Full length article

# Investigation on decision-making mechanism of residents' household solid waste classification and recycling behaviors

Xiaoyan Meng[a], Xianchun Tan[a,d], Yi Wang[a,d], Zongguo Wen[b,*], Yuan Tao[c,*], Yi Qian[b]

[a] Institutes of Science and Development, Chinese Academy of Sciences, Beijing 100190, China
[b] State Key Joint Laboratory of Environment Simulation and Pollution Control (SKLESPC), School of Environment, Tsinghua University, Beijing 100084, China
[c] Institute for Manufacturing, Department of Engineering, University of Cambridge, Cambridge CB3 0FS, United Kingdom
[d] School of Public Policy and Management, University of Chinese Academy of Sciences, Beijing 100049, China

## A B S T R A C T

Residents' participation in classification and recycling of urban household solid waste (HSW) is a critical factor for the success of municipal solid waste management. The aim of this study is to investigate the decision-making mechanism of residents' HSW disposal behaviors by merging the theory of planned behavior and the Attitude-Behavior-Condition theory. In this study, based on the survey data of 709 residents in Suzhou, China and structural equation modeling method, the main factors that affect residents' HSW disposal behaviors and their degree of influence were analyzed, followed by discussion on decision-making mechanisms. The findings show that residents' behavioral selection has been significantly related to four intrinsic subjective factors and seven external objective factors, and the combined effect of the latter ones is nearly twice of that of the former ones. Moreover, the convenient of environmental facilities and services are most effective at promoting residents' participation in HSW classification and recycling. Specifically, the observed variables of publicity and education, accessibility to recycling facilities, accessibility to classification facilities, willingness to participation of classification and residents' environmental awareness are the five most significant factors. The impact of laws and regulations is not significant; however, this may be because that there was no mandatory laws, regulations and incentive mechanisms on HSW classification and recycling in Suzhou in this period, and there is still a big gap and room for improvement in this aspect in mainland China. Finally, the study put forward relevant policy recommendations for the comprehensive management of urban HSW classification and recycling.

## 1. Introduction

With the development of the economy and the improvement of residents' living standards, urban household solid waste is increasing rapidly in many countries all over the world. At present more and more governments regard the principles of HSW's decrement, recycle and harmless as the goals of urban municipal solid waste management. Nothing wrong with that waste source separation and recycling has major potential benefits to an effective management of waste by addressing the problem of landfill shortage and resource savings. However, there is a considerable distance towards achieving its full potential in practice. One of the main reasons is the weak residents' engagement in waste management policies (e.g. classification, recycling). Since residents' participation in HSW separation and recycling is the key to affecting urban solid waste classification management, then, the question is, how to increase the participation rate of residents?

This requires a clear understanding of the main influencing factors and decision-making mechanisms of residents' HSW disposal behaviors (RWDB). Understanding RWDB could enable decision makers and local governments to design more-effective policies for improving waste separation and recycling.

As the world's largest developing country, China has already entered a period of rapid urbanization. From 1998–2017, urbanization in China has increased at an average annual growth rate of more than 1%. As of 2017, 58.52% of China's total population lives in urban areas or cities (National Bureau of Statistics of China, 2018). In the meantime, the rapid industrial development has consumed massive resources and given rise to urban household solid waste (HSW). At present, two thirds of China's big and medium cities are engulfed in waste, with more than 500 million square meters of land nationwide encroached due to the dumping of household solid waste (Fei et al., 2016). There is no doubt that the classification and recycling of HSW is strategically important

for alleviating resource and environmental restrictions. As early as 2000, China started to carry out pilot programs for waste separation and recycling in eight cities including Beijing, Guangzhou, and Shanghai (Meng et al., 2018). Since 2016, waste classification has been elevated to an unprecedented high level. President Xi Jinping specifically pointed out that it is necessary to introduce the waste classification system to more areas when he presided over the Central Leading Group on Financial and Economic Affairs in December 2016. The National Development and Reform Commission and the Ministry of Housing and Urban-Rural Development released the "Implementation Plan on the Household Solid Waste Classification System" on March 18, 2017, requiring that 46 cities nationwide take the lead to implement mandatory classification of household solid waste and that the recycling rate of household solid waste exceed 35% by 2020. However, the present management of household solid waste classification and recycling is not satisfactory. In pilot cities for household solid waste classification, the participation rate of household solid waste classification is still low, and there is no substantial progress made in waste reduction (Yan, 2018). It is a pressing problem to cultivate residents' habits of source classification and resource recycling, and improve their participation in waste classification and recycling in the comprehensive management of urban household solid waste. Therefore, it is theoretically and instructively significant to tap into the main impact factor and decision-making mechanism and formulate targeted policies to improve residents' participation in household solid waste classification and recycling.

There have been some research conducted to explain why individuals may or may not engage in waste management policies, such as waste prevention, source separation and littering (Bortoleto et al., 2012; Abdelradi, 2018; Wang et al., 2018). In summary, there are two classes of theoretical methods for research on residents' environmental behavior and choices at home and abroad (Jackson, 2005), one is the research method based on environmental sociology, and the other is the research method based on environmental psychology. The first method starts from the interaction between micro-individuals and socio-environmental systems and considers that an individual's ideas and behavioral choices are determined by the process and status of social and technological development (Singh et al., 2018). The second method mainly considers the effect of irrational factors on individual behavior. The most common theory of planned behavior (TPB) falls into the first category. Ajzen (1985) developed TPB based on the theory of reasoned action, which emphasizes that an individual's behavior is influenced by attitude, subjective norm, and perceived behavioral control (Ajzen, 1985). Many scholars have studied waste classification and recycling behavior with the TPB theory (Botetzagias et al., 2015; Gao et al., 2017; Lizina et al., 2017). For example, Nguyen et al. (2015) find that personal ethics are a significant impact factor in promoting residents' behavioral intention to participate in waste classification and recycling; the study by Park and Ha (2014) indicates that residents are encouraged and affected when they see their neighbors or friends classify and recycle waste.

Although the TPB theory inspires studies on residents' recycling behavior, its model framework has strong limitations. The TPB theory mainly considers intrinsic factors; however, other factors also affect the process when behavioral intentions turn into behavior (Boldero, 1995). Stern and Oskamp (1987) constructed a complex environmental behavior model, proposing that environmental behavior is the result of related external factors and intrinsic factors working together. Based on this, Guagnano et al. (1995) proposed the Attitude-Behavior-Condition (A-B-C) theory, which states that individuals' behavior (Behavior, B) results from the combined effect of residents' attitudes (Attitude, A) and external conditions (Condition C), and considers that external conditions are crucial factors in determining whether residents perform waste recycling behavior. Tucker further refined the model and proposed a research model in which residents' HSW disposal behavior is determined by attitude, subjective norms, social norms, and external

conditions (Tucker et al., 1998).

However, much of the research up to now has separately studied individuals' waste prevention behavior (Bortoleto et al., 2012), waste source separation behavior (Zhang and Wen, 2014), domestic recyclable resource recycling behavior (Fei et al., 2016), etc. Few published studies have been able to draw on any systematic research into HSW disposal behaviors including all possible waste disposal methods simultaneously. There has been no known research on a behavioral decision-making mechanism which considers both residents' participation in source classification and resource recycling. In addition, previous research on residents' HSW disposal behavior mainly focuses on willingness to participate in source classification and impact factors, however, studies that consider both internal subjective factors and external situational factors that influence individuals' waste management behaviors are still rare. In this study, in order to comprehensively understanding the decision-making mechanism of residents' HSW disposal behaviors, explore the factors have a significant effect on RWDB and the degree of their influence, we divided RWDB into three kinds according to different waste disposal ways selected (non-classification, classification deposition and selling recyclables after classification), and developed an hypothetical model by merging the TPB theory and A-B-C theory. The proposed model can consider both individual subjective factors and external situational factors that may influence the residents' HSW classification and recycling behaviors. Next a questionnaire was designed and the field survey was conducted in the five administrative districts of Suzhou, China. Then the initial hypothetical model was tested using structural equation modeling (SEM) based on the questionnaire data, and the significant paths and better indexes of fit were obtained through model evaluation and correction. Finally, the main influencing factors of RWDB and the sensitivity coefficient corresponding to each factor were explored, moreover, the decision-making mechanism of residents and policy suggestions were discussed.

The results of this study could provide a theoretical support for policy formulation on urban household solid waste classification and recycling in China and other countries in the word. The initial research hypotheses and conceptual models are organized in Section 2 based on previous literature reviews. Section 3 introduces the research methodology for data collection and structural equation modeling. Section 4 presents data analysis, model testing and results. The discussions and policy recommendations are conducted in Sections 5, and 6 covers the conclusions.

## 2. Initial research hypotheses and conceptual models

In order to propose reasonable hypotheses of the initial measurement model, we searched and summarized a large number of prior research on the impact factors of residents' waste disposal behavior. In recent years, domestic and foreign scholars have conducted relevant research on it (Boonrod et al., 2015; Borthakur and Govind, 2017; Guo et al., 2016). Based on literature reviews, this paper summarizes factors of frequent occurrence and with a significant effect. Previous studies have shown that residents' HSW disposal behaviors may be affected indirectly by four main aspects, namely, environmental attitudes, social norms, environmental knowledge, publicity and education, environmental facilities and services (situational factors). Further, by combining the Theory of Planned Behavior and A-B-C Theory, this study puts forward an initial conceptual and measurement model on the decision-making of RWDB, together with its indicated hypotheses (see Fig. 1). The definitions of individual hypotheses regarding RWDB are as follows.

In the initial model, the study assume that the four latent variables of "environmental attitudes (EA)", "social norms (SN)", "environmental knowledge, publicity and education (EP)" and "environmental facilities and services (EF)" have path effect on RWDB ($H_1$, $H_2$, $H_3$ and $H_4$), and each observed variable is reflected by several observed variables. The paper has set up 15 possible observed variables based on the literature