represent the whole country.

Relationship between lifestyle and experience of using rainwater

Of the respondents, 185 people (10.3%) had experience of using rainwater and 1,609 people (89.7%) had no such experience. Table 2 shows a cross tabulation of individual attributes by proportion of people with and without experience. Significant differences were not observed for lifestyle, but were observed between genders and age groups. While significant differences were not observed for occupation or housing style, significantly more men (12.1%) than women (8.5%) had experience. By age group, there were 59 people (16.1%) with experience in their 20s, 39 people (10.8%) in their 30s, 36 people (10.0%) in their 40s, 22 people (6.2%) in their 50s, and 29 people (8.3%) in their 60s ($p<.001$), showing that a higher proportion of elderly people had experience of RWH compared with younger generations. These results show that many people still do not have experience of RWH. However, as mentioned above, about 90% of people have expressed an active desire to install RWH facilities, which shows that there is room for growth, and necessary to promote the activities and policy of RWH.

3.3 Relationship between lifestyle and recognition of RWH activities

Table 3 shows the recognition of RWH activities is different according to lifestyle. Looking at the items with the highest percentage of responses among the RWH activities, the participants who have ever experience or known the RWH activity as storing rainwater are female, age 20s, student, employee, people who own a single-family house, especially in lifestyle of age 20s and student. Possible reasons as following, the number of rainwater storage facilities introduced to public institutions such as government and schools rapidly increased since Japan was hit by a severe drought at 1994. And the schools are designated as evacuation places in the event of disasters. Many schools use rainwater for washing toilet to saving energy even it is not in a water supply emergency

situation. Therefore, young generation have more chance to experience storing and using rainwater.

In using rainwater, the respondents of women, age 60s, unemployed, non-worker, people who own a single-family house are highly motivated to use rainwater as the domestic water. Because water usage fee can be saved by using rainwater for daily life, so it is assumed that those people who want to reduce the economic burden might have experience.

In permeable paving of infiltrating, the willingness of responses in male, age 20s, student, employee, public housing was high. Here, the permeable paving used at parking lots or roads has advantages such as suppressing the discharge of rainwater which could reduce the temperature of ground in summer. The people who usually using cars or go out might have more chance to experience.

In the evapotranspiration, there are no items with a particularly high selectivity ratio, and it can be said that the citizens don't have many experience the activities on the evapotranspiration compare to other activities. Besides, activities related to evapotranspiration require time for maintenance of plants, activities carried out in the garden or rooftop, restricted by places, and difficult to maintain and manage. As a result, basically only people who own a single-family house or over the age of 60 that have time and space to experience planting trees and maintain rain gardens.

Relationship between lifestyle and WTW and WTP for RWH

1. **WTW and WTP for RWH**
   Table 3 shows the subjects' WTW and WTP for RWH. For WTW, the mean value was 25.3 hour/year, median was 6 hour/year, minimum was 0 hour/year, and maximum was 1,277.5 hour/year. For WTP, the mean value was 8,756.3

Table 1 Total result of lifestyle

Items		Proportion	Number
Gender	Male	50.2%	893
	Female	49.8%	901
Age Range	20s	20.4%	366
	30s	20.2%	362
	40s	20.0%	359
	50s	19.8%	356
	60s	19.6%	351
Occupation	Employee	59.6%	1,070
	Self employed	5.7%	103
	Full-time housewife/husband	20.3%	365
	Student	2.2%	39
	Unemployed	7.7%	139
	Other	4.3%	78
Employment status	Worker	70.6%	1,212
	Non-worker	29.4%	504
Housing style	Own an apartment or mansion	17.3%	312
	Own a single-family house	48.0%	866
	Rent an apartment or mansion	26.5%	475
	Rent a single-family house	3.9%	70
	Public housing	2.7%	48
	Other	1.6%	29
	Homeowner	66.4%	1,172
	Renter	33.6%	593
	Single-family house	52.8%	932
	Multi-family house	47.2%	833

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JPY/year, median was 2,000 JPY/year, minimum was 0 JPY/year, and maximum was 1,005,050 JPY/year. In addition, there were 265 protest responses that answered 0 times for WTW and 456 protest responses for WTP. This indicates that people have more WTW for RWH than they have WTP. This result is consistent with the trend toward citizen participation in volunteer activities in Japan, as noted by Mamada (2010). In other words, in their willingness to participate in RWH, Japanese people have less resistance toward offering labor in the form of volunteering than they do toward offering money.

These results indicate that when promoting public participation in RWH, initiatives that ask people to provide time and labor would be more effective than creating activities that cost money.

Table 2 Percentage of rainwater harvesting experience by lifestyle

Items		Experienced	Number	No experience	Number
Gender	Male	12.1%	109	87.9%	792
	Female	8.5%	76	91.5%	817
Age range	20-29	16.1%	59	83.9%	307
	30-39	10.8%	39	88.2%	323
	40-49	10.0%	36	90.0%	323
	50-59	6.2%	22	93.8%	334
	60-69	8.3%	29	91.7%	322
Occupation	Employee	10.9%	117	89.1%	953
	Self employed	8.7%	9	91.3%	94
	Full-time housewife/husband	7.4%	27	92.6%	338
	Student	20.5%	8	79.5%	31
	Unemployed	12.2%	17	87.8%	122
	Other	9.0%	7	91.0%	71
Employment status	Worker	11.1%	134	88.9%	1078
	Non-worker	8.7%	44	91.3%	460
Housing style	Own an apartment or mansion	7.4%	100	92.6%	762
	Own a single-family house	11.6%	23	88.4%	287
	Rent an apartment or mansion	9.9%	47	90.1%	428
	Rent a single-family house	17.1%	12	82.9%	58
	Public housing	2.1%	1	97.9%	47

* Significant at 1% ** Significant at 5%

2. **Relationship between lifestyle and WTW for RWH**

Significant lifestyle-based differences in WTW for RWH was observed between age groups, occupations, employment status, and housing type (Table 4). Regarding age, the mean WTW for people in their 60s was significantly higher than that for people in their 20s (27.1 hour/year), 30s (22.1 hour/year), and 40s (21.6 hour/year). For occupation, the mean WTW for full-time housewives/husbands (32.7 hour/year) was significantly higher than that for company employees (24.4 hour/year). For employment status, the mean WTW for non-workers was significantly higher than that for workers. For housing type, the mean WTW for owners of single-family homes was significantly higher than that for renters of apartments or condominiums. These results show that WTW for RWH differs depending on a person's lifestyle; WTW for RWH was particularly high in elderly people age 60 or older, and for non-workers such as full-time housewives/husbands. This is likely because members of these

groups tend have more free time than people in middle age, who are mostly workers, and thus have less resistance to giving their time and labor

to RWH activities. Therefore, when promoting participation in RWH among older people and non-workers, initiatives that ask for time and labor can be expected to be more successful.

3. **Relationship between lifestyle and WTP for RWH**

   Significant lifestyle-based differences in the WTP for RWH was observed only for gender and housing style (Figure 3). For gender, men (10580.7 JYP/year) had a significantly higher WTP than women (6915.6 JYP/year). For housing style, the mean WTP value of owners of single-family homes (9503.0 JYP/year) was significantly higher than that of renters of apartments or condominiums (6242.6 JYP/year). The reasons for these differences in WTP values are thought to be as follows. First, the mean income of Japanese men is about 1.9 times higher than that of women (Statistics Japan 2018), which would suggest that men would be less resistant than women to pay for RWH. Next, homeownership rates increase with income in Japan (Statistics Japan 2011). Moreover, owners of single-family homes constitute 90% of the homeowner population (Statistics Japan 2014). Thus, people who live in their own single-family homes have higher incomes than people who live in rented apartments or condominiums, and are thus more willing to pay for RWH.

   The above results show that people's WTP varies depending on their lifestyles. Gender and housing style in particular appear to have some kind of relationship to the WTP for rainwater harvesting. Moreover, because of the income characteristics of men and people who live in their own homes in Japan, initiatives that ask the population to provide money may be preferable.

4. **Relationships between experience of using rainwater and WTW and WTP for RWH**

   Table 3 shows the relationships between having experience of using rainwater and WTW and WTP for RWH. For WTW, people with experience (56.6 hour/year) exhibited a significantly higher mean value than people with no experience (21.7 hour/year)—the former being 2.6 times higher than the latter. For WTP, people with experience (15082.6 JPY/year) also exhibited a significantly higher mean value than people with no experience (8028.9 JPY/year) —the former being 1.9 times higher than the latter. This shows that WTW and WTP differ depending on whether a person has experience of using rainwater. People with experience exhibited higher WTW and WTP levels than people with no experience. This suggests that to promote RWH among the public, it is important to get people to actually experience using rainwater.

CONCLUSION

This study sought to examine the hypothesis that people's WTW and WTP for rainwater harvesting are varying depend on their lifestyles and clarify the state of people's interest in RWH. In general, to promote public participation in RWH, local governments should provide subsidies to install and manage the RWH facilities, which include setting rainwater tanks, refurbishing parking lots of individual houses use permeable paving, to let the citizens participate in RWH easier. Moreover, it would be helped to promote infiltrating and evapotranspiration activities to the young people and who do not have spaces to RWH activities by providing public spaces in community and holding some events to let them experience RWH activities.

In Japan, National Resilience Project has been developed to prevent disasters since the Great East Japan Earthquake. Even though the water supply penetration rate is high, it is predicated that an interruption of the lifeline in a disaster will occur. Due to the high motivation for participation in activities related to storage and utilization, Japanese citizens are thought to be interested in water supply in a disaster. Moreover, as urbanization worsens environments and climate changes, which increase the risk of disaster, so citizen's RWH participation is indispensable.

Indonesia is a country with many disasters such as earthquakes, tsunami, and floods, especially for urban floods and land subsidence which is becoming normal in recent years. Besides, high dependence on groundwater will make city's water supply in high risk. Therefore, RWH is an important way to maintain citizens' domestic water in disaster. Further, infiltrating and evapotranspiration activities are meaningful to create green space and recharge groundwater by providing a public place for RWH activities and organizing tree planting events. From this point of view, research on the willingness of citizens participating in RWH in Japan will be a basic reference of promoting the participation of RWH in the social environment where disaster risk increases.

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Table 3 Relationship between lifestyle and rainwater harvesting activities (Percentage)

		Storing		Using		Infiltrating			Evapotranspiration		
		Rainwater Tank	Basin	Domestic Water	Cooling Water	Permeable Paving	Compost &Mulch	Downspout Disconnection	Tree Planting	Green Roof	Rain garden
Gender	Male	17.6	7.3	17.4	8.9	13.1	4.2	6.1	10.3	6.9	8.2
	Female	18.0	5.9	19.1	9.6	10.6	5.7	4.9	9.8	8.3	8.1
Age range	20-29	19.3	8.7	17.2	9.8	12.5	4.1	5.6	8.7	6.8	7.2
	30-39	17.5	7.6	18.0	9.6	11.3	4.7	6.0	9.3	8.9	7.1
	40-49	17.3	5.5	18.5	10.6	11.6	4.7	5.4	10.0	8.1	8.4
	50-59	17.7	6.1	18.6	9.1	12.0	5.1	5.5	9.9	7.5	8.5
	60-69	16.9	4.9	19.0	7.1	11.9	6.3	4.7	12.5	6.9	9.8
Occupation	Employee	17.8	7.2	17.4	10.1	12.6	4.9	5.5	9.6	7.8	7.2
	Self employed	15.9	6.8	18.4	7.4	11.3	3.9	5.5	11.3	8.4	11.0
	Full-time housewife/husband	17.4	5.1	19.9	8.2	10.0	6.0	5.5	11.2	7.6	9.0
	Student	23.1	7.7	15.4	8.5	15.4	4.3	5.1	5.1	8.5	6.8
	Unemployed	17.0	4.7	20.6	8.8	12.0	4.0	5.4	11.8	6.6	9.1
Employment status	Worker	17.8	7.2	17.4	9.8	12.5	4.8	5.5	9.6	7.8	7.5
	Non-worker	17.3	5.4	20.2	8.2	10.2	5.6	5.7	11.0	7.3	9.1
Housing style	Own an apartment or mansion	17.4	5.5	19.4	8.6	10.5	5.4	5.7	11.6	6.1	9.6
	Own a single-family house	18.9	8.1	17.4	9.1	14.0	4.1	5.3	8.0	9.5	5.7
	Rent an apartment or mansion	18.6	9.0	18.6	7.1	12.9	5.2	5.7	10.5	4.3	8.1
	Rent a single-family house	17.5	7.3	16.9	10.7	12.5	4.4	5.4	8.6	9.5	7.2
	Public housing	17.4	5.6	14.6	7.6	14.6	7.6	3.5	10.4	11.1	7.6

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Endnotes

1. Research methods of this study used an online questionnaire survey by Cross Marketing Inc.. Cross Marketing Inc., a company with about 3.77 million active survey panels, was contracted to conduct the online survey. Thus, the survey was one that obtained responses from a panel registered with an online research company. Although sampling was performed on a large panel network, the panel was composed of internet users, which makes the population somewhat vague. It is unclear if this population can be considered representative of the nation as a whole. This represents a limitation to the method of this study. Nevertheless, we adopted this method because a large sample can be obtained easily, omissions do not occur, responses selected irresponsibly can be excluded, etc.

2. Proportion of the working people is 76% in Japan (Statistics Japan, 2018)

3. Proportion of homeowners is 60.7% in Japan (MILT, 2010)

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