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Effect of Public Space on Collective Action for Rural Waste Management and the Mediating Effects of Social Capital

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Abstract: Public spaces enhance social interactions and contacts, yet few scholars have linked public spaces to the governance of commons for rural waste management. We thus explore the direct and mediated effects of public spaces on collective action for rural waste management. The research was conducted in the Jiangsu Province of Eastern China by interviewing 290 farmers from 9 different counties. The individual dataset was collected from the measurement of public space, social capital and collective action for rural waste management. Public space characteristics include scale, entering frequency and accessibility. A structural equation modelling approach was employed to analyse the path and relationship of these variables. The results show that public space has a direct and positive effect on collective action for rural waste management, which could be attributed to the specific dimensions of scale, entering frequency and accessibility. We also find that social capital positively mediates the relationship between public spaces and collective action. This study highlighted the importance of public space use to rural environmental governance. Social capital is recommended to promote the collective action for rural waste management. The results contribute to the literature on public space research and imply that public space should be considered by policymakers to enhance environmental development and rural revitalisation.

Keywords: public space; collective action; social capital; rural waste management; China



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1. Introduction

With rapid economic development, industrialisation and urbanisation, Chinese rural communities are facing enormous challenges in processing the excessive waste generated by local community members [1,2]. Waste treatment is essential for sustainable resource management [3]. However, the lack of knowledge and awareness about waste separation and collection are major barriers for rural waste management [4,5]. Thus, rural residents, who commonly throw waste in the wild, rarely have an incentive to participate, owing to the time-consuming and tedious nature of recycling and processing. Thus, they need to change their traditional way of disposing garbage freely into an efficient way with centralised treatment through recycling stations and waste processing facilities. In response, efficient resource management systems have been transformed to strike a balance between environmental quality and economic efficiency by using market or administrative strategies—for example, imposing rubbish collection fees, green bonus, fines, etc. [6]. Among all possible reform strategies, collective action for rural waste management has been one of the most frequently adopted strategies across the rural areas of China [7].

In order to initiate and realise collective action, community members need a distinct locale to create and sustain interactions, which then create a form of common sense and order among residents. This process makes public space the cradle of public life. According to Cao [8], public space is not only a physical arena, but it also contains existing forms of social activities and organisations that have a certain publicity and are relatively fixed in a specific space. In this sense, as a 'space for participation and amicable behaviours' [9]

and an unrestricted public sphere (public spaces are spaces within which the ‘public sphere’ is formed, policed and contested’) where contacts and interactions can occur [10], a ‘shared understanding and identity’ is a prerequisite for collective action [11]. Public space is therefore an important arena in which community members’ social connections are generated, interact and are sustained and may exert substantial effects on the formation of collective action [12,13]. More importantly, it is the use and participation of rural residents in the space that define its public nature [14]. While the importance of social and cultural practices in public spaces has been recognised in the literature, how the relationship among rural public spaces, participation processes and collective action functions needs to be further explored.

Many previous studies have shown that public spaces are believed to foster and enhance social life and community members’ social interactions [15,16]. They are of vital importance in promoting and sustaining public life [17–19]. For example, in the relationship between community gardens and collectivity, the structure, practices and rules of private and public gardens, in whichever state, are positively related to community building and urban greening [20]. A survey conducted in Melbourne demonstrated that urban community gardens could provide an opportunity for enhancing social capital [21]. Therefore, public spaces, such as community gardens, can be seen as a platform to build both social capital and connectedness, which contribute to sustainable development [22]. In addition, public space is not just the centre of the public realm; its morphological, environmental and aesthetic values are also of great importance [23,24]. However, research on rural public spaces, as well as their social and cultural practices, has attracted little attention [25].

Moreover, some scholars study the relationship between information technology, public space and collective action and have found that the internet impacts the democratic transition depending on the interaction between the state and society (adapted from University of California Los Angeles Center for Communication Policy and the Chinese Academy of Social Sciences (2003, pp. 27, 29, 30, 31)) [26]. Melucci and Avritzer [27] also contended that democracy crises are associated with the deficiency of public space for solving social and cultural complexities. In order to cope with the consequences of crisis-ridden Athens, Vaiou and Kalandides [28] found that practices of solidarity and material spaces are a ‘laboratory’ in which to form a public sphere. Just as Harvey pointed out, ‘[. . .] a clearer and broader definition of that public that not only can truly access so-called public space, but can also be empowered to create new common spaces for socialization and political action’ (p. xvi) [29]. Although previous research has indicated that public spaces are key for collective action [30–32], the mechanisms, especially the role of social capital and how social capital structures the relationship between public space and collective action, need to be systematically explored. Since public space usage is difficult to measure, the well-designed indicators are necessary to justify this relationship by employing individual datasets from participants’ self-reported questionnaires.

This study will focus on how public space usage, with all its demonstrated functions, can promote the social capital between rural residents and increase the possibility of collective action for rural waste management. The goal of this research is to examine the relationship between rural residents’ public space use and their participation in collective actions. We specifically focus on the role of rural residents’ social capital in bridging this relationship. To empirically examine this relationship, we conducted this study in nine counties with 290 rural residents in eastern China, and the Structural Equation Modelling was recruited to examine these relationships.

The remainder of this paper is organised as follows. In Section 2, we propose a theoretical framework and derive our research hypotheses to be tested. We present the estimation strategy and data in Section 3. In Section 4, we present our empirical results and further discuss them in Section 5. In Section 6, we draw conclusions and provide insights into policy implications.

2. Theoretical Framework and Research Hypothesis

2.1. Public Space in the Chinese Rural Community

Unlike salons, cafes, bars, squares and churches, which are popular in Europe and America, public spaces in Chinese rural communities are mostly ancestral halls, temples, vendors, village committees, cultural stations, libraries and squares. On one hand, China's rural public space is conceptualised as places into which rural residents can enter and exert social, political and commercial functions. On the other hand, it is considered a form of institutionalised organisation, including activities that generally take place or exist in the community, such as traditional rituals, cooperatives and funerals/wedding celebrations.

Owing to historical and cultural differences, China's rural public space formed automatically through local residents' interactions. The members are homogenous, and rural residents discuss public affairs in ancestral halls, achieve public consensus and maintain the order in villages. Different from the Western culture of individualism, China's public space addresses the importance of collectivism. As traditional Chinese rural society is kinship-based, clans have a strong influence on the decisions of public affairs. After the founding of the People's Republic of China, the state power grew dramatically to the commune and brigade levels, which are represented by rural collectives in the institutional forms of public space. The 'publicity' of the village community is more obvious because of the process of collectivisation and the communalisation of the village society. This created special village collective production and a living realm during the people's commune. We see this specifically manifested in the production brigade, administrative assembly and rural art activities. It provided a new system that guaranteed the integration and orderly obedience of rural society at that time.

In the reform and opening-up era, the state loosened its vertical control, creating the space for negotiations between the state and rural residents. This is reflected by the rise of 'community endogenous' public spaces, such as cooperatives, square dancing halls and open markets. Urbanisation, social transformation and market-oriented economic reforms have empowered local residents to select the public space that matches their economic interests and preferred lifestyles [33,34] in order to build their self-chosen identities, find 'someone like me' [35] and satisfy their physical, cultural and social functions.

2.2. Public Space and Collective Action

As an arena for participants to rationally and critically deliberate and debate social issues [36,37], public space provides a platform for community members to access and nurture public spirits, integrate diverse interests and demands, strengthen social ties and enhance the capacity for resource sharing [38,39]. It also increases the individuals' ability to coordinate their interests by allowing for the deliberation of public issues through 'a network for communicating information and points of view' [40].

These ideas and opinions could be expressed by open discourse; they are generally the ideas that could advance public interests and further affect collective decision making to enhance the participants' capability to find a consensus on public issues [41,42].

Moreover, public spaces perform a wide range of functions in community members' daily lives [43,44]. Public spaces are conducive to community members' physical and mental health, as well as community development. As 'a realm of our social life in which something approaching public opinion can be formed', 'public space also enables private individuals to assemble and to form a public body' [45,46].

In this sense, public space contributes to community binding and sustainable development [47,48]. The success of collective action in improving the environment and influencing individual decision-making outcomes requires places where ideas can be communicated, debate can be conducted and a general consensus can be reached [49]. Therefore, we formulate the following hypothesis:

Hypothesis 1 (H1). *Public space is positively associated with collective action for rural waste management.*

2.3. Mediating Effects of Social Capital

Social capital is defined as the ‘capacity for individuals to command scarce resources by virtue of their membership in networks of broader social structures’ [31]. Putnam popularised the concept of social capital, which has been correlated with the positive outcomes of civic engagement [50,51]. Francis [52] and Gehl [53] demonstrated the relationship between community members and public spaces through human action, visual involvement and value attachment. Public space, as spaces where participants can encounter, discuss and communicate ideas as well as share information [54], is conceived to build social capital through social participation, frequent interactions and knowledge transfer [55]. The concept of social capital is manifested as norms of trust, social networks and reciprocity that transcend the relations between people and are linked to public space in three ways:

First, public space increases community members’ opportunities to have encounters with others, which is a prerequisite to developing social networks [56]. Collective action attaches an importance to public space because of its role in generating and maintaining social networks, which are cultivated through informal or formal exchanges and interactions among participants; these relations help them solve public issues, thereby acting as the creators of collective identity [57,58]. In this process, spontaneous interactions in public spaces also contribute to the formation of strong and weak ties and further stimulate social attachment [59,60].

Second, public space provides the opportunity to build social connections and common ground by creating a platform for idea sharing, social contact and involvement [61,62]. In other words, public space is believed to foster and enhance participants’ social inclusion and community partnerships [57,63,64]. Just as Hillenbrand pointed out, ‘the primary way libraries build social capital is by providing a shared public space for a variety of 15 different groups within the community, accommodating diverse needs and enhancing social interaction and trust’ [65]. In general, public space is seen as ‘the process of interactions that lead to relationships, build trust and create social capital’ [66]. Social trust functions as the ‘central mechanism for the formulation, aggregation, creation, and implementation of collectively binding decisions’ [67].

Third, activities in public spaces have the function of forming social reciprocity, building other-regarding interests and achieving a collective consensus [23,68]. Public space plays the role of shaping public behaviour and cultivates a sense of the commons [69]. Community members depend on the public space to satisfy their social, functional and political needs, and they gain life enrichment and community development [22]. In this process, the shared experience of community members, the attachment with place and events build reciprocity for further collective action in community issues. Figure 1 presents the directing effects of public space on the collective action and mediating effects of social capital. In general, public space is viewed ‘as an instrument for creating social capital’ [32]. Based on the analysis above, the hypothesis is generalised as follows:

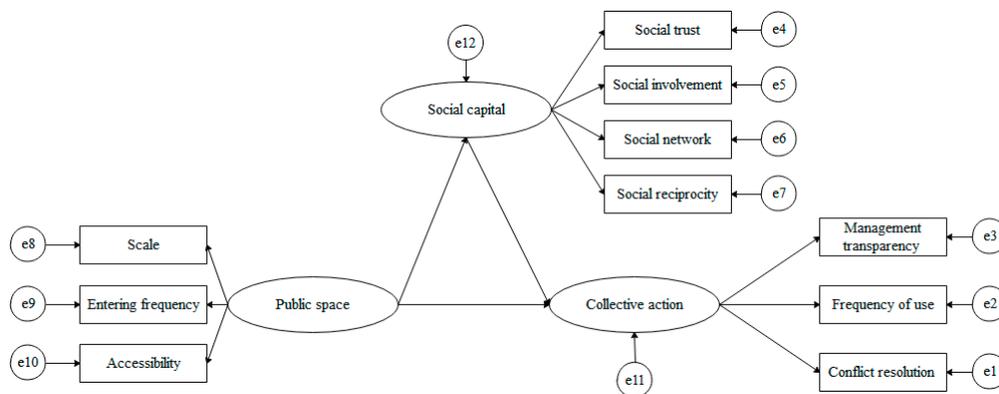


Figure 1. Mediating Effects of Social Capital.

Hypothesis 2 (H2). *Social capital mediates the relationship between public space and collective action.*

3. Methodology

3.1. Research Context and Data

We collected data through a typical case study and stratified a sampling approach considering the economic development level and its representativeness for rural waste recycling practices. First, we grouped regions into rural areas with good waste recycling practices and selected the survey area in rural Yangzhou, Jiangsu Province, China. Yangzhou is located in the middle part of the Yangtze River Delta in Jiangsu Province, and because of its good rural waste recycling practices, it was selected as the investigation unit. Next, we employed a stratified sampling approach. We randomly selected nine counties—Xiannv, Daqiao, Fangxiang, Wenchang, Yuetang, Liuji, Lingtang, Gongdao and Xiejia—with a total of 300 households. The inclusion criteria required that respondents be aged 18 years or older, they be able to communicate freely with enumerators and that they have lived in the community for more than 1 year. Owing to the inconsistent and incomplete survey questionnaire, 10 out of the 300 participants were excluded from the survey sample. The survey elicits information on demographics, economic conditions, farmers' perceptions of environmental protection, waste recycling practices, components of social capital and public space.

Rural solid waste management is carried out in a three-tier system: community-level treatment is the process of storing and transporting waste from households to local collection points, township-level treatment includes storage and transportation from village collection points to waste collection systems in the county and county-level waste collection systems are mainly responsible for recycling and disposal [70]. Rural solid wastes are normally divided into organic waste, non-recyclable inorganic waste and recyclable waste. Because of financial and institutional constraints, local governments are mainly responsible for waste transport and processes at the county and town levels; the initiatives in collection, waste sorting and transport mainly depend on collective actions at the village level [70].

3.2. Measures

The public spaces in which community members frequently participated are generalised into 21 types (Table 1). The questionnaire included two items to assess the importance of public space: (1) Do you always go to public spaces? The respondents were asked to answer by using a seven-point Likert scale (1 = 'never', 2 = 'rarely', 3 = 'not often', 4 = 'sometimes', 5 = 'often', 6 = 'quite often' and 7 = 'always'). (2) Does this type of public space have an important influence on your life? The responses were delivered via a seven-point Likert scale, ranging from 1 ('not important') to 7 ('very important'). The score of public space was obtained by multiplying these two items. The dimensions of public space, including scale, entering frequency and accessibility, were measured as follows.

Table 1. Types and proportion of rural public space.

Scale	Frequency	Accessibility	Category of Public Sphere	(%)
Small	Low	Semi	Village council/party branch/ancestral hall/wedding ceremony/funeral	16.21
Small	High	Semi	Temple/cooperative	8.28
Small	Low	Full	Reading room/rural culture station	2.76
Small	High	Full	Kiosk/supermarket/public square/canteen/card room/village open market	39.31
Large	High	Semi	Wholesale market	5.52
Large	Low	Full	Temple fair/carnival	3.45
Large	High	Full	County open market	20.34
Large	Low	Semi	County meeting/professional association	4.14

Note: The classification is based on Han et al. [71].

3.2.1. Public Space

The classification of public space can be highly differentiated in terms of its multiple dimensions from physical, social, cultural and political perspectives [49,72]. For example, public spaces incorporate political meanings, as they act as arenas for conflicts, demonstrations and negotiations [73], and they can be constructed from social encounters, individual experiences and political activities [47]. Some researchers divide them based on how they are produced and constructed [74]. Based on our research objectives, we focus on community members' activities and their connections with public spaces and divide them into three dimensions, that is, the scale of the public space (the extent of the public space that community members are able to reach), the community members' frequency of visits to the public space and the degree to which the public space is accessible to outsiders [71,75,76]. Therefore, we constructed a three-dimensional public space framework to observe and analyse the relationships between public spaces and collective action for rural waste management.

The scale dimension of public space is measured as the physical scope that community members can reach. Scale dimensions can be divided into large-scale and small-scale public spaces. The large-scale public space corresponds to the county level, and small-scale public spaces are mostly limited to townships (towns) and village levels that community members can reach. The respondents were asked to score every public space they entered. We defined 15 types of public spaces as large-scale and 6 as small-scale. If the average score of the large-scale public space is larger than that of the small-scale one, the former is dichotomised from 5 to 7 based on three divisions of the score; however, if the two scores are equal, the value of the large-scale space is dichotomised as 4, and that of the small-scale space is dichotomised from 1 to 3 based on three divisions. Finally, the scale dimension was dichotomised into a seven-point Likert scale from small to large-scale public spaces.

The entering frequency dimension is measured by the community members' rate of entering the public space. The calculation process of the entering frequency and accessibility dimensions is similar to that of the scale dimension. The respondents were asked to select the frequency of each gathering in public space using a seven-point Likert scale (1 = 'never', 2 = 'rarely', 3 = 'not often', 4 = 'sometimes', 5 = 'often', 6 = 'quite often' and 7 = 'always').

Regarding the items of accessibility, if community members can freely enter and exit the public space, it is defined as an accessible public space; if a public space is mostly occupied by the same type of community member (e.g., the same profession) or only a certain group of community members can enter, it is called a semi-accessible public space. The responses were dichotomised by an expert review based on a seven-point Likert scale.

3.2.2. Social Capital

Based on the classification of Miao et al. [77], social capital is divided into the dimensions of social trust, social network, social reciprocity and social involvement, which are assessed using a seven-point Likert scale (1 = 'totally disagree', 2 = 'disagree', 3 = 'somewhat disagree', 4 = 'neither agree nor disagree', 5 = 'somewhat agree', 6 = 'agree' and 7 = 'totally agree'). For the indicator 'Village leaders can be trusted' (social trust), we measured the answer on a seven-point Likert scale; for the indicator 'The number of people who come to your family wedding ceremony' (social network), we measured the response on a seven-point Likert scale (1 = 1–10, 2 = 11–20, 3 = 21–40, 4 = 41–80, 5 = 81–120, 6 = 120–150 and 7 = above 150). For 'When community members have tricky problems to resolve, they ask you for help' (social reciprocity), we measured the answer on a seven-point scale (1 = 'never', 2 = 'rarely', 3 = 'a bit', 4 = 'sometimes', 5 = 'often', 6 = 'many times' and 7 = 'frequently'). For 'The frequency of handling public affairs' (social involvement), we measured the answer on a seven-point Likert scale (1 = 'never', 2 = 'rarely', 3 = 'a bit', 4 = 'sometimes', 5 = 'often', 6 = 'many times' and 7 = 'frequently').

3.2.3. Collective Action

Collective action was measured based on a study by Akuriba et al. [78]. From the perspective of conflict resolution ('handling conflicts in waste recycling successfully'), management transparency ('information flow among members of transparency in waste discharge timeliness') and frequency of use ('frequency in the use and maintenance of waste treatment facilities'), each question was answered on a seven-point Likert scale (1 = 'totally disagree', 2 = 'disagree', 3 = 'somewhat disagree', 4 = 'neither agree nor disagree', 5 = 'somewhat agree', 6 = 'agree' and 7 = 'totally agree'), with a higher score indicating a higher level of collective action performance.

3.3. Structural Equation Model

Owing to the property of structural equation modelling (SEM) in addressing causal effects and endogeneity problems, we employ the multivariate statistical technique to explore the relationships between latent variables and observed variables. The factor analysis and path analysis in SEM can be realised by the measurement and structural models, and the direct and indirect effects can be estimated by the paths of exogenous variables affecting the endogenous variables directly and indirectly. The structural equation model (see Miao et al. [79]) is represented as follows:

$$y = \Lambda_y \eta + \varepsilon \tag{1}$$

$$x = \Lambda_x \zeta + \delta \tag{2}$$

$$\eta = B\eta + \Gamma\zeta + \zeta \tag{3}$$

where y is the vector $p \times 1$ of the endogenous observed variables, x is the $q \times 1$ vector of exogenous predictors or observed variables, η is the $m \times 1$ random vector of the latent endogenous variables, ζ is the $n \times 1$ vector of latent exogenous variables, Λ_y is the $p \times m$ matrix of the coefficients (or loadings) of the relationship between y and η , Λ_x is the $q \times n$ matrix of coefficients (or loadings) of the regressions of x on ζ and ε and δ are the $p \times 1$ and $q \times 1$ vectors of the measurement errors of y and x , respectively.

In the element of β_{ij} of the $m \times m$ matrix, B reflects the effects of the j th endogenous latent variable on the i th endogenous latent variable, and the element γ_{ij} of the $m \times n$ matrix Γ reflects the effects of the j th exogenous latent variable on the i th endogenous latent variable. ζ is the $m \times 1$ vector of structural errors (SEM refers to Tang & Folmer [80]).

The SEM estimation is processed as follows. First, we carry out a confirmatory factor analysis to ensure that each construct of the model is significant and that the value is over 0.6. The empirical results indicated acceptable reliability and convergent validity for the scale items. Second, the measurement model and structural model are analysed to explore the relationship between the latent construct and observable indicators, as well as the relationship between latent and observable variables. Third, the direct and indirect effects of public space and social capital were also examined using bootstrapping techniques. Finally, we examined the goodness-of-fit indices to assess the reliability and validity of the model. The descriptive statistics of all the exogenous and endogenous variables are shown in Table 2.

Table 2. Descriptive statistics of observed indicators and exogenous and endogenous variables.

Variables	Definition	S.D.	Mean	Min.	Max.
Exogenous variables					
Public space					
Scale	Based on the calculation of scale in the public space	1.228	2.16	1	7
Frequency	Based on the calculation of frequency in the public space	1.123	2.07	1	7
Accessibility	Based on the calculation of scales in the public space	1.276	2.02	1	7

Table 2. Cont.

Variables	Definition	S.D.	Mean	Min.	Max.
Endogenous variables					
Collective action					
Conflict resolution	Handling of tensions in waste recycling conflicts	1.966	3.42	1	7
Management transparency	Information flow among members about transparency in waste discharge timeliness	1.228	2.16	1	7
Frequency of use	Frequency of use and management of facilities	2.094	3.58	1	7
Mediating variable					
Social capital					
Social trust	Trust level among village leaders	2.054	4.17	1	7
Social involvement	Frequency of handling public affairs	1.996	4.57	1	7
Social network	Number of people who come to your family wedding ceremony	1.909	3.97	1	7
Social reciprocity	When community members have tricky problems to resolve, they ask you for help	1.927	3.88	1	7

4. Empirical Analysis

4.1. Descriptive Statistics

Eight different categories of public spaces were observed in the sample (Table 1). Community members' social and demographic characteristics may have influenced their participation and interaction in public spaces. Among the samples, 42.1% were male and 57.9% were female. Most of these participants were middle-aged and older than 46 years (23.4% between 46 and 55 years; 25.2% over 56 years old). However, the proportion of youngsters was relatively small (only 9%). The education level was mainly high school and vocational school (accounting for 30.7% and 32.8%, respectively). Of the respondents, 51.7% had lived for more than 31 years. The annual income was over CNY 50,000. Of the respondents, 61.4% had a migrating working experience. Internet use was common in the survey area, with 60% of the respondents in the village WeChat group.

Based on the classification of Han et al. [71], in terms of scale, entering frequency and accessibility, the public space could be divided into eight sub-types, as shown in Figure 2. The proportions of each type are presented in Table 1. We found that community members in a small scale, a high entering frequency and an accessible public space accounted for the largest proportion in our sample (39.31%), followed by large-scale, high entering frequency and accessible public space (20.34%); and small-scale, low entering frequency and semi-accessible public space constituted the third in our sample (16.21%). Small-scale, high-entering frequency and accessible public space can provide community members with a good place for communication and generate relatively sufficient social capital, which is beneficial for promoting cooperative behaviour.

The structure of rural public spaces demonstrates the characteristics of small-scale spaces, high entrance frequencies and accessibility. Kiosks, open markets and public squares were the three most important public spaces entered into by community members. The respondents tended to rely on the public space for social interactions, obtaining general information, leisure activities and discussing public issues. For other public spaces that satisfy specific functions, such as ancestral halls and elder associations, community members considered them for spiritual soothing and business expansion opportunities. In general, public spaces could be divided into four types based on their functions: economic, political, religious and cultural public space. We also divided them into physical and non-physical public space based on the existence of physical entities. We found that physical public spaces are more abundant than non-physical public spaces. The distribution of public space is shown in Table 3. The four types of public spaces are available in nine counties; however, they are unequally distributed. For example, Muslim Minorities are mainly located in Lingtang counties, so religious public spaces are abundant, while there are relatively fewer entertaining public spaces compared to other counties. Xiannv county

is famous for its industrial economy, and it is reflected in its large quantity of economic public spaces. Daqiao county owns intangible cultural heritage; the development of the painting brush cultural industry drives the flourishing of cultural public spaces. Wenchang county is adjacent to Yangzhou city, so the layout of public space is similar to the city public space. Liuji county is the industrial base of e-commerce enterprises. Non-physical public spaces, e.g., professional associations, play an important role in the cultivation of trust, reciprocity, etc. and further promote business development.

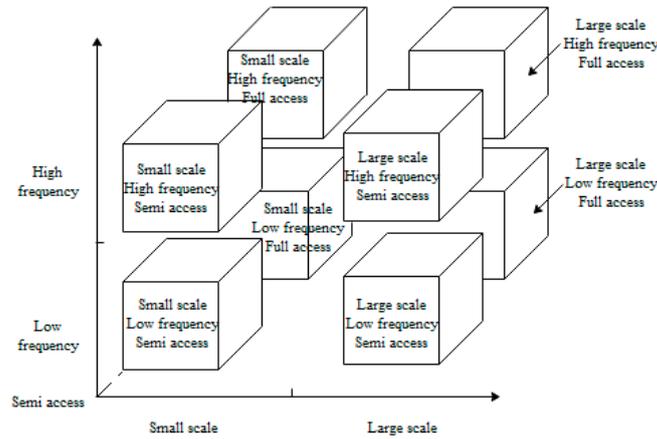


Figure 2. Types of public space.

Table 3. The distribution of public space in nine counties.

County	Types	Physical Public Space	Non-Physical Public Space	County	Types	Physical Public Space	Non-Physical Public Space
Xiannv	Economic space	●●●●●	●●	Wenchang	Economic space	●●●●●	●●
	Political space	●●●	●●●		Political space	●●●●	●●●●
	Religious space	●●●●●	●●		Religious space	●	●●●
	Cultural space	●●●	●●●		Cultural space	●●●●	●●●
Daqiao	Economic space	●●●●	●●	Yuetang	Economic space	●●●	●●
	Political space	●●●	●●●		Political space	●●●	●●●
	Religious space	●●●●	●●●		Religious space	●●●●●	●●●
	Cultural space	●●●	●●●●		Cultural space	●●●●●	●●
Fangxiang	Economic space	●●●	●●	Liuji	Economic space	●●●	●●●●●
	Political space	●●●●●	●●●		Political space	●●●●	●●
	Religious space	●●●	●●		Religious space	●●●●●	●
	Cultural space	●●	●		Cultural space	●●●	●●●
Lingtang	Economic space	●●●	●●	Gongdao	Economic space	●●●	●●
	Political space	●●●	●●		Political space	●●●	●●●
	Religious space	●●●●●	●●●●		Religious space	●●●●●	●●●
	Cultural space	●●●	●		Cultural space	●●●	●●
Xiejia	Economic space	●●●●●	●●●				
	Political space	●●●	●●●				
	Religious space	●●●●●	●●●				
	Cultural space	●●●	●●●				

Notes: 1. Economic physical public space: supermarket/kiosk/county open market/wholesale market/village open market/canteen; Economic non-physical public space: cooperative/professional association; 2. Political physical public space: village council; Political non-physical public space: County meeting/party branch; 3. Religious physical public space: ancestral hall/temple; Religious non-physical public space: wedding ceremony/funeral/temple fair; 4. Cultural physical public space: rural culture station/reading room/card room/public squares; Cultural non-physical public space: carnival. “●” represents the abundance of public space.

4.2. Relationship between Public Space and Collective Action

To ensure the empirical measure properties of reliability and validity, internal consistency, convergent validity and discriminant validity tests were conducted. The Cronbach's alpha reliability test was conducted and revealed a value of 0.889, which is higher than 0.7, indicating a fairly good internal consistency. The Cronbach's alpha values of the main three constructs—public space = 0.889, social capital = 0.905 and collective action = 0.808—are all higher than 0.7, indicating a fairly good model fit. Additionally, the values of the Bartlett test (1845.649), Kaiser–Meyer–Olkin test (0.859) and significance test (Sig = 0.000 < 0.01) all demonstrate a good measurement model fit. Finally, we used the average variance extracted (AVE) and composite reliability (CR) to evaluate convergent and discriminant validity. The values of AVE and CR were greater than 0.5 and 0.7, respectively, which demonstrates that the latent constructs could be explained by observed variables. The empirical results of the measurement model are shown in Table 4.

Table 4. Estimation results of the measurement model.

Construct	Indicators	Coefficient	Cronbach's Alpha	AVE	C.R.
Public space	Accessibility	0.90	0.889	0.823	0.933
	Scale	0.86			
	Frequency	0.79			
Social capital	Social trust	0.84	0.905	0.723	0.913
	Social involvement	0.80			
	Social network	0.83			
	Social reciprocity	0.88			
Collective action	Frequency of use	0.79	0.808	0.607	0.820
	Transparency	0.87			
	Conflict resolution	0.65			

The overall model fit was checked using a series of indices of χ^2 (109.248, CMIN/DF = 3.414), a root-mean-square error of approximation (RMSEA = 0.091), a goodness of fit index (GFI = 0.928), an adjusted goodness-of-fit index (AGFI = 0.877) and a comparative fit index (CFI = 0.958). Because the value of χ^2 may vary owing to the sample size, it is deemed acceptable. Considering the indices' cut-off criteria, GFI and CFI are greater than 0.8, and RMSEA is lower than 0.1, indicating a good overall model fit.

The total effects of public space on social capital and collective action were all significant. Specifically, public space had positive effects not only on social capital (0.588, $p < 0.01$) but also on collective action for rural waste management (0.573, $p < 0.01$). Apart from the total effects of public space on collective action, it can be divided into direct and indirect effects. Public spaces showed direct positive effects on social capital (0.588, $p < 0.01$), that is, participation and interaction in public spaces are conducive to the accumulation of social capital. In addition, public space not only had direct positive effects on collective action (0.315, $p < 0.01$) but also indirect positive effects on collective action via social capital (0.259, $p < 0.01$). Thus, public space could enhance the possibility of collective action for rural waste management through social capital accumulation. Finally, social capital had a direct positive effect on collective action (0.431, $p < 0.01$) but no indirect effects. These empirical results are consistent with H1.

4.3. The Mediating Effects of Social Capital

The mediation analysis showed that social capital partially mediates the relationship between public spaces and collective action for rural waste management. Therefore, the H2 is confirmed by the mediation analysis. This means that public space not only has direct effects on collective action but also exerts its effects on collective action through

social capital. Therefore, there are two channels for realising collective action for rural waste management: through direct public space participation to increase the likelihood of collective action and through the cultivation of social capital. The higher the social capital, the more community members will form and maintain collective action. Table 5 demonstrates the direct, indirect and total effects of public space on collective action for rural waste management. This finding corresponds with Aabø et al.'s conclusion that libraries are public spaces for building social capital [81]. This is also verified by Chen and Ke, whose empirical study in Singapore and the Taiwan Library (a variety of public spaces) found a probable increase in bridging social capital among library visitors [82].

Table 5. Total, direct and indirect effects of public space based on SEM.

	Public Space	Social Capital	Collective Action
Total effects			
Public space	0.588 ***		
Social capital	(0.093)		
Collective action	0.573 ***	0.440 ***	
	(0.066)	(0.054)	
Direct effects			
Public space	0.588 ***		
Social capital	(0.001)		
Collective action	0.315 ***	0.440 ***	
	(0.001)	(0.001)	
Indirect effects			
Public space	0.000		
Social capital	0.259 ***		
Collective action	(0.001)	0.000	

Note. *** $p < 0.01$. Standard errors are reported in parentheses based on bootstrapping techniques.

5. Discussion

The emergence of public space brings about the possibility of rural 'spontaneous social interaction'. Although common pool resource management still relies on the external constructive order to some extent, the natural order within the public space exerts pivotal effects in the formation of collective action. Our study explored the effects of public spaces on collective action for recycling waste and the mediating role of social capital exerted between these relationships. To overcome the challenges of integrating heterogeneous actors in the collective management of waste treatment, we used a theoretical framework to explore the relationship between public space, social capital and collective action and found a positive relationship between public space and collective action. Moreover, this relationship was mediated by social capital.

Our findings demonstrate that public spaces have a positive effect on collective action. The dynamic and flexible structure of public space serves as an important arena between the private sphere and the state, in which people can freely express their concerns and ideas about collective interests [45]. Our research verifies the views that 'the physical and social dynamics of public space play a central role in the formation of publics and public culture' [69].

Specifically, 'social interaction (in public space) not only promotes the development of mutual obligation and commitment, but also the formation of other-regarding interests' [83]. By allowing for spontaneous social interaction in the public space, the possibility of collective action is exemplified by the formation of formal and informal networks, trust, reciprocity and community building [84–86].

Moreover, we revealed the mediating effects of social capital exerted between public space and collective action. This would happen if rural residents are willing to participate

in public spaces, if there is more time for social interaction in rural centres and if there is an ease of access to avenues, which may promote place attachment and nurture collective awareness. In this process, social capital can be cultivated and leveraged to reduce the transaction costs for various stakeholders' preferences and interests [87]. Therefore, social capital is 'intrinsic to social functioning' and public will formation in daily interactions in the public space [88]. This also corresponds with Mazumdar et al.'s finding that public space could enhance social capital through increased interaction and as an avenue for collective activities [89].

Finally, the social dynamics of public space create a domain of common concern by structuring and channelling community members' conflicting ideas and interests [90]. Public space promotes collective action, where social capital is reinforced through gatherings and meetings [39]. Our study demonstrates that public space is 'a catalyst for social and political transformation' [91]. Based on this logic, the pathway to realise collective action is activity-based in that it addresses the importance of public space participation. The pathway is also meaning-based in that it emphasises the role of social capital in enhancing community members' perception of belonging and attachment. Thus, public space is the source of the collective action needed to 'legitimate authority in any functioning democracy' (Rutherford 18) from the bottom up, as the former is a necessary process that accelerates grassroots governance reform.

6. Conclusions

Environmental challenges related to rural waste management afflict rural residents' livelihoods and sustainable rural development. Addressing such challenges requires effective collective action and coordination among rural residents, which is often difficult to achieve. We investigated the possible role of public space in overcoming the challenges of integrating heterogeneous actors in the collective management of rural waste management. It is hypothesised that public spaces are an important prerequisite for collective action. A procedure based on a structural equation model was proposed to identify the importance of public space in realising collective action in waste treatment management. The findings identify the positive effect of public space on collective action, in which social capital mediates the link between public space and collective action.

Therefore, policy interventions could be designed to promote community member meetings, open discussions and public space participation, thus enhancing the community's capacity to build public space, form social capital and initiate or sustain collective actions. Compared with existing research, this study provides a new lens to realise collective action by designing an energetic public space in relation to scale, entering frequency and accessibility. This work, however, has some limitations. One of the main limitations regarding the study of public space and its multi-dimensions—from physical, social, cultural and political perspectives—is that our research mainly studies public space from physical perspectives; the data were not available from the other perspectives. This means that empirical research that is focused on the different perspectives of public space will make the overall results more accountable. For future research directions, more focused and stringent research programs are essential to enhance the understanding of public space study and its application in—and usefulness for—collective action. At the same time, we draw lessons for follow-up research; other potential mediators may also need to be identified and merit further investigation.

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