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# Villagers' attitudes and behaviors toward rural solid waste management under environmental authoritarianism in China

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Rapid urbanization and industrialization in China, combined with a rural-urban dual structure, have resulted in significant challenges for rural solid waste management (RSWM). Through the issuance of regulations and guidelines, and the allocation of substantial funds, the Chinese government has achieved remarkable success in implementing a top-down, linear, and authoritarian waste system, with the national village-level coverage rate of the rural waste management system growing from zero to over 90% in less than 20 years. This paper provides insights into the factors that influence villagers' responses (attitudes and behaviors) to authoritarian environmental policy measures. Using primary data from Meizhou County in Guangdong Province (the poorest county in China's richest province), the study finds that villagers' attitudes are significantly affected by their satisfaction with the government's RSWM and their environmental concern, while villagers' behaviors are significantly influenced by their approval level of the local environment, the availability of solid waste collection (SWC) facilities, and their environmental concern. Thus, villagers' SWC behaviors are mainly influenced by practical convenience and internal motivation. In general, government-relevant factors do not directly impact villagers' SWC behaviors but significantly moderate villagers' behaviors. Surprisingly, the variable of villagers' education level is a significantly negative factor in affecting both RSWM attitudes and behaviors, implying that future RSWM policy measures should take consider democracy more and value villagers' participation.

## KEYWORDS

rural solid waste management, villagers' attitudes and behaviors, rural China, authoritarian environmental governance, democracy environmental governance

## 1 Introduction

Solid waste management (SWM) is a global issue, particularly in fast-developing regions, where waste management cannot keep up with the pace of development ([World Bank, 2018](https://www.worldbank.org/)). China is a dual-structured country, with rural regions lagging behind urban regions generally. Rural China is facing more severe waste problems due to the expanding

economy (Liao et al., 2018). Traditionally, rural household waste was consumed and recycled by nature (Han et al., 2018). However, due to the increasing quantity and changing composition of waste, waste in rural areas have exceeded nature's capacity to handle, resulting in the phenomenon of "junk-sieged villages".

According to the garbage industry report data, the total annual quantity of rural solid waste (RSW) reached 227 million tons in 2017 (Qianzhan Institution, 2019). The Vice Minister of the Department of Agriculture and Rural Affairs reported that almost a quarter of RSW was not collected or processed (Xin Hua News Agency, 2020), which poses a significant threat to villagers' daily life and harms their bodies directly and indirectly (Han et al., 2018). Even worse, RSW pollutes agricultural land, water, and air, which resulting in contaminated agriculture products that affect public health. The effectiveness and efficiency of RSWM in China affects more than 600 million rural population living on about 9 million square kilometers of land. Acknowledging the seriousness of the RSW problem, the Chinese government has made great effects to solve it since around 2005. This includes issuing a series of laws and regulations, a large number of investments, and promotions on environment protection (Wang et al., 2017).

Due to the public goods nature of environmental protection, the government plays an important role in its management in most countries. Environmental authoritarianism is potentially a superior basis for public policy (Gilley, 2012), and has made some success in East Asia including Japan and China (Beeson, 2014). In the historical context of China's authoritarian rule, the Chinese-style logic of governance is embedded into the environmental governance, making it a top-down linear path (Zang and Lv, 2017). A nationwide panel data (in 2005, 2008, and 2012) indicates that rural solid waste collection (RSWC) facilities and services have rapidly increased from 3% to about 50% (Wang et al., 2016). Another national survey in 2016 announced that RSWC services cover more than 80% of villages across the country (Wang et al., 2017). In September 2020, in the third session of the 13<sup>th</sup> People Congress, the Ministry of Agriculture and Rural Affairs claimed that over 90% of villages have been covered by the RSW collection, transfer, and treatment system. Beeson (2018) pointed out that there is no sign of disappearing in China's particular variety of authoritarian rule, and the growing environmental problems are a possible reason for the durability of authoritarianism.

Considering the mismanagement, ineffectiveness, and injustice of authoritarian environmental governance, researchers put forward the idea of "participatory governance" in developed countries 50 years ago (Heibronner, 1974; Dryzek, 1987). Li and Reuveny (2006) analyzed data from more than 100 countries from 1961 to 2000 and found that participation can reduce environmental degradation. A Chinese case study in Shandong Province revealed that the current RSWM has unintended consequences, such as the erosion of rural environmental responsibility, social differentiation, power reconstruction, and environmental injustice (Sun, 2019). Empirical studies on environmental authoritarianism are rare, particularly in rural areas.

The main objective of this study is to identify the key determinants of villagers' attitudes towards RSWM and their RSWC behaviors under China's environmental authoritarianism. To achieve this goal, a survey is designed to collect primary data on villagers' RSWM attitudes and RSWC behaviors. A multi-variable

analysis of the villagers' RSWM attitudes and RSWC behaviors is conducted. Finally, policy recommendations based on the empirical findings are provided.

## 2 Relevant research and background

This section provides background information for this paper, including a literature review, an overview of RSW in China, the current situation of RSWM, and the development of related regulations.

### 2.1 Related research

Studies on RSWM in China can be divided into two categories. The first category focuses on the provision of RSWM services at the village level (Wang et al., 2016; Pan et al., 2017; Cao et al., 2018), while the second category is related to individual attitudes and behaviors toward RSWM (Zeng et al., 2016; Han et al., 2018; Ma et al., 2020).

Studies on RSWM service supply are more about the facilities, policies, villager officers, and their villagers. According to a panel survey of 101 villages' RSWC conducted by Wang et al. (2016), there has been an overall significant increase in RSWC facilities, but richer villages tend to have more facilities. However, as noted by Pan et al. (2017) and Wang et al. (2017), RSWC service is not equally provided due to the uneven economic development, and some RSWC services are not practical but merely for "showcasing" (Pan et al., 2017). Additionally, villages with more educated villagers tend to discharge less waste (Huang et al., 2013). However, there is no significant correlation is shown between villagers' educational level and the RSWC service (Cao et al., 2018).

Individual-level studies have identified significant factors influencing attitude and behaviors towards RSWM including government regulations (Ma et al., 2018) and efforts (Wan et al., 2015); social factors, such as education level (Han et al., 2019) and culture (Han et al., 2018); economic factors, such as income (Han et al., 2019) and consumption (Han et al., 2018); and psychology factors, such as local identity (Pei, 2019) and attitude in the environment (Ma et al., 2018). A study of 14 developing countries found that education, training, and demonstration projects play a positive role in improving people's awareness of environmental protection. Different traditions and cultures, living habits, geography, and climate in different places lead to diverse environmental behaviors (Han et al., 2018). Ma's (2020) survey of 689 villagers in Shanxi Province in China revealed that the policy instruments not only directly affect pro-environmental behaviors but also indirectly affect perceived value.

The literature on RSWM in China is extensive. However, few studies have addressed its typical authoritarian governance, despite it being one of the eight major research clusters in environmental governance research (Ohno, 2019). Available literature on China's environmental authoritarianism mainly focuses on legislation (Gilley, 2012; Beeson, 2017; Wang and Jiang, 2020) and policy (Liu et al., 2019), but is rare on public response. Researchers outside China have made significant contributions to the field. For example, String et al. (2006) examined three case studies to address the

potential of adoption management to make environmental management more democratic. Wallington and Lawrence (2008) studied a natural resource management experiment in Australia to discuss the responsibility of environment governance from federal and state governments to community-based bodies. Newig and Fritsch (2009) used 47 existing case studies as empirical data and found out that involved actors' preferences determine the environmental outcomes, but there is no correlation between government efficiency and decision-making scale. Hidayat and Stoecker (2018) analyzed a survey of city-wide residents in the US and found that community-based organizations could have a positive impact on civic environmentalism, environmental justice, and sustainability.

## 2.2 RSW in China

China's economy experienced rapid growth since 2000, but its development is still mainly in urban regions. Rural migrant workers have become an important economic engine, and income from these workers, which is often transferred to their parents and children in rural areas, has led to a significant increase in rural consumption of industrial products (Wang et al., 2014). In traditional self-sufficient rural economy, waste can be reused and recycled within villages, and returned to nature (Sun, 2019). However, the variety, component, and amount of waste are becoming similar between rural and urban areas. In 2010, the annual quantity of waste from rural regions (234 million tons) exceeded that from urban regions for the first time (Wang et al., 2016).

## 2.3 The development of RSWM in China

Although rural waste has increased dramatically since 2000, the environmental governance in China showed little concern about rural regions. Before 2010, there was no standardized nor systematic SWM in rural regions (He, 2012).

In 2002, the 5th National Conference on Environmental Protection clearly proposed the idea that "environmental protection is one of the most important governmental functions." In 2005, the National People's Congress issued the Law of the Prevention and Control of Environmental Pollution by Solid Waste, which brought RSWM under public scrutiny for the first time. In 2006, the Patriotic Health Campaign Committee Office and the Ministry of Health issued the "Notice on the Investigation of the Current Situation of Rural Drinking Water and Environmental Sanitation," which is a nationwide environmental sanitation investigation that covered both urban and rural regions for the first time. In 2010, the Ministry of Environmental Protection issued the "Notice on Rural Life Pollution Control Technology Policy," which directly prohibited villagers from littering, piling up, or burning RSW. In 2015, the Ministry of Housing and Urban-rural Development collaborated with nine other ministries to issue the *Guidance on Rural Solid Waste Governance*. In January 2018, the General Office of the Communist Party of China Central Committee and the General Office of the State Council issued and distributed the *Three-Year Action Plan for the Improvement of Rural Human Settlements*.

Since 2010, RSWM special funds have been set up in three-level (national, provincial, and municipal) financial sections, and county-level governments include RSWM fees into the budget. Before that, the national public budget for community sanitation did not differentiate between urban and rural regions. The *12th Five Year Plan* proposed to build "clean and tidy villages" and to provide accompanying government investments, such as the Rural Environmental Protection Special Fund. Since 2010, the national public financial expenditure for environmental protection and community sanitation has been increasing every year. For example, in 2019 it accounted for about 4% of the total expenditure. Compared to 2018, the public expenditure for urban and rural communities together grew 16.1%.

After a series of RSWM pilot programs, the "village collection, township transfer, county treatment" united model (Figure 1) was promoted throughout China. This model is based on the "Guidance for Construction and Investment of Rural Domestic Waste Classification, Collection, Transportation and Treatment Projects" (2013) and the "Guidance on Improving Rural Human Settlements" (2014). In the RSWM framework, RSWC is the first step and the foundation of subsequent steps of RSW transfer and treatment (Cao et al., 2018). The completion rate and quality of RSWC depend on individual villagers.

## 3 Theoretical model and hypotheses

Environmental authoritarianism is a model of top-down governance to address pro-environmental issues, with limited community participation (Wang and Jiang, 2020). According to Beeson (2010), the combination of environmental crisis and authoritarian traditions has led to the prevalence of environmental authoritarianism in East Asia, particularly in China.

### 3.1 Environmental attitudes and behaviors under China's environmental authoritarianism

The theory of reasoned action posits that attitude is a key determinant of behavior (Ajzen, 1991). Our model is to identify factors affecting attitudes and behaviors towards RSWM among villagers, and to determine whether government-related factors have mediating effects under China's environmental authoritarianism.

There are two thoughts in environmental behaviors. One suggests that individuals make active choices based on personal attitude, knowledge, and demographic characteristics; while the other posits that external factors such as social norms and facilities play a more significant role. As a matter of fact, both internal and external factors can play a role in shaping individual environmental behaviors. Based on the literature and field survey, factors included in the model are promotion, social norms, environmental identity, facilities, environmental concern, satisfaction to government's RSWM jobs, gender, age, education, and family size. The following hypotheses are proposed:



**FIGURE 1**  
The management framework of RSWM in China.

**Hypothesis 1a.** (H1a). If a villager has a higher level of satisfaction with the government's RSWM jobs, he or she will be more likely to fully support RSWM.

**Hypothesis 1b.** (H1b). If a villager has a higher level of satisfaction with the government's RSWM jobs, he or she will be more likely to strictly follow the government's requirements to clear waste.

**Hypothesis 2a.** (H2a). If a villager has a higher perception that the government's promotion makes him or her more concerned about RSW, he or she will be more likely to fully support RSWM.

**Hypothesis 2b.** (H2b). If a villager perceives that the government's promotion makes him or her more concerned about RSW, he or she will be more likely to strictly follow the government's requirements to clear waste.

**Hypothesis 3a.** (H3a). If a villager has a higher perception that all neighbors follow the government's requirements to clear waste, he or she will be more likely to fully support RSWM.

**Hypothesis 3b.** (H3b). If a villager has a higher perception that all neighbors follow the government's requirements to clear waste, he or she will be more likely to strictly follow the government's requirements to clear waste.

**Hypothesis 4a.** (H4a). If a villager has a higher level of satisfaction with the local environment and has no plan to move to another place, he or she will be more likely to fully support RSWM.

**Hypothesis 4b.** (H4b). If a villager has a higher level of satisfaction with the local environment and has no plan to move to another place, he or she will be more likely to strictly follow the government's requirements to clear waste.

**Hypothesis 5a.** (H5a). If a villager has a higher perception that there are reasonable waste collection facilities in the village, he or she will be more likely to fully support RSWM.

**Hypothesis 5b.** (H5b). If a villager has a higher perception that there are reasonable waste collection facilities in the village, he or she will be more likely to strictly follow the government's requirements to clear waste.

**Hypothesis 6a.** (H6a). If a villager has a higher perception that environmental protection is not only the government's responsibility but everyone's, he or she will be more likely to fully support RSWM.

**Hypothesis 6b.** (H6b). If a villager has a higher perception that environmental protection is not only the government's responsibility but everyone's, he or she will be more likely to strictly follow the government's requirements to clear waste.

**Hypothesis 7.** (H7). If a villager reported he or she fully supports RSWM, he or she is more likely to strictly follow the government's requirements to clear waste.

Drawing upon them, a theoretical framework is formulated (Figure 2).

### 3.2 Mediating role of government-relevant factors

ABC theory of emotion is widely applied including pro-environmental research (Guagnano et al., 1995). By certain antecedents, an individual's belief (attitude) might adjust, and then relevant consequences appear (behavior). As to China's environmental authoritarianism of RSWM, the government has designed, invested, and built up a complete RSWM system for villagers. Government-relevant factors might not only directly affect villagers' attitudes and behaviors respectively, but act as a catalyst to affect the relationship between villagers' attitudes and behaviors. Therefore, the following hypotheses are proposed:

**Hypothesis 8.** (H8). Villagers' satisfaction with the government's RSWM jobs positively moderates the positive impact of villagers' RSWM attitudes to RSWC behaviors.

**Hypothesis 9.** (H9). Villagers' perception of the government's promotion positively moderates the positive impact of villagers' RSWM attitudes to RSWC behaviors.

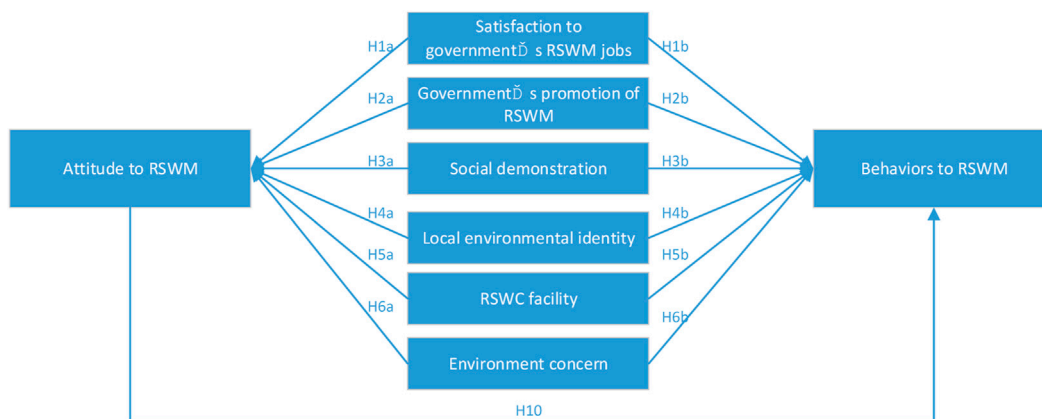
**Hypothesis 10.** (H10). Villagers' perception that "environment protection is not only government's responsibility, but everyone's" positively moderates the positive impact of villagers' RSWM attitudes to RSWC behaviors.

Drawing upon this, a theoretical framework is formulated (Figure 3).

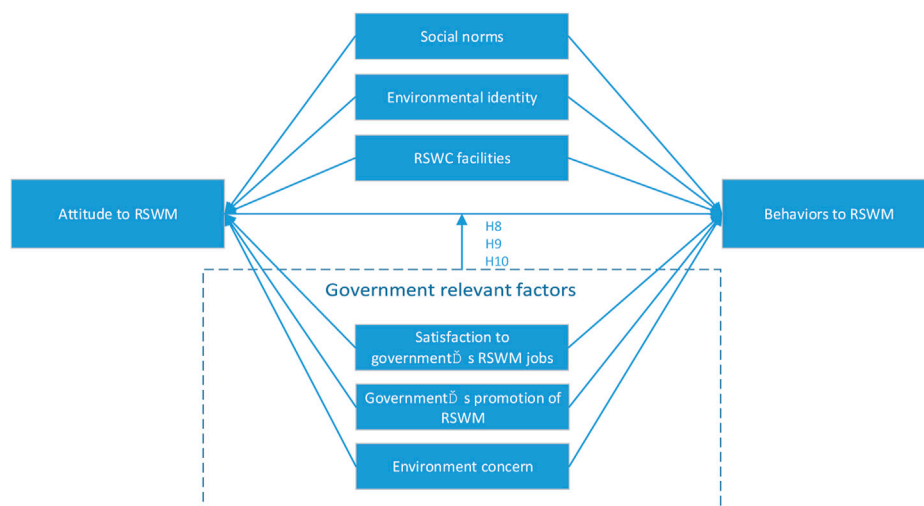
## 4 Data collection

### 4.1 Study area

The data for this study were collected through a questionnaire survey of rural households in Meizhou County, Guangdong



**FIGURE 2**  
The theoretical framework of villagers' attitudes and behaviors to RSWM.

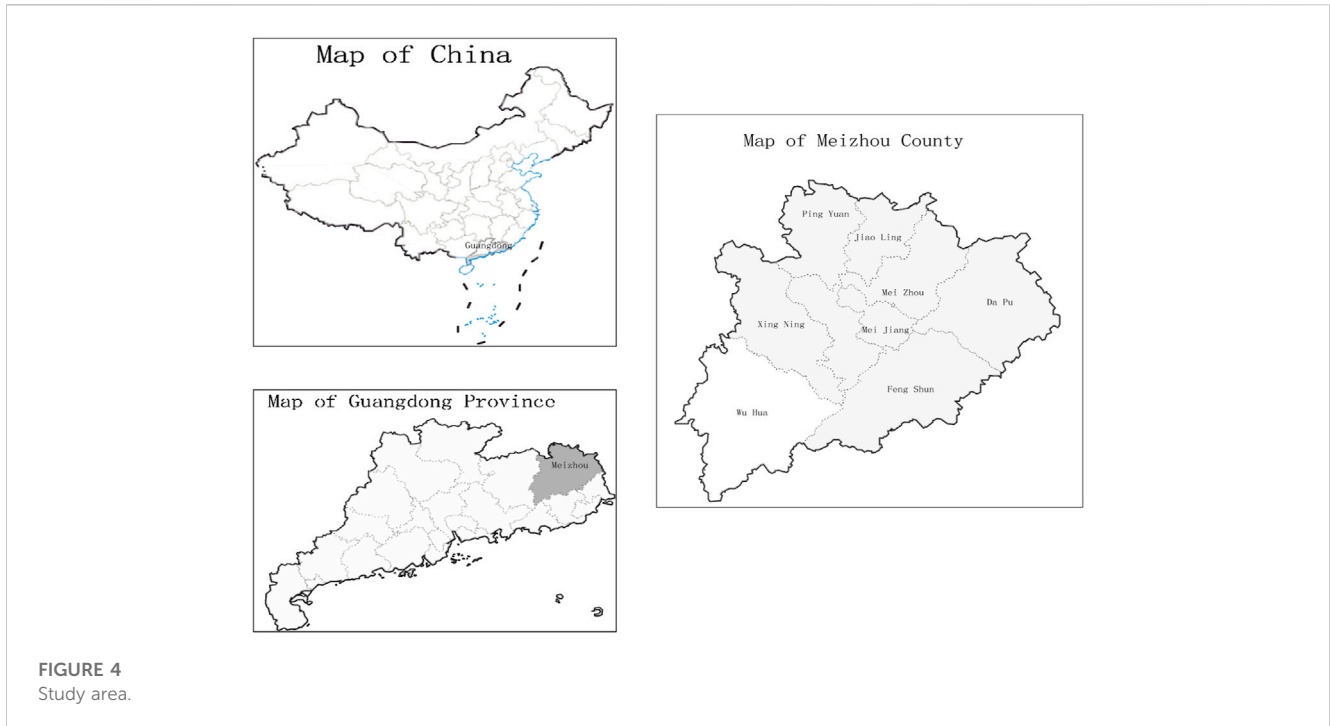


**FIGURE 3**  
The theoretical framework of mediating role of government-relevant factors.

Province in February 2020 (Figure 4). The survey was conducted in Meizhou County because it is the most representative area of environmental authoritarianism. All eight towns in Meizhou County were planned for investment, but due to COVID-19, one town (Wuhua Town) was not completed. Two villages were randomly selected from each of the seven towns, and twenty-five farmers were randomly selected from each selected village. Of the 350 rural households surveyed, 46 questionnaires were invalid due to missing key information. The final sample includes 304 households, yielding an effective survey rate of 86.86%. Meizhou County has a permanent population of 3,876,900, of which 1,846,200 live in rural areas.

In 2015, the Provincial People's Congress of Guangdong Province issued the *Regulations of Guangdong Province Urban-Rural Solid Waste Management*, which defined and clarified standards for village cleaning, rural waste handling

requirements, and waste classification specifications. In 2018, the Department of Housing and Urban-Rural Development of Guangdong Province issued and distributed *Guidelines for Rural Solid Waste Governance* to regulate the practical operation of villagers' waste management by local governments and villages. The Guangdong Province government promoted the "one county one landfill, one town one station, one village one point" policy for RSWM construction. According to data presented by the Department of Housing and Urban-Rural Development of Guangdong Province in 2018, Guangdong had constructed waste landfills in 66 counties out of 69 counties, waste treatment stations in all 1,139 towns, and waste collection points in all 198,000 villages. Additionally, about 180,000 village cleaners were on duty, and the government had provided 2.67 billion RMB in special financial funding for rural waste management (including solid waste and liquid waste)



**TABLE 1** Demographic characteristics of the respondents.

Variable	Category	Frequency	Percentage (%)
Gender	Male	166	54.61
	Female	138	45.39
Age	<20	38	12.50
	20–30	77	25.33
	31–40	37	12.17
	41–50	47	15.46
	51–60	44	14.47
	>60	61	20.07
Education	Primary school or below	52	17.11
	Junior middle school	93	30.59
	Senior middle school	59	19.41
	College or above	99	32.57
Family size	<4	48	15.12
	4	81	26.64
	5	81	26.64
	>5	94	30.92

from 2012–2017. In 2019, during an on-site promotion meeting held by the Guangdong provincial housing and urban-rural system to implement a revitalization strategy and improving the rural living environment, it was announced that the goal was to processed 100% of RSW by the end of 2020.

Meizhou County was selected as the case study sample due to its unique position as the poorest county in China’s richest province, Guangdong. In 2020, Guangdong’s GDP reached 1.61 trillion USD, the highest GDP in China for 32 years, while Meizhou County’s GDP was 17.56 billion USD, less than 1.1% of Guangdong’s GDP. Additionally, Meizhou County has the lowest *per capita* GDP at 4,535 USD. Therefore, Meizhou County is an ideal area to study the impact of RSWM funding from Guangdong provincial finance in a typical environmental authoritarianism setting.

## 4.2 Descriptive characteristics

Table 1 presents descriptive statistics for the characteristics of the survey respondents.

Table 1 shows that 54.61% ( $n = 166$ ) respondents are male. The largest age group of respondents is between 20 and 30 years old (25.33%), followed by the over-60-years-old group (20.07%), the 41-to-50-years-old group (15.46%), the 51-to-60-years-old group (14.47%), the younger-than-20-years-old group (12.17%), and the 31-to-40-years-old group (12.17%,  $n = 37$ ). The high percentage of young people in rural China during the survey period is a seasonal phenomenon that occurs every February due to schools’ winter vacation and the Spring Festival public holiday. Of the respondents, 32.57% have a college or higher education level, while a similar percentage (30.59%) have junior middle school education. 19.41% have a senior middle school education, and 17.11% only have primary education or less. The same percentage of respondents (26.64%) have 4 or 5 family members, while over 30.92% have a larger family with more than 5 members, and 15.12% have a smaller family with less than 4 members.

TABLE 2 Variables' settings and descriptions.

Variable name	Variable definition and assignment	Mean	Standard deviation	Expected sign
Attitude to RSWM	Do you fully support RSWM? 1 = yes; 0 = no	0.793	0.406	
Behaviors to RSWM	Do you strictly follow government's requirements to clear waste? 1 = yes; 0 = no	0.645	0.479	
Satisfaction to government's RSWM jobs	I am pretty satisfied with the government's work in RSWM. 1 = total not agree; 2 = not very agree; 3 = not sure; 4 = quite agree; 5 = totally agree	4.000	1.169	+
Government's promotions of RSWM	The government's promotion of RSWM makes me more concerned about the RSW issue. 1 = totally not agree; 2 = not very agree; 3 = not sure; 4 = quite agree; 5 = totally agree	4.217	1.046	+
Social norms	All neighbors follow governments' requirements to clear waste. 1 = totally not agree; 2 = not very agree; 3 = not sure; 4 = quite agree; 5 = totally agree	3.924	1.119	+
Local environment identity	I am satisfied with the local environment and will not move to other places. 1 = totally not agree; 2 = not very agree; 3 = not sure; 4 = quite agree; 5 = totally agree	4.069	0.656	+
RSWC facilities	There are reasonable waste collection facilities in my village. 1 = totally not agree; 2 = not very agree; 3 = not sure; 4 = quite agree; 5 = totally agree	3.895	1.156	+
Environmental concern	Environmental protection is not only the government's responsibility but everyone's. 1 = totally not agree; 2 = not very agree; 3 = not sure; 4 = quite agree; 5 = totally agree	4.694	0.656	+
Gender	Gender 1 = male; 2 = female	1.454	0.499	-
Age	Age 1 < 20; 2 = 20–30; 3 = 31–40; 4 = 41–50; 5 = 51–60; 6 > 61 years old	3.543	1.734	-
Education	Years of formal education	10.680	3.774	+
Family size	Family member 1 < 4; 2 = 4; 3 = 5; 4 > family members	3.697	1.126	-

## 5 Empirical analysis

This section analyzes the survey data introduced above to empirically understand the association between villagers' attitudes towards RSWM and their RSWC behaviors. Additionally, the analysis exams the impact of villagers' satisfaction with the government's RSWM jobs, RSWC social norms, local environment identity, RSWC facility situation, environmental concern, personal characteristics, and family characteristics on the aforementioned factors.

### 5.1 Variables

Table 2 presents the variables used in the empirical analysis, with the detail of variable settings and basic statistics results. Based on previous RSWM literature and an understanding from field survey, the study predicts the direction of impact on villages' RSWM attitudes and RSWC behaviors. As our study focuses on government-relevant issues. Half independent variables pertain to the governments.

### 5.2 Empirical model

This study employs logit regression to model the association between the villager's RSWM attitudes and behaviors, and a series of independent variables. Logit regression is commonly used when the dependent variable is binary. In this study, villagers' attitude towards RSWM are measured by whether they fully support RSWM or not, while their RSWC behaviors are measured by whether they strictly follow the government's RSWC rules to clear waste or not. The answer

to these two options corresponds to the different situations and attributes of each responding villager. Each villager's RSWM attitude and behavior are represented by a dummy variable, as shown below:

$$D_i = \begin{cases} 1 & \text{if a villager fully supports RSWM} \\ 0 & \text{if a villager does not fully support RSWM} \end{cases} \quad (1)$$

$$D_i = \begin{cases} 1 & \text{if a villager strictly follows RSWC rules} \\ 0 & \text{if a villager does not strictly follow RSWC rules} \end{cases} \quad (2)$$

This study constructs a binary model based on theories and practices to quantify the factors influence villagers' RSWM attitudes and RSWC behaviors.

$$\ln\left(\frac{P_i}{1 - P_i}\right) = \alpha + \sum_{n=1}^n \beta_n x_{ni} \quad (3)$$

here the dependent variable  $p_i$  represents the probability of fully support RSWM or strictly follow RSWC rules. The intercept parameter is denoted by  $\alpha$ , while  $\beta$  represents a vector of regression coefficients. Additionally,  $x_{ni}$  represents a vector of  $n$  independent variables (such as age or local environment identity).

## 6 Result and discussion

### 6.1 Factors influencing RSWM attitudes and RSWC behaviors

This study conducted a logit analysis using Stata 12 to assess the factors associated with the villagers' RSWM attitudes and RSWC behaviors. The result of the analysis are presented in Table 3.

TABLE 3 Logit regression fitted model coefficients.

Variables	Logit model to RSWM attitude	Logit model to RSWC behavior
	Coef. (Std. Err.)	Coef. (Std. Err.)
Satisfaction to government's RSWM jobs	0.465*** (0.160)	-0.125 (0.164)
Government's promotions of RSWM	-0.022 (0.179)	0.228 (0.162)
Social norms	0.009 (0.179)	-0.077 (0.166)
local environment identity	0.079 (0.175)	0.282* (0.162)
RSWC facilities	0.258 (0.166)	0.467*** (0.152)
Environmental concern	0.585** (0.235)	1.263*** (0.279)
Gender	0.342 (0.334)	0.105 (0.299)
Age	0.008 (0.127)	0.237** (0.117)
Education	-0.132** (0.057)	-0.087* (0.052)
Family size	0.057 (0.150)	-0.269* (0.146)
RSWM attitude	—	1.487*** (0.298)
_cons	-3.501** (1.619)	-7.329*** (1.723)

Note: \*, \*\*, \*\*\* represent significant differences at the 10%, 5%, and 1% levels, respectively; the values in parentheses are standard deviation.

The estimated coefficients of the logit model reveal that three of the ten selected variables are statistically significant for RSWM attitudes; while six of the ten are significant for RSWC behaviors. The RSWM attitude significantly influences RSWC behaviors at the 1% level. Among the three significant influencing factors, positive factors for villagers' RSWM attitudes include being satisfied with the government's RSWM jobs and the environmental concern. Contrary to the predictions, the education variable has a negative effect on villagers' RSWM attitudes. Regarding villagers' RSWC behaviors, positive factors include local environment identity, RSWC facilities, environmental concern, and age, while negative factors are education level and family size. The variables of age and education are opposite to predictions. In summary, this study supports H1a, H6a, H4b, H5b, H6b, and H7.

The coefficient of the variable "satisfaction to government's RSWM jobs" is positively and significantly associated with villagers' RSWM attitudes at the 1% level. This finding is consistent with previous literature both in urban (Wan et al., 2015) and rural areas (Ma et al., 2020). A study in a rapidly urbanizing area in Thailand also found that increased government spending on SWM (such as on-time waste collection), improves individuals' waste clearing performance (Yukaling et al., 2018). Conversely, a in Lebanon found that insufficient government funding and effects are serious obstacles to waste management and could even lead to a trash crisis (Ahad et al., 2020). In Ma et al.'s (2020) study, the government's RSWM policy instruments not only directly affect behaviors but also indirectly affect them through individuals' perceived value. The study explain that in rural China, villagers' consideration of RSWM does not depend on personal feelings about the environment, but rather on governmental policy. This is an example of the ideal state of authoritarian management (Gilley, 2012). However, in our study, "satisfaction with government's RSWM jobs" is not statistically significant for villagers' RSWC

behaviors. This is a drawback of authoritarian, as insufficient public participation may make it more difficult to implement practical action. Other empirical studies also reveal a gap between intention and behavior in waste management (Zhang et al., 2020; Zhou et al., 2023) and another possible reason is the obstacles to follow RSWC rules at the execution level, such as convenient facilities.

As for the local environment identity, the variable "being satisfied with the local environment and not planning to move to another place" has a positive and significant impact on villagers' RSWC behaviors at the 10% level. This supports the finding from Candelo et al. (2017) that individuals with higher levels of local identity contribute more to local public goods. However, in contrast to the findings of Hernandez, et al. (2010) and Pei (2019), our study finds no significant effect of villagers' local environmental identity on their RSWM attitudes. One possible reason for this discrepancy is the gap between pro-environmental intention and support for detailed RSWM, which may be explained by a lack of participation.

Reasonable RSWC facilities has a positive effect on villagers' RSWC behaviors at the 1% level. When villagers perceive that they have reasonable RSWC facilities, they are more likely to follow waste disposal rules accurately. It is generally understood that better RSWC facilities make it more convenient for villagers to complete RSWC tasks. Researchers have explained that sufficient bins, more funding, and more services demonstrate the government's strong political determination, which can increase people's willingness to follow RSWC rules (Yuka et al., 2018; Ma et al., 2020). However, our study find no significant relationship between reasonable facilities and villagers' RSWM attitudes. One possible explanation is that RSWC facilities are provided free of charge by the government, but are not sought after or demanded by villagers. Therefore, the sufficiency of RSWC facilities is not related to their environmental attitudes.



The variable of environmental concern has a positive and significant effect on both villagers' RSWM attitudes (at the 5% level) and RSWC behaviors (at the 1% level). In our survey, the environment concern variable refers to villagers' subjective judgment of their responsibility to the environment beyond the idea that pro-environmental action are solely the responsibility of the government. We find that villagers who are aware of their personal responsibility to the environment, in addition to governments' responsibility, were more likely to fully support RSWM and accurately follow RSWC rules. Public awareness is an important factor that influences environmental behaviors (Dhokhikah et al., 2015). Individuals feel proud when their behaviors align with their moral concern, and guilty when they do not (Onwezen et al., 2013).

The variable of age has a statistically significant effect on RSWC behaviors at the 1% level. Wang et al. (2018) found out that young people are more likely to participate in pro-environmental behaviors because they are more receptive to pro-environmental information. In contrast, a survey of RSWM across 12 provinces in China found out that older respondents are more likely to pay for RSWM, possible because they are more involved in RSWC works and more concerned about RSWM quality (Zeng et al., 2016). However, our study finds no significant correlation between age and RSWM attitude. One possible explanation is that although the older generation in rural China has less education and updated information, they strongly trust the government, and are more willing to follow governments guidelines than to act on their environmental attitudes. A similar explanation to pro-environmental behaviors is found in a Vietnamese case study (Nguyen et al., 2019), which shares cultural roots and political history with China.

The education variable has a negative statistically significant effect on RSWM attitudes at the 5% level and a negative effect on RSWC behaviors at the 10% level, which is opposite to expectation. We find that villagers who have received more formal education are less likely to fully support RSWM and strictly follow RSWC rules. This contradicts most literature, which suggests that people with higher education levels are more positive toward pro-environment behaviors. The common explanation is that education can improve an individual's environmental awareness (Song et al., 2016; Triguero et al., 2016). However, a survey in Guilin (Ma et al., 2018) and another in Suzhou (Zhang et al., 2014) also found that there is a significantly negative relationship between an individual's education level and pro-environmental intention. One possible explanation for the negative effect of education on pro-environmental is that while education can improve an individual's environmental awareness, it can also expose them to a bigger picture of environmental issues, leading to less trust in governments and traditional bureaucratic system. This is particularly relevant in China, which is currently undergoing a rural-urban dual structure that creates significant differences in social culture and economic opportunities between rural and urban areas. Specifically, villagers who receive middle school education are more likely to leave villages from towns, while those who receive higher education tend to move to cities. In rural China, educated villagers are more independent in decision-making, while others are more likely to rely on government guidance.

The variable of family size has a significantly negative effect on RSWC behaviors at the 10% level. This means that families with

more members are less likely to strictly follow government RSWC rules. This finding is consistent with previous studies (Kang et al., 2018) and can be explained by the fact that larger families generate more waste (Han et al., 2018), which creates higher pressure in waste collection tasks. However, family size does not significantly affect RSWM attitudes. One possible reason for this is that the environmental attitudes are more personal and have less to do with family size.

A positive and significant coefficient at the 1% level when RSWM attitude was set as an independent variable and RSWC as a dependent variable. This suggests that villagers who fully support RSWM in attitude are more likely to strictly follow RSWC rules in behavior. This finding is consistent with previous researches on RSWM in China (Zhang et al., 2015; Ma et al., 2018), and can be explained by the theory of planned behavior (TPB), which posits that an individual's behavior is primarily determined by their behavioral intention (Ajzen and Fishbein, 2005). TPB theory is widely applied to pro-environmental behaviors research, and most indicate that attitude plays the most significant role in the predicting intention, which in turn positively affects behavior.

## 6.2 Moderating effect of government-relevant factors

To further assess the government-relevant factors associated with the villagers' RSWC behaviors, we set variables of satisfaction with government RSWM jobs, government promotions of RSWM, and environmental concern as moderators. Table 4 presents the logit analysis results with interactive items of moderators and variables of villagers' RSWM attitudes. Model 1 is the logit regression of 10 independent variables and villagers' RSWC behaviors. In Model 2, we added interactive items of the variable of satisfaction with the government's RSWM jobs and the RSWM attitude to Model 1. In Model 3, we added interactive items of the variable of government promotions of RSWM and the RSWM attitude to Model 1. In Model 4, we added interactive items of the variable of environmental concern and the RSWM attitude to Model 1.

All three moderators have significantly positive moderating effects on the relationship between villagers' RSWM attitudes and RSWC behaviors. The finding supports H8, H9, and H10.

The interactive item of RSWM attitudes and satisfaction with the government's RSWM jobs has a significantly positive effect on villagers' RSWC behaviors at the 10% level. Specifically, villagers who are more satisfied with the government's RSWM are more likely to exhibit a positive RSWM attitude towards practical RSWC behaviors, that is, strictly following the government's rules for waste disposal. Additionally, the interactive item of RSWM attitudes and the government's promotions of RSWM also has a significantly positive effect on villagers' RSWC behaviors at the 10% level. Villagers who agree more strongly that the government's promotions make them more concerned about RSW issues are more likely to exhibit a positive RSWM attitude in personal practice. Finally, the interactive item of RSWM attitudes and environmental concern has a significantly positive effect on villagers' RSWC behaviors at the 5% level. Villagers who agree more strongly that "environmental protection is not only

TABLE 4 Logit regression fitted model coefficients of moderating effect.

Variables	Model 1	Model 2	Model 3	Model 4
Satisfaction to government's RSWM jobs	-0.125 (0.164)	-0.282 (0.186)	-0.150 (0.163)	-0.163 (0.164)
Government's promotions of RSWM	0.228 (0.162)	0.226 (0.163)	0.092 (0.178)	0.227 (0.164)
Social norms	-0.077 (0.166)	-0.094 (0.168)	-0.090 (0.167)	-0.086 (0.168)
local environment identity	0.282* (0.162)	0.279* (0.162)	0.268* (0.161)	0.271* (0.161)
RSWC facilities	0.467*** (0.152)	0.449*** (0.153)	0.459*** (0.153)	0.454*** (0.153)
Environmental concern	1.263*** (0.279)	1.211*** (0.279)	1.225*** (0.279)	1.093*** (0.288)
Gender	0.105 (0.299)	0.080 (0.301)	0.080 (0.301)	0.081 (0.301)
Age	0.237** (0.117)	0.236** (0.118)	0.243* (0.118)	0.242** (0.119)
Education	-0.087* (0.052)	-0.082* (0.053)	-0.074 (0.053)	-0.071 (0.053)
Family size	-0.269* (0.146)	-0.274* (0.147)	-0.287* (0.148)	-0.288* (0.148)
RSWM attitude * satisfaction to government's RSWM jobs		0.172* (0.097)		
RSWM attitude * government's promotions of RSWM			0.155* (0.087)	
RSWM attitude * environmental concern				0.156** (0.076)
_cons	-7.329*** (1.723)	-6.958 (1.732)	-6.913 (1.730)	-6.897 (1.738)

Note: \*, \*\*, \*\*\* represent significant differences at the 10%, 5%, and 1% levels, respectively; the values in parentheses are standard deviation.

government's responsibility but everyone's" are more likely to exhibit a positive RSWM attitude towards RSWC behaviors.

## 7 Conclusion and limitation

Our study in Meizhou County, the poorest county in the richest province (Guangdong) in China, provides insight into the RSWM attitudes and behaviors among villagers in the context of authoritarian environmental governance with significant investment and new policies. The survey results shed light on the factors that influence Chinese villagers' approach to environment protection, which is a typical example of a public good led by governments in the top-down linear path.

The study finds that almost 80% of villagers fully support RSWM, and their positive attitude towards RSWM is a relatively persistent and stable psychological construct that is only influenced by a few external factors. Governments' RSWM promotions, neighbors' RSWC behaviors, the satisfaction of the local environment, and RSWC facilities have no statistical relevance to villagers' RSWM attitudes. Only three factors significantly affect villagers' RSWM attitudes, two of which are positively related to governments, including satisfaction with government RSWM jobs and the belief that environmental protection is not only government's responsibility but everyone's. Additionally, the study finds a high positive correlation between RSWM attitudes and RSWC behaviors. In summary, the government is a key positive factor influencing villagers' RSWM attitudes in China, leading to high participation in RSWC. The study suggests that governments should focus on making villagers satisfied with their RSWM jobs and promoting the idea that the responsibility of RSWM belong to everyone, not just the government.

Regarding RSWC behaviors, almost 65% of villagers claim to strictly follow RSWC rules, and have more statistically significant

influencing factors compared to RSWM attitudes. Interestingly, satisfaction with governments' RSWM jobs does not significantly affect villagers' RSWC behaviors, but factors including local environment identity, RSWC facilities, environmental concern about responsibility, age, education, and family size do. Therefore, villagers' RSWC behaviors are not influenced by external factors, including satisfaction of government RSWM jobs, promotions, neighbors' behaviors, but rather by personal ideas and characteristics. The study suggests that there should be less investment in RSWM promotions and more in RSWC facilities.

All three government-relevant variables have a significantly positive moderating effect on the relationship between RSWM attitudes and RSWC behaviors. In rural China, although government-relevant factors do not directly affect villagers' RSWC behaviors, they indirectly affect their RSWC behaviors by shaping their RSWM attitudes. Specifically, the study finds that the efficiency of government RSWM jobs leads to proper RSWC behaviors among villagers.

The survey finds that, contrary to common understanding, education has a negative impact on both RSWM attitudes and RSWC behaviors among Chinese villagers. Additionally, there is a significant gap in socioeconomic and social psychology between rural and urban areas in China. Less-educated villagers, who are typically older, tend to a strongly trust in the government, while educated villagers who leave rural regions and have studying and living experiences in urban regions, have broader horizons and their own insights. The study suggests that the current government RSWM policy is effective for a large percentage of villagers, particularly the older generation who are regulated residents in rural China. However, as time passes, governments should update their RSWM policy measures to take the new generation into greater consideration. Participatory governance can be one of the optimization directions.

This study limited by its used of data from only one county. While Meizhou is an appropriate sample, further studies should include more sample areas for comparative analysis. Additionally, this survey relied on self-reports rather than direct observation to measure respondents' behaviors. These limitations will be addressed in future studies.

## Data availability statement

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

## Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

## Author contributions

Conceptualization, HIL; methodology, HAL; formal analysis, HIL and HAL; investigation, HIL and DH; resources, QM and JL; data curation, DH and JL; writing—original draft preparation, HIL and DH; writing—review and editing, JL; supervision, HAL; All authors contributed to the article and approved the submitted version.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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