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Public willingness to pay and participate in domestic waste management in rural areas of China

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ABSTRACT

Broad and sustainable public willingness to pay (WTP) and willingness to participate (WTPP) are the basis of successful domestic waste management. Using questionnaires and statistical methods, we investigated the public WTP (73.72%), the public WTPP including willingness to use collection facilities (90.61%), to sort waste (78.70%), to deliver waste (93.28%) and to dispose waste (69.28%), the public willingness to work as a cleaner (62.50%), and their influential socioeconomic factors in rural areas of China, in order to provide more effective and practical policies for the waste management. Results indicated that men and wealthy subjects had greater WTP than women and poor subjects. Demonstration projects and public awareness of waste treatment necessity had significantly positive effects on WTP and WTPP. Villagers who received propaganda were more WTP and WTPP. Perception of environmental pollution could significantly enhance WTP without considering other factors. The older subjects had weaker WTPP compared with the youngest subjects based on single factor logistic regression. Education had a significant positive effect on and high correlation with WTP and WTPP, respectively. Public WTP and willingness to deliver waste decreased exponentially with increases in service fee and delivery distance, respectively. Public willingness to work as a cleaner exhibited logarithmic growth as expected wages increased. In the future, it will be necessary to take effective measures for rural waste management, such as providing demonstration programs, enhancing public awareness of waste treatment necessity, considering influences of service fees, delivery distance and expected wages, and developing sustainable rural economy to increase residents' incomes.

1. Introduction

Solid waste management is a global challenge, especially in economically developing countries due to their growing populations, life style changes, rising community living standards, and increasing waste generation (Hassan et al., 2016). When selecting the most appropriate solid waste management system for a certain territory, decision makers must consider technical aspects and implementation costs, as well as the attitudes of residents, public environmental awareness, behavior, and the willingness to pay (WTP) (Berenguer et al., 2005; Barr and Gilg, 2007; Khoo, 2009; Ferreira and Marques, 2015; Song et al., 2016).

Many previous studies have shown that public awareness and attitude (Chung and Poon, 2001; Dhokhikah et al., 2015), and broad and

sustainable public participation in source-separated waste collection (Zeng et al., 2016) are the basis of successful waste management in developing countries. For example, general knowledge about waste management had a significant correlation with the willingness to engage in waste management in India (Mukherji et al., 2016). A social survey conducted in Malaysia showed that people had a positive intention to participate in source separation for food waste in the household (Karim Ghani et al., 2013). In addition, Pakpour et al. (2014) found that attitudes, subjective norms, perceived behavioral control, moral obligations, self-identify, intention, action planning, and past behavior significantly predicted household waste collection behaviors in Iran. In Uganda, respondents expressed a high willingness to separate (76.6%) and compost (54.9%) solid waste (Mukama et al., 2016).

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Moreover, intentions and behavior toward domestic waste collection, and WTP are significantly influenced by gender, age, education, income, employment status, home ownership, location, and government policies (Danso et al., 2006; Rahji and Oloruntoba, 2009; Afroz et al., 2011; Banga et al., 2011; Martínez-Peña et al., 2013; Wang et al., 2014; Mukherji et al., 2016; Song et al., 2016; Triguero et al., 2016; Wang et al., 2018; Zeng et al., 2016). Mukherji et al. (2016) reported that the female, the older age group, the lower socioeconomic group, and the highest socioeconomic group had greater abstract knowledge of waste management. However, the samples used in different studies have generally yielded diverse conclusions. Hence, Kwetey et al. (2014) found that socioeconomic characteristics such as age, education, income, and employment had no significant effects on the WTP to improve waste services.

Currently, due to rapid development of the rural economy and social transformation in the rural areas of China, the characteristics of domestic waste fluctuated greatly (Han et al., 2018a) and public awareness of domestic waste characteristics and management was variable (Han et al., 2018b). Therefore, the government of China must address many environmental problems, particularly the increasingly severe consequences of domestic waste pollution based on the variation and effect of socioeconomic factors in rural areas (Han et al., 2015a,b). More than half of the households in the rural areas of China are willing to participate in separation programs (Zeng et al., 2016). However, the awareness of solid household waste separation and collection is still low among Chinese residents (Gu et al., 2015). The dominant barriers to participation are a lack of awareness regarding separation, inconvenience, and insufficient separation facilities (Zeng et al., 2016).

In general, sustainable development of the countryside requires an integral waste management strategy comprising all the stages from waste collection and transport to waste treatment and disposal. Many previous studies have addressed attention, participation, WTP for waste services, and the willingness to collect waste in cities, but few have considered the willingness to participate (WTPP) in all waste management processes and their influential socioeconomic factors in the rural areas of developing countries. If the governments of developing countries want to implement effective policies and build appropriate facilities to solve domestic waste issues, the public WTP and WTPP in waste management, and their influential socioeconomic factors must be considered or government policies and participation by producers cannot be implemented effectively.

Therefore, using questionnaires and statistical methods, we investigated China as a typical developing country to determine the WTP, the WTPP, the willingness to work as a cleaner, and their influential socioeconomic factors with respect to waste management in rural areas. One objective of this study was to explore the WTP and WTPP in waste management. The other objective was to clarify how the influential socioeconomic factors affect public WTP and WTPP in waste management in rural areas. The results of this study should be useful for decision makers, environmentalists, educators, and businesses when planning waste management.

2. Materials and methods

2.1. Survey methods and contents

The primary sources for the data used in this study were random questionnaires completed by 811 households in 59 villages from six provinces in West China in face-to-face interviews with well-trained interviewers. From each household, one member responded to our questionnaire. The investigated villages were typical because they presented different socioeconomic development levels (remote, suburban, developed and developing), different industries (agriculture, industry, tourism, livestock breeding and crop farming), different terrain and landform (plain, mountain and plateau), different climate (the subtropical zone, the plateau climate zone, the warm temperate zone

and the intermediate temperate zone) and different cultures (ethnic communities and variation of habits). Information was obtained about the following characteristics:

- (i) Socioeconomic characteristics of respondents and their households and villages, including their gender, age, educational level, and the annual household income and its sources;
- (ii) Current situation regarding demonstration projects and environmental protection propaganda programs in local villages.
- (iii) The perception of environmental pollution and awareness of waste treatment necessity;
- (iv) The WTP and the limit regarding the amount that could be paid;
- (v) The WTPP including the willingness to use collection facilities, the willingness to sort waste, the willingness to deliver waste and the willingness to dispose waste by village committees or by themselves;
- (vi) The willingness to work as a cleaner.

2.2. Data analysis

Statistical analyses were performed with Microsoft Excel 2016 and SPSS 19.0. 811 samples were withdrawn but effective size of each influencing factor was different for excluding the default samples and unselected samples according to the principle of Logistic regressions.

Logistic regressions were widely used to analyze the main factors that influenced WTP (Rahji and Oloruntoba, 2009; Afroz, et al., 2011; Triguero et al., 2016). The estimated model employed has the following form (Rahji and Oloruntoba, 2009):

$$\text{Prob(Yes)} = [1 + e^{-BX}]^{-1} \tag{1}$$

i.e.

$$P_i(Y_i = 1) = \frac{1}{1 + e^{-BX}} \tag{2}$$

$$\text{Prob(No)} = 1 - P_i(Y_i = 1) \Rightarrow P_i(Y_i = 0) = 1 - P_i(Y_i = 1) \tag{3}$$

But

$$P_i(Y_i = 0) = \frac{1}{1 + e^{BX}} \tag{4}$$

Manipulation of (3) and (4), gives

$$1 - P_i(Y_i = 1) = \frac{1}{1 + e^{BX}} \Rightarrow \frac{P_i(Y_i = 1)}{1 - P_i(Y_i = 1)} = e^{BX} \tag{5}$$

The right-hand side of the above Eq. (5) is the ratio of the probability of Yes (willingness) to the probability of No (unwillingness) for WTP and WTPP. The logarithm of the odd ratio to base e yielded the linear log model:

$$\ln \left[\frac{P_i(Y_i = 1)}{1 - P_i(Y_i = 1)} \right] = BX$$

Therefore the willingness (W) = $[B'X]$,

$$\text{Log} \frac{P_i}{1 - P_i} = \beta_0 + \beta_i X_i + e \tag{6}$$

where P_i is the probability of Y_i . $Y_i = 1$ if the respondent is willing to pay and willing to participate in waste management; otherwise, $Y_i = 0$; β_0 is a constant term; β_i is the coefficient of independent variables; X_i is a vector of explanatory independent variables; and e is a random error term. The independent variables in this model are gender, age, education, income, awareness of waste treatment necessity, perception of environmental pollution, demonstration projects and propaganda program in local villages.

Given Eq. (6), the empirical model allowed us to examine the influence of each single factor as:

$$PW_i = \beta_0 + \beta_{i1} X_i + e. \tag{7}$$

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