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Study on the impact of social capital on the rural residents' conscious interpersonal waste separation behavior: evidence from Jiangxi province, China

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Guiding rural residents to implement interpersonal waste separation in their daily lives consciously is crucial for controlling solid waste pollution in developing countries. This paper utilizes survey data from Jiangxi Province which is one of the national pilot zones for ecological conservation in China to analyze the impact of the social capital that includes social networks, social trust, and social norms on the rural residents' conscious interpersonal waste separation behavior. The empirical results indicate that social capital has a positive effect on the rural residents' conscious interpersonal waste separation behavior, wherein the effects of social networks and social trust are significant. Among the three dimensions of social capital, social networks and social norms are substitutable, while social trust and social norms have a complementary effect on each other. Moreover, the ecological cognition and subjective norm play a significant mediating role in the relationship between social network, social trust, and social norms and the rural residents' conscious interpersonal waste separation behavior, while the government policies plays a significant moderating effect.

KEYWORDS

social capital, conscious interpersonal waste separation behavior, rural residents, ecological cognition, China

1 Introduction

Proper disposal of waste has become an urgent problem all over the world. The World Bank's report points out that global waste will increase by 70% by 2050 without any intervention (Kaza et al., 2018). In China, the representative of developing countries, the amount of waste produced has increased continuously with economic growth in recent years, and the annual growth rate of the rural residents' *per capita* solid waste has reached 8% to 10 (Moh and Manaf, 2013). Thus, the proper disposal of waste in China is not only an important way to improve the living environment and achieve green development for itself, but also provides policy enlightenment for other developing countries worldwide.

There are several dimensions of social capital, and the existing research has explored the impact of different dimensions of social capital such as social network, social prestige and social engagement on residents' waste separation behavior (Cao et al., 2023), and it has been confirmed that the impact is significant by researchers (Ling and Xu, 2020; Hua et al., 2021; Wang and Zhang, 2022; Wang et al., 2023). However, the mechanism is not clear yet.

Moreover, these studies consider the dimensions of social capital to be independent of each other, but some researchers have suggested that the dimensions of social capital have interactive effects (Hsu and Hung, 2013; Zhang et al., 2023; Saleem and Zhang, 2024). Existing research has not yet focused on the interaction between the dimensions of social capital on residents' waste separation behavior. Additionally, urban residents' waste separation behavior can be categorized into habitual separation behavior, decision-making separation behavior, interpersonal separation behavior, and civic separation behavior and the factors affecting the waste separation behavior vary significantly among different types (Chen, 2018). The residents' interpersonal waste separation behavior represents their participation in the activity. However, few researchers have primarily addressed the influence of social capital on the residents' interpersonal waste separation behavior. In the context of rural China, where social relations are complex, the life behavior of residents is deeply embedded in the social capital, with social networks, social trust and social norms as the core elements (Bian, 1997). It remains to be further studied the impact of different dimensions of social capital on rural residents' conscious interpersonal waste separation behavior.

Therefore, this paper discusses the interaction and the mechanism of social capital on the rural residents' conscious interpersonal household waste separation behavior, with a focus on the division of social capital into social networks, social trust, and social norms. To explain the mechanism, this paper introduces the mediating effect test of ecological cognition and subjective norm. The aim is to offer a reference that guides rural residents in consciously motivating others to participate in waste separation during interpersonal activities, thereby enhancing the human ecological environment.

The remaining sections are as follows. Section 2 presents the research hypothesis. Section 3 describes the methods, including the research area, the survey design, the samples and data collection, as well as the regression model. Section 4 reports the empirical results. Section 5 discusses the results and provides the policy implications. The last section summarizes the conclusions.

2 Theoretical analysis and research hypothesis

2.1 Social capital and rural residents' conscious interpersonal household waste separation behavior

According to social capital theory, social capital has an important impact on individual behavior and decision-making (Putnam, 1993). The existing studies have also shown that social capital will affect farmers' pro-environmental behavior decisions. For example, Yang et al. (2020) find that social capital helps farmers overcome the difficulties of applying organic fertilizer. The social capital includes the social network, social trust and social norms (Putnam, 1993). The social network encompasses the interconnectedness of individuals, while social trust denotes the level of trust and confidence individuals have towards each other, and social norms represent the shared rules, standards, and expectations that govern social behavior within the society. Accordingly, social capital may affect the rural residents' conscious interpersonal waste separation behavior through these three dimensions.

The social embedding theory argues that individuals are not completely independent when making decisions of their behaviors, and the social network embedded by the individuals will change their perception and affect their behavior and decision-making by providing them with information (Killworth and Bernard, 1974). Moreover, because the rural residents are in a rural society linked by consanguinity, kinship, and business relationship (Fei, 2012), they can get timely and accurate information and government policies on waste separation when they communicate with others. When the rural residents have more contact with others, they will get more comprehensive information about the waste separation and then have a better understanding of the ecological benefits brought by the waste separation, which is conducive to stimulating their inner awareness of environmental protection. Driven by environmental awareness, rural residents may take the initiative to appeal to others to separate waste in their lives to protect the ecological environment.

The trust theory suggests that when individuals interact with others based on trust, the sharing of knowledge and the exchange of information will affect the individual's thoughts and attitude, which leads to the change in the individual's behavior decision (Uslaner and Conley, 2003; Jing et al., 2017; Harring et al., 2019). Accordingly, the rural residents communicate and interact with family and friends in their daily lives out of trust towards them (Granovetter, 1985). Then, they can easily acquire the relevant knowledge of waste separation in communication and interaction, which will help them fully realize the important value of waste separation to the ecological environment, and affirm the necessity and rationality of waste separation for rural residents. As a result, the rural residents may actively suggest their relatives and friends to participate in waste separation in their lives.

The normative focus theory points out that when a certain social norm gains the focus of individual attention, the social norm will guide the occurrence of individual behavior by changing intrinsic values (Cialdini et al., 1990). Many scholars have confirmed the important role of social norms in activating individual pro environmental behavior (Sparkman and Walton, 2017; Bergquist et al., 2019). According to this, when the majority of the rural residents support the view that everyone should participate in waste separation, others may be affected by their imperceptible influence to realize that waste separation by everyone is highly respected in rural society, and that any violation will be met with isolation and unfriendly attitudes. As the rural residents are the members of the rural "acquaintance society", who are concerned about the attitudes of others towards them, they will adopt the environmental protection idea that everyone should participate in the waste separation, which is similar or consistent with those of the majority in rural areas, in order to avoid being isolated or receiving unfriendly attitudes from others. Thus, the rural residents will take the initiative to remind, stop, and persuade others to change their behavior and participate in waste separation together. Based on this, this paper proposes the following hypothesis:

Hypothesis 1: Social capital has a direct impact on rural residents' conscious interpersonal waste separation behavior.

Hypothesis 1a: Social networks have a direct impact on rural residents' conscious interpersonal waste separation behavior.

Hypothesis 1b: Social trust has a direct impact on rural residents' conscious interpersonal waste separation behavior.

Hypothesis 1c: The social norms have a direct impact on rural residents' conscious interpersonal waste separation behavior.

2.2 The interaction of the dimensions of social capital

Previous studies have shown that the pairwise interactions of various dimensions of social capital affect individual behavioral decision-making. For example, Zou et al. (2020) find that the interaction between social networks and social norms will encourage rural residents to withdraw from homestead. Zhang et al. (2023) found that village level trust and various dimensions of social capital jointly affect the farmers' climate-related disaster adaptation behavior. Similarly, the rural residents' conscious interpersonal waste separation is also a kind of behavioral decision. Then the pairwise interaction between the dimensions of the social capital may also play a role in the process, which leads to the following hypotheses:

Hypothesis 2: The pairwise interactions between the dimensions of the social capital affect the rural residents' conscious interpersonal waste separation behavior.

2.3 The mediating effect of social cognition

The social cognitive theory presents that the environment affects individual cognition (Putnam, 1993). Accordingly, social capital, as a special form of the social environment, can also influence the rural residents' conscious interpersonal waste separation. Existing studies also show that social capital affects residents' ecological cognition (Xiao et al., 2021). From the view of social networks, rural residents can exchange experiences on waste separation with their neighbors, relatives, and friends, which helps them accumulate knowledge about waste separation to improve their ecological awareness. From the view of social trust, the rural residents' understanding of waste separation and their ecological awareness will be developed in the process of sharing and exchanging the knowledge and policies of waste separation out of their trust in their family and friends. From the view of social norms, when the rural residents actively consider and accept the idea of waste separation to integrate into the group in which the majority promotes this pro-environment activity, their ecological cognition of environmental protection behavior such as waste separation will be formed. Therefore, the following hypotheses are proposed:

Hypothesis 3: Social capital has a positive effect on rural residents' ecological cognition.

Hypothesis 3a: Social networks have a positive effect on rural residents' ecological cognition.

Hypothesis 3b: Social trust has a positive effect on rural residents' ecological cognition.

Hypothesis 3c: The social norms have a positive impact on rural residents' ecological cognition.

The behavioral economic theory suggests that cognition is the prerequisite for individual behavioral decision-making, so the individual's perception of things will affect their behavioral preferences and intentions (Ajzen, 1991). Accordingly, when the rural residents realize that the failure of the waste separation will cause water and soil pollution and lead to ecological imbalance, while the proper implementation of waste separation can lead to the reutilization of resources and protect the ecological environment, they may have a positive attitude towards the waste separation and form the environmental protection concepts of waste separation. With these environmental protection concepts, rural residents may take the initiative to publicize the ecological benefits of waste separation to their relatives and friends and guide others to carry out the waste separation in their daily lives. Notably, previous studies also indicate that individuals' ecological cognition can influence their pro-environmental behavior (Kotchen and Reiling, 2000; Halkos and Matsiori, 2014; Paço and Lavrador, 2017; Chen et al., 2022). Therefore, this paper proposes the following hypothesis:

Hypothesis 4: Ecological cognition has a positive impact on the rural residents' conscious interpersonal waste separation behavior.

2.4 The mediating effect of subjective norm

Subjective norms refer to the social pressure perceived by individuals when implementing a certain behavior, mainly derived from external information and human factors (Mayer et al., 1995). In terms of rural environment, social capital measures the collection of resources obtained by rural residents in the process of social interaction and connection with others, playing as one of the sources of subjective norms for garbage separation formed by rural residents. In terms of social networks, frequent communication and discussion among family and friends about household waste separation may lead rural residents to understand the healthy, environmental, and economic benefits related to household waste separation, which can help stimulate their belief in the need for household waste separation. In terms of social trust, the lack of separation of household waste can lead to environmental pollution and health threats, which can have adverse effects on oneself and others. In an environment where people are familiar with each other and mutually benefit, when rural residents are aware of the consequences of not classifying garbage, they may feel the need to sort it in their daily lives. In terms of social norms, when most rural residents carry out garbage separation in their daily lives and the government vigorously promotes garbage separation policies, it sends a signal of responsibility to rural residents to carry out garbage separation, helping them establish the concept of garbage separation. In addition, research by scholars has confirmed that social capital may affect the subjective norms of residents (He et al., 2022; Xu et al., 2024). Based on this, the following assumptions are proposed:

Hypothesis 5: Social capital has a positive impact on the ecological cognition of rural residents.

Hypothesis 5a: Social networks have a positive impact on the ecological cognition of rural residents.

Hypothesis 5b: Social trust has a positive impact on the ecological cognition of rural residents.

Hypothesis 5c: Social norms have a positive impact on the ecological cognition of rural residents.

The Theory of Planned Behavior suggests that subjective norms can influence individual behavioral decisions (Ajzen, 1991; Wang et al., 2018). Many studies have shown that subjective norms have a positive impact on guiding rural residents to implement household waste classification behavior. In rural areas, residents perceive a strong expectation from people around them, such as family and neighbors, to classify their household waste. They often choose to follow the expectations of those around them, generate a strong willingness to classify waste, actively participate in household waste classification, and actively advise others to reduce waste pollution in their daily lives. Therefore, the following assumptions are proposed:

Hypothesis 6: Subjective norms have a positive impact on the conscious interpersonal garbage classification behavior of rural residents.

2.5 The moderating effect of government policy

In theory, the impact of social capital on the behavior of rural residents will vary depending on differences in government policies. On the one hand, government policies may help social capital guide rural residents to consciously implement interpersonal waste sorting behavior. The government's promotion of garbage classification policies has expanded the channels for rural residents to acquire knowledge of household garbage classification. The garbage classification facilities provided by the government can provide convenience for rural residents to carry out garbage classification. In this context, rural residents are more likely to quickly learn about household waste classification policies through social interactions with others, and the information they obtain about household waste classification may be more comprehensive and accurate. Therefore, they have a stronger sense of identification and understanding of household waste classification policies, which is conducive to actively discussing household waste classification with their surrounding relatives and friends, and actively teaching household waste classification skills. On the other hand, government policies may also lead to negative impacts of social capital on the conscious interpersonal garbage sorting behavior of rural residents. Government policies regulate the behavior of residents through behavior guidance and value guidance (He et al., 2022), and the promotion of household waste classification policies in rural areas cannot do without the support and support of rural acquaintance society (Jiang and Li, 2023). The government's promotion of the four-classification system for household waste poses significant behavioral challenges for rural residents, or if administrative measures are too strict, it may lead to fear or resistance towards household waste classification behavior among rural residents. Rural residents with large social networks and a core position in their relationship networks may lead others to make negative evaluations of government policies, resulting in poor enthusiasm and participation in household waste classification, and even hinder others from doing so. At this point, the implementation of government policies may lead to a negative impact of social capital on the conscious interpersonal garbage sorting behavior of rural residents. Based on the above analysis, this article proposes the following assumptions:

Hypothesis 7: Government policies has a moderating effect on the relationship between social capital and the conscious interpersonal garbage separation behavior of rural residents.

Based on the above analysis, this paper constructs a theoretical analysis model of the impact of social capital on the rural residents' conscious interpersonal waste separation behavior (Figure 1).

3 Materials and methods

3.1 Regression model

This paper utilizes a regression model for analysis. Considering that the dependent variable, rural residents' conscious interpersonal waste separation behavior, is measured by the average score of three items and treated as a continuous variable, we construct the following regress model to analyze whether social capital has an impact on rural residents' conscious interpersonal waste separation behavior:

$$\boldsymbol{Y = \alpha_0 + \alpha_1 ZB_i + \alpha_2 Con + \varepsilon_1} \quad (1)$$

In this equation, Y stands for the rural residents' conscious interpersonal waste separation behavior, ZB_i denotes the social capital, including social network, social trust and social norms. Con is a collection of a series of control variables, such as ecological values, gender, age and income, etc., and ε_1 is a random error term.

Given that the impact of each dimension of social capital on individual behavior is interdependent (Zou et al., 2020), this study introduces pairwise interaction terms among the three dimensions of social network, social trust, and social norms in the baseline regression model, to investigate the interactive effects of each dimension. The constructed model is as follows:

$$\boldsymbol{Y = \beta_0 + \beta_1 WL + \beta_2 XR + \beta_3 GF + \beta_4 WL^{*} XR + \beta_5 WL^{*} GF + \beta_6 XR^{*} GF + \beta_7 Con + \varepsilon_2} \quad (2)$$

Where, the variable, WL, XR and GF denote the social network, social trust and social norms respectively. The interaction terms of social network and social trust, social network and social norms, and social trust and social norms are shown as $WL^{*}XR$、 $WL^{*}GF$, $XR^{*}GF$ respectively. The meanings of other variables are consistent with Eq. 1.

Moreover, this paper examines the mediation role of the ecological cognition in the relationship between social capital and the rural residents' conscious interpersonal waste separation behavior with the aim to examine whether social networks, social trust, and social norms can indirectly influence rural residents' conscious interpersonal waste separation behavior through ecological cognition. Based on the research of Wen and Ye (2014), the

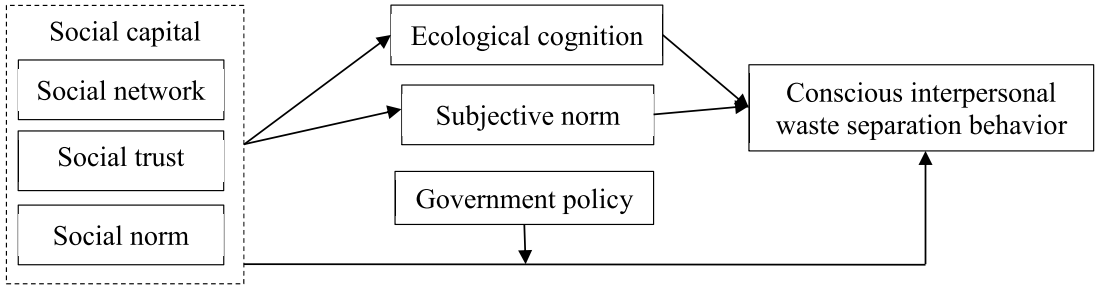

FIGURE 1
The theoretical analysis model.

mediating mechanism of ecological cognition is tested using the stepwise regression method, and the model is constructed as follows:

$$Y = \vartheta_0 + \vartheta_1 \mathrm{WL} + \vartheta_2 \mathrm{XR} + \vartheta_3 \mathrm{GF} + \vartheta_4 Con + \varepsilon_3 \quad (3)$$

$$M_i = \gamma_0 + \gamma_1 \mathrm{WL} + \gamma_2 \mathrm{XR} + \gamma_3 \mathrm{GF} + \gamma_4 Con + \varepsilon_4 \quad (i = 1, 2) \quad (4)$$

$$Y = \mu_0 + \mu_1 \mathrm{WL} + \mu_2 \mathrm{XR} + \mu_3 \mathrm{GF} + \mu_4 Mi + \mu_5 Con + \varepsilon_5 \ (i = 1, 2) \quad (5)$$

Where the variable $M_i\ (i, 2)$ respectively denote ecological cognition and subjective norm, and the meanings of the other variables are consistent with Eq. 2.

3.2 Study area

This research takes Jiangxi Province as a study area which is located in the southeast of China. Selected as the first batch of national pilot zones for ecological conservation with a good ecological foundation in 2014, Jiangxi Province has achieved comprehensive implementation of household waste separation in rural areas. As of March 2022, 14 counties (cities, districts) in Jiangxi Province have started the pilot of rural household waste separation, including four national demonstration counties such as Graungfeng City in Shangrao City, Ruichang City in Jiujiang city, Chongyi county in Ganzhou city and Jing'an county in Yichun city. However, the key to implement the normalization of waste separation effectively is the initiative of rural residents to conduct waste separation. At present, the embedding of social capital into rural environmental governance has become an important method to alleviate rural environmental pollution (Cao et al., 2023; Xu et al., 2024). It is very important for rural residents to actively promote others to separate waste at its source in their daily lives through interpersonal activities, which is crucial for protecting and consolidating the existing achievements of ecological civilization construction. Therefore, considering its representativeness, this paper selects Jiangxi as the study area to explore the impact of social capital on the rural residents' conscious interpersonal household waste separation behavior.

3.3 Survey design

The survey questionnaire of this study includes the following three parts. The first part concerns the rural residents' conscious interpersonal waste separation behavior. Refer to Chen et al. (2017), we designed three questions such as " I will take the initiative to persuade my relatives and friends around me to carry out waste separation", which are measured by a 5-point Likert scale that 1 represents for strongly disagree and 5 for strongly agree. The second part includes questions related to social capital and its dimensions, ecological cognition, as well as ecological values. According to Putnam (1993), we consider three dimensions of social capital: social network, social trust and social norm, which are measured by the questions that " I often talk to my friends and family about environmental issues", " I have a high level of trust in environmental laws and regulations", " People around me are ashamed of destroying the ecological environment" respectively. The social capital is measured as the mean of these three dimensions. Ecological cognition is measured by the question "I have a high level of knowledge about rural ecological protection" referring to Halkos and Matsiori (2014). The ecological values are measured by three questions such as "I would like to protect the environment in my daily life" according to Stern et al. (1999). Subjective norm is measured using the Cordano and Frieze (2000) scale, which included three questions: "Classifying household waste is more in line with my status", and 5-point Likert scale is used for measurement. The government policy draws on the research of Chen (2018) and selects "whether there are facilities for sorting and disposing of household waste in your village (such as garbage bins for sorting and disposing)" for measurement, where 0 = none and 1 = yes. The third part regards the respondents' socio-demographic characteristics including gender, age, income, and education level.

3.4 Sample and data collection

To ensure the quality of the survey, the survey steps are as follows: First, we selected the samples for pre-survey using the stratified random sampling method according to the economic development level of the regions in Jiangxi Province and the characteristics of the distribution of pilot projects on the rural households' waste separation. A total of 160 samples were collected through an online questionnaire survey system and then preliminary tests on the data were conducted to assess their reliability and validity. After eliminating variables with unsatisfactory reliability and validity, and trimming unnecessary questions, the formal questionnaire was formed. Secondly, we adopted various methods such as random

TABLE 1 Description of the basic characteristics of the rural population of the sample.

Variable	Category	Frequency	Percentage (%)
Gender	Male	390	54.78
	Female	322	45.22
Income	≤10,000	188	26.4
	10,000–30,000	217	30.47
	30,000–50,000	168	23.6
	50,000–80,000	86	12.08
	≥80,000	53	7.44

household visits, group interviews, random visits, and online questionnaires to conduct the investigation. A total of 774 samples were collected. Finally, we excluded the invalid samples and there are 712 valid samples obtained, with a validity rate of 92%.

4 Results

4.1 Demographic profile of the respondents

Table 1 displays the descriptive statistics of the sample. The respondents are primarily male, making up 54.78% of the total. The overall income level is relatively low, with 56.17% of the samples having an annual *per capita* income of less than 30,000 yuan, 35.23% of the samples between 30,000 and 80,000 yuan, and 8.60% of the samples more than 80,000 yuan. Compared with the Jiangxi Statistical Yearbook 2022 which states that the male population accounted for 51.70% of the total population and the average annual income of rural residents was 23,400 yuan in Jiangxi Province in 2021, it is evident that the gender distribution and income structure of the samples align with the actual situation in Jiangxi Province, which suggests that the survey data is somewhat representative.

4.2 The common method biases test

To prevent common method bias from affecting the research results, this paper employs the Harman single-factor test method for testing. Using Stata 16.0, we conducted an exploratory factor analysis on all items in the questionnaire. The load value of the first principal component, which was obtained without rotation, was used to represent the degree of data homogeneity bias. The test results reveal that there are a total of four factors. Furthermore, the load value of the first factor is below the standard value, indicating the absence of significant common method bias.

4.3 Reliability and validity test

To ensure the reliability of the scale, we utilize Stata 16.0 software for reliability and validity analysis, using Cronbach's alpha coefficient (α) and composite reliability (CR) values to test the reliability of the scale. The results show that the Cronbach's alpha coefficient (α) and composite reliability (CR) values for each latent variable exceeded the critical value of 0.7, thereby indicating a high level of reliability and excellent stability for the scale.

The validity analysis encompassed convergent validity and discriminant validity. The convergent validity analysis was conducted using standardized factor loadings and average variance extraction (AVE) values. The results demonstrate that the standardized factor loadings for each latent variable were greater than 0.5, and the AVE values were all above 0.8, indicating good convergent validity for each latent variable. For the discriminant validity test, it is observed that the square root of the AVE value for each latent variable was greater than its correlation coefficient with other latent variables, suggesting a high discriminative power between each of these latent variables. In addition, with the help of SPSS, discriminant validity was tested by calculating the Heterogeneity to Elemental Ratio (HTMT). As shown in Table 2, the majority of HTMT values are within the standard range (i.e., less than 0.85), indicating that the scale has good discriminant validity.

4.4 Contingency table analysis

In order to analyze the heterogeneous characteristics of rural residents' conscious interpersonal garbage classification behavior from the perspective of social capital sub dimensions, this section selects social capital (social network, social norms, social trust) as the differentiation indicator and applies a contingency table with the conscious interpersonal garbage classification behavior of rural residents. The results are shown in Table 3.

According to the data in Table 3, there is a consistent positive correlation between the mean dimensions of social capital such as social network, social norms, and social network, and the performance of rural residents in their conscious interpersonal garbage classification behavior. This indicates that the wider the social network of rural residents, the stronger the constraints on household waste classification among the villagers, and the higher the level of trust among the villagers, the more likely rural residents are to actively persuade or assist others in garbage classification in their daily lives. Among the three elements of social capital, social trust plays the strongest role.

4.5 Baseline regression results

To ensure accurate model estimation, a multicollinearity test was conducted using Stata 16.0 software on the explanatory variables involved in the study. The results indicate that the average variance inflation factor (VIF) for each explanatory variable is 1.68, which is below the standard value of 2.0. This suggests that there is no serious issue of multicollinearity among the explanatory variables. Table 4 displays the regression outcomes derived from Eq. 1. Specifically, in Model (1), social capital serves as the independent variable, and the results indicate a significant positive effect of social capital on the rural residents' conscious interpersonal waste separation behavior. Model (2) distinguishes social capital into social networks, social trust, and social norms, and the results show that social networks and social trust have a significant positive impact on the rural residents' conscious interpersonal waste separation behavior, while the impact of social norms is not significant.

TABLE 2 Results of HTMT test.

Variables	1	2	3
1. Conscious interpersonal waste separation behavior	-		
2. Social capital	0.631	-	
3. Ecological Values	0.771	0.660	-
4. Subjective norm	0.854	0.732	0.858

TABLE 3 Contingency table analysis.

	Variable	Assignment	The mean of various levels of conscious interpersonal garbage separation behavior				
			1	2	3	4	5
social network	I often chat with my family and friends about topics related to environmental protection	5-point Likert scale	2.130	2.605	3.060	3.852	4.506
social trust	I have a high level of trust in environmental laws and regulations	5-point Likert scale	2.870	3.360	3.717	4.420	4.773
social norm	People around me think it's embarrassing to damage the ecological environment	5-point Likert scale	2.957	3.140	3.566	4.180	4.662

4.6 Results of interaction effects

According to Eq. 2, we introduce two-way interactions between social networks, social trust, and social norms to analyze the interactive effects among dimensions of social capital. The results are shown in Table 5. It can be observed that there is a significant negative interaction effect between social networks and social norms, indicating a substitution relationship between these two dimensions. However, there is a significant positive interaction between social trust and social norms, indicating that social trust and social norms act as amplifiers for each other. Hence, Hypothesis H3 is accepted.

4.7 Results of mediating effects

According to Eqs 3–5, the mediating variable of ecological cognition and subjective norm are introduced to examine whether social trust, social networks, and social norms affect the rural residents' conscious interpersonal waste separation behavior through ecological cognition. The estimation results of the mediating effect model of ecological cognition are presented in Table 6. As demonstrated in Model (1), social networks and social trust have a significant have a significant positive impact on rural residents' conscious interpersonal waste separation behavior. Model (2) indicates that social networks, social trust, and social norms have a significant positive influence on rural residents' ecological cognition, leading to the acceptance of Hypotheses H3, H3a, H3b, and H3c. Model (3) demonstrates that ecological cognition has a significant positive impact on rural residents' conscious interpersonal waste separation behavior and Hypothesis H4 is henceforth accepted. By combining the results of models (1), (2), and (3), it can be concluded that ecological cognition plays a partial mediating role in the influence of social networks and social trust on rural residents' conscious interpersonal waste separation behavior, while it fully mediates the effect of social norms on rural residents' conscious interpersonal waste separation behavior.

Furthermore, as shown in Model (4), the three dimensions of social capital (social network, social trust, and social norms) have a significant promoting effect on the subjective norms of rural residents, indicating the validity of hypotheses H5, H5a, H5b, and H5c. Model (5) indicates that the stronger the subjective norms of rural residents, the more likely they are to consciously implement interpersonal garbage classification behavior in their daily lives, i.e., accept hypothesis H6. Based on the estimation results of the comprehensive models (1), (4), and (5), it can be found that subjective norms play a partial mediating role in the influence of social networks and social trust on the conscious interpersonal garbage classification behavior of rural residents, and there is a complete mediating role in the influence of social norms on the conscious interpersonal garbage classification behavior of rural residents.

To examine the significance of the mediating effect of ecological cognition and subjective norm, the Bootstrap interval analysis was conducted and the results are shown in Table 7. It demonstrates that for the three pathways are "social networks-ecological cognition-conscious interpersonal waste separation behavior", "social trust-ecological cognition-conscious interpersonal waste separation behavior" and "social norms-ecological cognition-conscious interpersonal waste separation behavior," the confidence intervals for the mediating effect of ecological cognition do not include 0. This indicates that there is a significant mediating effect of ecological cognition in the relationship between social networks, social trust, social norms, and rural residents' conscious interpersonal waste

TABLE 4 Estimation results of baseline regression.

	Model (1)	Model (2)
	Conscious interpersonal waste separation behavior	Conscious interpersonal waste separation behavior
Social Capital	0.513***	
	(14.35)	
Social Networks		0.215***
		(5.46)
Social Trust		0.248***
		(8.04)
Social Norms		0.041
		(1.14)
Ecological Values	0.374***	0.386***
	(8.35)	(8.61)
Gender	−0.032	−0.044
	(−0.60)	(−0.82)
Education	−0.018	−0.018
	(−0.55)	(−0.52)
Income	0.013	0.013
	(0.58)	(0.57)
Age	0.003	0.003
	(1.43)	(1.47)
Adjusted R^2	0.474	0.490
Sample Size	712	712

Note: (1) ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. (2) The T-values are shown in parentheses.

separation behavior. In terms of the mediating effect of subjective norms, among the three mediating paths of "social network subjective norms conscious interpersonal garbage sorting behavior", "social trust subjective norms conscious interpersonal garbage sorting behavior", and "social norms subjective norms conscious interpersonal garbage sorting behavior", the confidence interval of the mediating effect of subjective norms does not include 0. This indicates that subjective norms in social networks, social trust. There is a significant mediating effect between social norms and conscious interpersonal garbage sorting behavior among rural residents.

4.8 Result of moderating effect

In order to verify the moderating effect of government policies on the conscious interpersonal garbage separation behavior of rural residents in terms of social capital, the samples were divided into groups with and without garbage separation facilities based on the values of government policy variables. Regression was performed on

TABLE 5 Results of interaction effects between dimensions of social capital.

	Model (1)	Model (2)
	Conscious interpersonal waste separation behavior	Conscious interpersonal waste separation behavior
Social Networks	0.248***	0.241***
	(8.04)	(7.79)
Social Trust	0.215***	0.243***
	(5.46)	(5.28)
Social Norms	0.041	0.020
	(1.14)	(0.50)
Social Networks * Social Trust		−0.001
		(−0.04)
Social Networks * Social Norms		−0.067**
		(−2.45)
Social Trust * Social Norms		0.055*
		(1.75)
Control Variables	Controlled	Controlled
Adjusted R^2	0.490	0.487
Sample Size	712	712

Note: (1) ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. (2) The T-values are shown in parentheses.

Eq. 1, and the results are shown in Table 8. Comparing models (1) and (2) in Table 8, it can be seen that regardless of whether the village is equipped with garbage sorting bins, the impact of social capital on the conscious interpersonal garbage sorting behavior of rural residents is significantly positive. However, the regression coefficient of social capital is larger in the group without garbage sorting facilities (0.606 > 0.443), which means that in areas without garbage sorting facilities, social capital has a greater impact on guiding rural residents to consciously implement interpersonal waste sorting behavior. This indicates that government policies play a moderating role in the relationship between social capital and the conscious interpersonal garbage classification behavior of rural residents, confirming hypothesis H7.

5 Discussion and policy implication

5.1 Discussion

This study indicates that social capital plays a significant role in the rural residents' conscious interpersonal waste separation behavior, which is consistent with existing literature. According to existing literature, enhancing social capital is an effective way to encourage residents to carry out household waste separation behavior (Kithia, 2015; Hua et al., 2021). This study confirms that this influence is also relevant in

TABLE 6 Estimation result of the mediating effects.

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
	Conscious interpersonal waste separation behavior	Ecological cognition	Conscious interpersonal waste separation behavior	Subjective norm	Conscious interpersonal waste separation behavior
Social Networks	0.248***	0.503***	0.199***	0.169***	0.163***
	(8.04)	(17.85)	(5.36)	(6.55)	(5.65)
Social Trust	0.215***	0.094***	0.205***	0.220***	0.104***
	(5.46)	(2.63)	(5.22)	(6.69)	(2.82)
Social Norms	0.041	0.212***	0.020	0.148***	−0.034
	(1.14)	(6.45)	(0.55)	(4.91)	(−1.01)
Ecological Cognition			0.098**		0.503***
			(2.38)		(12.33)
Control Variables	Controlled	Controlled	Controlled	Controlled	Controlled
Sample Size	712	712	712	712	712
Adjusted R^2	0.490	0.645	0.487	0.614	0.575

Note: (1) ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. (2) The T-values are shown in parentheses.

the realm of conscious interpersonal waste separation behavior among rural residents.

This paper further examines the interactive influence of the three dimensions of social capital, social networks, social trust, and social norms, on the rural residents' conscious interpersonal waste separation behavior. In particular, this paper discovers that social networks and social norms are substitutive, while social trust and norms are complementary in guiding rural residents to consciously engage in interpersonal waste separation behavior. This result further expands the research of Hsu and Hung (2013), which argues that the dimensions of social capital are not independent, but may have interactive effects. The results of this paper once again confirm this viewpoint.

This paper also finds that the effects of the dimensions of social capital are different. Social trust and social networks not only have a direct impact on the rural residents' conscious interpersonal waste separation behavior but also have an indirect impact through ecological cognition and subjective norm. This contradicts the conclusion of Wang and Zhang (2022), which argues that social trust and social networks do not have a direct impact on residents' waste separation behavior but can only indirectly drive residents to carry out waste separation by shaping environmental norms. One potential explanation for this is that within the context of China's commitment to ecological civilization construction, rural residents have a constant flow of information and resources about waste separation during their interactions with family and friends. People often believe that the surrounding residents are aware and committed to carrying out waste separation. Social trust and networks have a direct impact on motivating rural residents to participate in household waste separation through interpersonal activities.

Moreover, this paper discovers that ecological cognition completely mediates the influence of social norms on the rural residents' conscious interpersonal waste separation behavior, supporting the findings of Xiao et al. (2021) who conducted a study on the rational fertilization behavior of Chinese farmers, and reveals that the social norms play a significant role in shaping farmers' ecological cognition. The possible reason could be that amidst a long-term social environment that advocates for "everyone to participate in waste separation", rural residents may come to realize that protecting the ecological environment necessitates collective participation. This in turn enhances their awareness of the importance of ecological environment protection. Driven by ecological awareness, rural residents may proactively share government policies and knowledge related to waste separation in their daily interpersonal activities, encouraging surrounding residents to participate in waste separation.

Finally, it is found that government policies have a significant moderating effect on the relationship between social capital and the conscious interpersonal garbage classification behavior of rural residents. It can be seen that government policies play an important role in the classification of rural household waste in China. This indirectly confirms the views of many scholars at home and abroad that government policies are an important factor affecting residents' pro environmental behavior (Chen, 2018; Knickmeyer, 2020; Li et al., 2022; Cheng et al., 2023). This conclusion indicates that in guiding rural residents to actively participate in the process of household waste separation, it is necessary to reasonably equip household waste classification facilities and avoid the mixing of waste classification, collection, and treatment environment.

5.2 Policy implication

The above results draw the following policy implications: First and foremost, fostering the social capital of rural residents must be

TABLE 7 Results of the Bootstrap test for the mediating effect.

Pathway	Coefficient	Z- value	95% confidence interval	
			Lower bound	Upper bound
Social networks—Ecological cognition—Conscious interpersonal waste separation behavior	0.090	2.86	0.028	0.152
Social trust—Ecological cognition—Conscious interpersonal waste separation behavior	0.124	5.63	0.081	0.168
Social Norms—Ecological cognition—Conscious interpersonal waste separation behavior	0.152	6.51	0.106	0.198
Social networks—Subjective norm—Conscious interpersonal waste separation behavior	0.167	8.40	0.127	0.206
Social trust—Subjective norm—Conscious interpersonal waste separation behavior	0.229	8.18	0.182	0.284
Social Norms—Subjective norm—Conscious interpersonal waste separation behavior	0.210	8.58	0.160	0.265

TABLE 8 Results of the moderating effect.

	Model (1): Group without waste separation facilities	Model (2): Group with waste separation facilities
	Conscious interpersonal waste separation behavior	Conscious interpersonal waste separation behavior
Social Capital	0.606***	0.443***
	(6.45)	(11.33)
Control Variables	Controlled	Controlled
Sample Size	131	581
Adjusted R^2	0.304	0.493

Note: (1) ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. (2) The T-value is shown in parentheses.

emphasized to promote rural residents' conscious interpersonal waste separation behavior as the above results indicate that social capital plays an important role in it. The government can utilize WeChat, TikTok, and other Internet platforms to establish a communication group for villagers, which will bring together both those who work outside and domestic farmers. This initiative will not only strengthen the ties between rural residents but also foster the sharing of environmental protection knowledge and policies such as waste separation. The group chat will also address the concerns of rural residents, encouraging active participation in exchanges and interactions. This approach facilitates better understanding and trust between rural residents, ensuring they accurately receive environmental protection information and policies in their daily lives. It also helps to raise awareness about the environmental benefits that result from practices like waste separation to promote the initiative of rural residents to encourage others to get involved in the process of separating household waste.

Second, it is necessary to establish an environmental governance system that combines social trust and social norms considering of the complementary effect. By organizing the grassroots work teams, which mainly consist of village cadres, highly respected rural residents in the village, and village group leaders, the government can organize various environmental protection knowledge training, strengthen communication and learning among villagers, and enhance the level of social trust among them. Simultaneously, a new rural style that advocates civilized environmental protection can be established through various environmental protection awards and commendations, such as "Green Family" and "Beautiful Courtyard", creating a virtuous cycle where social trust and social norms mutually promote each other. The government can take multiple measures to promote rural residents' active engagement in waste separation and interpersonal behavior in their daily lives.

Third, the government should strengthen publicity and education efforts to heighten the ecological cognition and subjective norm of rural residents by utilizing both online and offline platforms considering the mediating effects. Online, it can actively employ official microblogs, WeChat official accounts, TikTok video numbers, and other online communication platforms to conduct environmental education and promotion. Offline, it can place and hang environmental slogans and propaganda posters on outdoor walls in rural areas, and delegate village cadres and respected rural residents to conduct oral propaganda on waste separation and other environmental protection behaviors in daily life, effectively disseminating environmental protection knowledge.

6 Conclusion

Social capital is a crucial way to promote rural residents to carry out conscious interpersonal waste separation behavior in their daily lives, which contributes to the establishment of a beautiful China. By utilizing the survey data of 712 rural residents in Jiangxi Province, the main findings are as follows.

Social capital has a facilitating impact on the rural residents' conscious interpersonal waste separation behavior in their daily lives. Specifically, social network and social trust both contribute to rural

residents' active participation in waste separation but social norms have no significant influence. The interaction between social network and social norms negatively affects rural residents' conscious interpersonal household waste separation behavior, whereas the interaction between social trust and social norms positively influences it. There is no interaction effect between social trust and social network. Moreover, the ecological cognition and subjective norm play a significant mediating role in the relationship between social network, social trust, and social norms and the rural residents' conscious interpersonal waste separation behavior, while the government policies plays a significant moderating effect. The aforementioned findings contain policy implications for enhancing the rural residents' conscious interpersonal waste separation behavior within China and other developing countries.

Data availability statement

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

Author contributions

YT: Formal Analysis, Methodology, Resources, Writing–review and editing. NL: Formal Analysis, Methodology, Writing–review and editing. JY: Data curation, Visualization, Writing–original draft. YL: Data curation, Visualization, Writing–review and editing. CL: Conceptualization, Supervision, Writing–review and editing.

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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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