



## Promoting public participation in household waste management: A survey based method and case study in Xiamen city, China



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### ABSTRACT

Limited success in 3R (reduce, reuse, recycle) implementation and conflicts in waste treatment plant construction call for active and sustained public participation in Chinese waste management. It is especially important to identify factors which affect citizen participation in waste reduction and recycling where waste policies are poorly implemented. In this paper we report the results of a research-constructed survey conducted in Xiamen, one of eight cities in China which have been operating waste source separation pilot programs since 2000. The results showed that while more than half of respondents were satisfied with local waste management, waste recycling was still inefficient and largely carried out by the informal sector. Satisfaction rates and basic residential house prices were positively correlated, and the satisfaction rate was higher in newly urbanizing areas than in old downtown and urban village areas. A structural equation model was used to identify key factors influencing citizen environmental willingness to participate in waste management, and this indicated that the most important influencing factor was citizen knowledge, followed by social motivation, while institutional factors had the smallest positive effect. Citizens who were better informed and lived in a community/family with more environmentally friendly behaviors have a greater propensity to participate in sustainable waste management. The model is useful for identifying causal relationships and ranking influencing factors in terms of their importance. The results indicate a waste policy hierarchy in Chinese cities, and future waste management should change from the current legislative-centered strategy. The results can be used to inform decision makers find locally effective strategies to improve public participation in waste management in accordance with socioeconomic and cultural conditions in China.

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### 1. Introduction

Waste management (WM) is an important service provided by local governments, but was traditionally regarded as an isolated environmental problem requiring technical engineering solutions before 2000. Techniques tended to focus on dealing with one type of waste, leading to a focus on single technologies instead of the waste management system. Consequentially, one waste problem can be solved, but other waste problems are often generated (Dijkema et al., 2000). As a complex adaptive system, WM requires a systematic approach which integrates environmental

effectiveness, social acceptability, and economic affordability. However, compared to technical issues, social-economic dimensions of municipal solid waste (MSW) management have not attracted sufficient attention from researchers around the globe (Ma and Hipel., 2016). The effectiveness of waste management directly affects the sustainability of a city (Othman et al., 2013), but WM in many developing countries only becomes a priority for urban planners and decision makers when basic needs such as food and livelihoods have already been met (Marshall and Farahbakhsh, 2013; Wilson, 2007). In addition, among socio-environmental concerns, more attention is usually given to water distribution and drainage. While WM receives less public attention and support, and is usually one of the least developed urban public sectors (Cave, 2014).

Due to an unprecedented rate and scale of urbanization, China is undergoing an extremely rapid growth in MSW and has become the

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world's largest waste generator. Waste generation and treatment rates have surpassed the urbanization rate, and despite considerable financial investment, WM has had limited success in implementing "3R" (reduce, reuse, recycle) principles (Huang et al., 2014). Setting up and improving end-pipe treatment facilities accounted for 73.6% of financial investment by the Chinese government between 2011 and 2015, while transportation and collection facilities accounted for 13.3%, food waste treatment facilities 4.1%, waste separation pilot projects only 8.0%, and the supervision system 1.0% (GOSCC, 2012). About 93.4% of Chinese MSW was treated by landfill or incineration in 2013 and 66.08% in 2008, but only a few facilities were available for waste recycling and source separation. Recent citizen campaigns to block construction of nearby incineration plants have transformed China's waste problem into a source of social conflict. From 2009 to 2014, residents in 12 cities protested incineration projects as a result of environmental concerns, and only 3 incineration projects were accepted while the others were cancelled or deferred. Investigations have indicated that such protests are usually related to public perception of environmental justice, inequitable distribution of risk, lack of trust in authorities and other political issues (Guidotti et al., 2008; Giaccaria and Frontuto, 2010; Sun et al., 2016).

China has launched pilot programs for source separation in eight cities since the year 2000, but the assessment of these cities has demonstrated a poor performance (Tai et al., 2011). Few cities have officially reported a recycling rate, and the paper recycling rate was less than 25% in Beijing, a pilot city for waste separation (Song, 2015). Policies and technologies imported from developed countries are often not well adapted to developing countries, because more than half of municipal waste is composed of organic material which is unsuitable for disposal by landfill or incineration (Xiao et al., 2015). Without separation, incineration encounters a range of problems including unsteady and unstable combustion, incomplete combustion, and increased formation of air pollutants due to high moisture and low energy content (Cheng et al., 2007). The costs of capital, operating, and maintenance for domestically developed facilities are only 1/3 to 1/2 of those of imported ones (Cheng and Hu, 2010). Waste composition indicates that there is great potential for increased composting and recycling in China. But composting has been an unpopular choice of MSW management primarily because of insufficient food waste and unreliable sources with low nutrient content and heavy metals in compost products (Cheng and Hu, 2010). The issue of food waste treatment is becoming more serious as landfill capacity limits are being reached.

Local governments in China nowadays face a dilemma in both source separation and treatment facility construction. Public participation is recognized as the main path toward sustainable WM and plays a vital role in environmental conflict management as it can bridge the gap between government and citizens (Joseph, 2006; Lin et al., 2010). WM strategies based on waste separation and recycling will only be successful if they achieve widespread public support, and so Chinese cities must develop comprehensive and locally effective public participation strategies to face WM challenges.

## 2. Literature review

Although WM systems are becoming more aware of the importance of considering multiple stakeholders, decision makers (governments/municipalities) and experts (technical supporters) are still the most active participants. Public awareness is now regarded as the most desirable driving factor of WM, rather than public health, resource scarcity or climate change (Diaz and Otoma, 2012). Local residents are non-ignorable stakeholders in both daily

WM and the decision making process (Garnett and Cooper, 2014; Tai et al., 2011). The structure and functions of public participation are founded on the performance patterns and attitudes of people, which are shaped by the local cultural and social context (Schubeler, 1996). Thus, the present challenge for WM is to enhance public participation, so as to fully incorporate local community opinion into specific policymaking, making it necessary to explore which factors promote public participation.

Along with the development of technical solutions, increasing emphasis is now given to strategies based on promoting individual behaviors in developed countries (Vicente and Reis, 2008). Demographic variables (age, gender and household typology) were most frequently investigated by empirical studies, but the roles of the variables were always distinct, and varied across different socio-economic background (Qu et al., 2007; Valle et al., 2004; Vicente and Reis, 2008). Knowledge and recycling time were positively related to participation willingness (Vicente and Reis, 2008; Cox et al., 2010; Gellynck et al., 2011), and spatial factors were also important influences on waste generation. MSW had some obvious concentration patterns which indicated that waste generation differed from region to region (Zhang et al., 2015). Attitude and social/personal norms received more attention in developed countries as supported by a cognitive psychological model, Theory of Planned Behavior (TPB) (Ajzen, 1991; Cheung, 1999; Tonglet et al., 2004). An extended TPB was constructed to examine factors associated with household waste behaviors in Iran, and moral obligation and social-economic background were addressed in a recycling program (Pakpour et al., 2014). Pilot recycling projects have included the use of economic incentives, legislation and public education motivate citizens, but it is difficult to determine the precise effects of these factors by direct observation, and previous research has suggested an inconsistent relationship between these factors and individual behaviors (Valle et al., 2004). Previous research has hardly addressed the causal relationship, and the importance of each potential influencing factor remains uncertain. It is difficult to fully understand public participation and provide effective government intervention without first understanding the contributions of all the influencing factors. In China, little research has focused on public willingness to participate in WM and its influencing factors, and the importance of these factors has not yet been well evaluated. Local context is important and design of a successful scheme may not necessarily be replicable elsewhere (Tucker et al., 2000). It is unlikely that the conclusions drawn from foreign studies and management theories will be automatically applicable in China, due to rapid increases in MSW generation, differences in waste composition, culture/social attitudes as well as the legislative environment. Diagnosing the importance of each factor in explaining participation willingness is an important tool to support future actions and communication strategies to enhance people's involvement in WM programs.

Based on previous research and the Chinese context, we hypothesized that several factors influenced people's willingness to participate in WM: (1) knowledge about how to be involved, including information, facilities and method; (2) institutions to formulate people's behaviors, including laws and regulations; (3) motivation to improve people's involvement, including incentives and moral norms.

This paper aimed to test the hypothesis and improve understanding of the factors influencing household willingness to participate in WM by reporting the results of a questionnaire survey in Xiamen, a rapidly urbanizing city in southeast China. The survey used an extensive sampling approach to evaluate citizen knowledge, satisfaction, and opinions. Structural equation models (SEM) were used to evaluate the influence of various factors involving multiple causal pathways among variables. SEMs are

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