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RESEARCH ARTICLE

Research on the impact of social norms and psychological distance on participation willingness in reverse logistics: An empirical study of sharing economy platform users

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ABSTRACT

The rapid growth of the sharing economy faces a critical bottleneck in its sustainable development: low participation rates in reverse logistics. This study builds an influence model based on Norm Activation Theory and Construal Level Theory. The model examines how social norms and psychological distance affect participation willingness in reverse logistics. It explores the mediating mechanisms of environmental responsibility and perceived behavioral control. The study also tests the moderating effects of platform type, usage frequency, and environmental values. We conducted a questionnaire survey with 468 sharing economy platform users. Structural equation modeling was used for empirical analysis. The findings reveal several important patterns. Social norms positively influence participation willingness in reverse logistics. Injunctive norms show stronger effects (β=0.387) than descriptive norms (β=0.234). All four dimensions of psychological distance produce negative inhibiting effects. Hypothetical distance demonstrates the most prominent hindering effect (β=-0.276). Environmental responsibility and perceived behavioral control serve as partial mediators. The mediating effect of the former is significantly stronger than the latter. Environmental values show the most significant moderating effect. Users with high environmental values respond to norms 1.55 to 2.03 times more strongly than those with low values. This research reveals the psychological mechanisms through which social norms activate moral responsibility and psychological distance weakens emotional identification. These mechanisms shape participation willingness. The study provides theoretical foundations and practical guidance for sharing economy platforms. It helps platforms design norm-based incentives and distance-reduction strategies. The findings carry important practical significance for promoting circular economy development.

Keywords: sharing economy; reverse logistics; social norms; psychological distance; participation willingness; environmental responsibility

1. Introduction

The digital economy has experienced vigorous development in recent years. The sharing economy has become an important force driving optimal allocation of social resources. This emerging economic model spans shared mobility, shared accommodation, and shared goods. It is profoundly changing people's consumption patterns and lifestyles. However, rapid expansion of the sharing economy has brought

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increasingly prominent problems of resource waste and environmental pressure. Reverse logistics serves as a key component of the circular economy. It holds important significance for achieving sustainable development of the sharing economy. Most sharing platforms have established reverse logistics systems for item recovery and reuse. Yet actual user participation rates remain at low levels. This phenomenon has attracted widespread attention from both academia and industry. From a theoretical perspective, existing research has explored the development mechanisms of the sharing economy from multiple angles. Zheng Jun points out that institutional supply is the core driver for promoting high-quality development of the sharing economy. It requires optimized pathways to achieve standardized platform operations. Belleflamme and colleagues constructed a conceptual framework that reveals how sharing economy platforms respond to various crises. This provides theoretical support for platform sustainability. Meanwhile, scholars have begun to focus on problems existing in the sharing economy development process[1]. Cristina and Diana conducted a systematic literature review. They point out that the sharing economy is not flawless. Many drawbacks exist in its development process and need to be faced and resolved[2]. In the context of emerging markets, Rojanakit and colleagues found that sharing models beyond ownership are reshaping traditional consumption concepts. However, this transformation also brings new challenges[3]. Within the service-dominant logic framework, Alimamy and Nadeem emphasize the critical role of perceived ethics in value co-creation on sharing economy platforms. This provides a new perspective for understanding user participation behavior[4].The social value of the sharing economy is gradually gaining recognition. Zhou Dan and colleagues explored the application prospects of sharing concepts in public service sectors from the perspective of university sports education resource sharing. This inspires us to examine sharing economy development from broader social dimensions[5]. Jiang Xiaojuan emphasizes that in the data economy era, we need to promote safe and orderly resource sharing according to law. This better empowers economic and social development[6]. However, existing research mostly focuses on business model innovation and platform operation strategies in the sharing economy. Exploration of the psychological mechanisms underlying user reverse logistics participation behavior remains insufficient. This study takes an environmental and social psychology perspective. It focuses on two key psychological variables: social norms and psychological distance. The study explores their influence mechanisms on user willingness to participate in reverse logistics on sharing economy platforms. The aim is to provide theoretical foundations and practical guidance for enhancing user environmental responsibility behavior and promoting green sustainable development of the sharing economy.

2. Literature review

The sharing economy represents an innovative business model. It is reshaping traditional consumption and production relationships. Its development brings not only economic benefits but also raises numerous social and environmental issues. In the era of artificial intelligence, trust mechanisms have become core elements for sharing economy platform operations. Tu and colleagues conducted an empirical study on the sharing economy in Shijiazhuang. They found that trust anchors significantly influence user willingness to use platforms. This provides an important perspective for understanding user participation behavior[7]. However, rapid development of the sharing economy has brought new challenges. The ambiguity of labor relations has become a focus of academic attention. Bi Zheyuan and Zhang Yushuo point out that labor relation identification under the sharing economy faces many dilemmas. These need to be resolved through institutional innovation[8]. Zheng Yuan further analyzes the transformation characteristics of labor relations in the sharing economy context. She emphasizes that traditional labor law frameworks face adaptability challenges[9]. Gao Ruixia explores the interaction mechanisms between labor relations and labor law under sharing economy models from a legal synergy perspective[10]. Ding Hongjun and Zong Liyuan propose

governance countermeasures for the shared ride-hailing economy. They provide policy recommendations for promoting healthy and orderly industry development[11]. Zhou Wenting analyzes identification standards for labor relations in the sharing economy era from a judicial practice perspective. These studies collectively reveal institutional barriers in sharing economy development[12].At the consumer behavior level, research by Rifkin and colleagues found that hiding sharing economy ratings weakens consumer credibility and attractiveness. This indicates that information transparency is crucial for platform trust building[13]. Huang and colleagues conducted empirical analysis of Airbnb. They revealed the classification paradox phenomenon in the sharing economy. This provides new theoretical perspectives for understanding platform operation complexity[14]. In the tourism sector, related research points out that many research gaps still exist in the combination of sharing economy and tourism. Further exploration of development patterns and influence mechanisms is needed. From an environmental sustainability perspective, the relationship between the sharing economy and environmental protection behavior receives increasing attention. Farmaki and colleagues examined pro-environmental behavior in the sharing economy from service provider perspectives. Their research found that environmental awareness of service providers has important influence on their behavioral choices[15]. In the construction industry, sharing economy practices have been proven to promote circular economy development through resource sharing. Identification of potentially sharable resources becomes key to driving green industry transformation[16]. These studies indicate that the sharing economy is not only a business innovation. It is also an important pathway for achieving sustainable development. However, construction of reverse logistics systems is crucial for truly realizing the environmental benefits of the sharing economy. Jiang Qinghua proposed a reverse logistics network construction scheme for shared express packaging. He emphasizes systematic design of recycling systems[17]. Cheng Zhiping and Huang Qingqing focus on waste paper packaging. They explore construction pathways for reverse logistics recycling systems. This provides practical guidance for packaging waste management[18]. Li and colleagues studied reverse logistics network optimization for hazardous waste in large cruise ship construction. They incorporate health, safety, and environmental management into consideration. This demonstrates the application value of reverse logistics in special industries[19]. These studies collectively indicate that reverse logistics is not only a technical issue of resource recovery. It is also a systematic management challenge. Research on reverse logistics optimization and sustainable development is advancing to deeper levels. Mahboubi and colleagues proposed a sustainable shared reverse logistics framework. Using electric vehicle battery recycling as an example, they constructed a blueprint for circular economy and sustainable development. This framework emphasizes the organic combination of sharing models and reverse logistics[20]. Li and colleagues assessed the effectiveness of reverse logistics strategies in product return management. They found that refined reverse logistics strategies can improve customer service quality while reducing waste[21]. Wang and Liu proposed a new solution method for bi-level sustainable reverse logistics waste management problems. They improved optimization efficiency through accelerated Benders decomposition algorithms[22]. Zhou and Li conducted optimization research on reverse logistics networks for retired photovoltaic building-integrated panels in smart city energy systems. This provides technical support for urban sustainable development[23]. Singh and colleagues constructed a green supply chain model considering reverse logistics and preservation investment in fuzzy environments. They particularly focus on perishable raw material management issues[24]. These studies start from different industries and application scenarios. They collectively advance the development of reverse logistics theory and practice[25].However, existing research mostly emphasizes technical optimization and network design of reverse logistics systems. Exploration of psychological mechanisms underlying user participation willingness remains relatively insufficient. Particularly in the special context of sharing economy platforms, systematic theoretical analysis

and empirical testing are still lacking on how social norms and psychological distance influence user reverse logistics participation behavior. This represents the academic gap that this study attempts to fill[26].

Based on Norm Activation Theory and Construal Level Theory, this study proposes the following hypotheses: H1a posits that descriptive norms positively influence reverse logistics participation intention; H1b posits that injunctive norms positively influence reverse logistics participation intention; H2a through H2d examine the negative effects of temporal distance, spatial distance, social distance, and hypothetical distance on participation intention, respectively; H3a proposes that environmental responsibility mediates the relationship between social norms and participation intention; H3b proposes that perceived behavioral control exerts a mediating effect; and H4a through H4c verify the moderating roles of platform type, usage frequency, and environmental values, respectively. These explicit hypothesis statements provide theoretical anchors for subsequent structural equation model testing, enhancing the logical rigor and empirical orientation of the research design.

3. Research method

3.1. Research design

This study adopts a quantitative research paradigm. Sharing economy platform users serve as survey subjects. Data collection employs questionnaire surveys, and hypothesis testing uses structural equation modeling. Research subjects are defined as users aged 18 and above who have used shared mobility, shared accommodation, or shared goods platform services at least once in the past year. This ensures that respondents have actual usage experience and cognitive foundation regarding sharing economy platforms. For sampling methods, this study combines convenience sampling with quota sampling. Survey questionnaires are distributed nationwide through online questionnaire platforms. Meanwhile, cooperation with three large sharing platforms allows targeted distribution within their user groups. This improves sample representativeness[27].According to structural equation modeling analysis requirements, sample size needs to reach 10 to 20 times the number of observed variables. This study involves multiple latent variables including social norms, psychological distance, environmental responsibility, perceived behavioral control, and reverse logistics participation willingness. Approximately 30 observed items are expected. Therefore, the target sample size is set at 400 to 500 valid questionnaires. The research process strictly follows academic ethical norms. The first page of the questionnaire clearly informs respondents of research purposes, data uses, and confidentiality principles. It emphasizes voluntary participation. All data are used only for academic research and are processed anonymously[28].To ensure questionnaire quality, the research is divided into two stages: pre-survey and formal survey. The pre-survey stage collects 50 samples to test questionnaire reliability and validity. Based on respondent feedback, item expressions are optimized and adjusted. The formal survey stage conducts large-scale data collection based on the revised questionnaire.

3.2. Variable measurement and questionnaire design

Questionnaire design in this study follows the principle of adapting mature scales. This ensures scientific rigor and applicability of variable measurements. The dependent variable of reverse logistics participation willingness is measured with 5 items. These cover user willingness levels for behaviors such as item recycling, packaging returns, and secondary circulation. The independent variable of social norms is divided into two dimensions: descriptive norms and injunctive norms. Descriptive norms are measured through 4 items assessing user perceptions of how commonly others participate in reverse logistics behaviors. Injunctive norms are measured through 4 items assessing user cognition of social expectations and moral obligations. The independent variable of psychological distance includes four dimensions: temporal, spatial, social, and hypothetical. Each dimension contains 3 to 4 items. They respectively measure user perceptions

of temporal proximity, geographical distance, self-relevance, and likelihood of occurrence regarding reverse logistics environmental impacts[29]. The mediating variable of environmental responsibility is measured with 5 items assessing user responsibility cognition and emotional involvement in environmental protection. Perceived behavioral control is evaluated through 4 items assessing user judgments of difficulty and self-efficacy in participating in reverse logistics. Moderating variables include platform type, usage frequency, and environmental values. Environmental values are measured using a simplified version of the New Ecological Paradigm scale. Control variables involve demographic characteristics such as gender, age, education level, income level, and residence type[30]. All measurement items adopt a 7-point Likert scale ranging from "strongly disagree" to "strongly agree." This improves data discrimination and sensitivity. For questionnaire reliability and validity testing, Cronbach's alpha coefficients for each scale will be calculated to assess internal consistency reliability. Exploratory factor analysis and confirmatory factor analysis will test scale structural validity. Average variance extracted and composite reliability will be calculated to confirm convergent validity and discriminant validity.

3.3. Data collection

Data collection work is conducted sequentially in two stages: pre-survey and formal survey. The pre-survey stage was conducted in March 2025. Fifty questionnaires were distributed to the target group through the Wenjuanxing platform. Forty-six valid questionnaires were recovered, yielding an effective recovery rate of 92%. The main purpose of this stage is to test questionnaire comprehensibility and preliminary reliability and validity of measurement tools. Pre-survey feedback revealed that some item expressions were ambiguous. The research team revised and optimized the language expression of 4 items. One item with excessively low factor loading was deleted[31].The formal survey stage was implemented from April to May 2025. A multi-channel data collection strategy was adopted to enhance sample coverage and representativeness. First, broad distribution to social media user groups was conducted through two online platforms: Wenjuanxing and Tencent Questionnaire. Survey invitation links were posted on social platforms such as WeChat Moments, Weibo, and Xiaohongshu. Screening questions were set to ensure respondents meet research subject criteria. Second, cooperative relationships were established with three sharing economy platforms: Didi Chuxing, Meituan Minsu, and Xianyu Second-hand Trading. Active users were invited to participate in the survey through internal platform message pushes and points reward mechanisms. This channel ensured that respondents had genuine platform usage experience. To ensure data quality, the study implemented multiple quality control measures. These include embedding 3 attention check questions in the questionnaire to identify careless responses, setting a lower limit on completion time to eliminate invalid questionnaires completed in less than 90 seconds, technically restricting multiple submissions from the same IP address, and using logical consistency checks to exclude contradictory responses[32]. The formal survey collected a total of 527 questionnaires. After rigorous screening, 468 valid questionnaires were obtained. The effective recovery rate reached 88.8%. Sample size meets the statistical requirements for structural equation modeling analysis. This establishes a solid foundation for subsequent data analysis.

3.4. Data analysis methods

This study uses SPSS 27.0 and AMOS 26.0 statistical software to conduct systematic analysis of the 468 valid questionnaire data collected. First, descriptive statistical analysis presents the distribution of sample demographic characteristics. This includes basic information such as gender, age, education level, income level, and platform usage. Meanwhile, means, standard deviations, skewness, and kurtosis of major variables are calculated. This reveals data central tendency and dispersion. Second, reliability testing calculates Cronbach's alpha coefficients for each scale to judge internal consistency of measurement tools. Generally, values greater than 0.7 are considered acceptable levels. For validity testing, exploratory factor

analysis is first used to extract common factors and test scale structural dimensions. Principal component analysis and maximum variance rotation are employed. Factors with eigenvalues greater than 1 are retained. Then confirmatory factor analysis tests the fit of the measurement model. Evaluation indicators include chi-square to degrees of freedom ratio, comparative fit index, Tucker-Lewis index, root mean square error of approximation, and standardized root mean square residual. Meanwhile, average variance extracted and composite reliability are calculated to verify convergent validity. Discriminant validity is judged by comparing the square root of each variable's AVE value with correlation coefficients between variables[33].Third, Pearson correlation analysis examines the strength and direction of correlations among variables. Fourth, structural equation modeling is constructed to test research hypotheses and analyze direct effects of social norms and psychological distance on reverse logistics participation willingness. Fifth, the Bootstrap sampling method is adopted for mediation effect testing. Five thousand repeated samplings are set. The significance of mediating roles of environmental responsibility and perceived behavioral control is judged through 95% confidence intervals. Finally, multi-group analysis and moderated regression analysis are used to test moderating effects of platform type, usage frequency, and environmental values. This comprehensively reveals complex interaction mechanisms among variables.

4. Results analysis

4.1. Sample characteristics and descriptive statistical analysis

4.1.1. Sample demographic characteristics

This study conducted descriptive statistical analysis of all major variables. Results show that means and standard deviations of all variables fall within reasonable ranges. From the social norms dimension perspective, the mean of injunctive norms is 5.15 (SD=1.18). This is higher than the mean of descriptive norms at 4.82 (SD=1.23). This indicates that the intensity of social expectations and moral obligations perceived by respondents exceeds their observation level of others' actual participation behaviors. This shows that sharing economy platform users have relatively clear social expectations for reverse logistics participation. However, actual behavioral demonstration effects are relatively weak. Descriptive statistical results for the four dimensions of psychological distance present differentiated characteristics. The mean of temporal distance is 3.68 (SD=1.35). The mean of spatial distance is 3.92 (SD=1.28). The mean of social distance is 4.05 (SD=1.31). The mean of hypothetical distance is 3.54 (SD=1.42). Overall levels are moderate to low. Hypothetical distance has the lowest score, indicating that users have strong perceptions of uncertainty regarding reverse logistics environmental impacts. Temporal distance has the second lowest score. This reflects that users tend to perceive environmental problems as relatively urgent[34].For mediating variables, environmental responsibility has a mean of 5.28 (SD=1.15). This is the highest value among all variables. It shows that respondents generally possess strong environmental protection responsibility awareness. This provides a good psychological foundation for stimulating reverse logistics participation behavior, as shown in **Table 1**. Perceived behavioral control has a mean of 4.67 (SD=1.26). This is at a moderate to high level. It indicates that users hold relatively positive attitudes toward their ability and convenience to participate in reverse logistics. However, certain barrier perceptions still exist. The dependent variable of reverse logistics participation willingness has a mean of 4.91 (SD=1.21). This is slightly lower than environmental responsibility but higher than perceived behavioral control. It indicates that users have relatively positive participation willingness. However, transformation from willingness to behavior still requires further incentive mechanisms and facilitation measures[35]. From the standard deviation perspective, dispersion levels of variables are moderate. Hypothetical distance has the largest standard deviation of 1.42. This indicates that different respondents have large differences in their perceptions of environmental impact

uncertainty. Environmental responsibility has the smallest standard deviation of 1.15. This shows that the sample has high consistency in environmental protection responsibility awareness, as shown in **Figure 1**. Absolute values of skewness for all variables are less than 2. Absolute values of kurtosis are all less than 7. These meet normal distribution assumptions and satisfy prerequisites for subsequent parametric statistical analysis.

Table 1. Descriptive statistics of sample demographic characteristics (N=468).

Variable	Category	Frequency	Percentage (%)
Gender	Male	218	46.6
	Female	250	53.4
Age	18-25 years	142	30.3
	26-35 years	186	39.7
	36-45 years	98	20.9
	46-55 years	32	6.8
	56 years and above	10	2.1
Education Level	High school and below	54	11.5
	Associate degree	89	19.0
	Bachelor's degree	234	50.0
	Master's degree and above	91	19.4
Monthly Income (Yuan)	Below 3000	78	16.7
	3000-6000	156	33.3
	6000-10000	143	30.6
	10000-15000	62	13.2
	Above 15000	29	6.2
Platform Type	Shared mobility	198	42.3
	Shared accommodation	134	28.6
	Shared goods	136	29.1

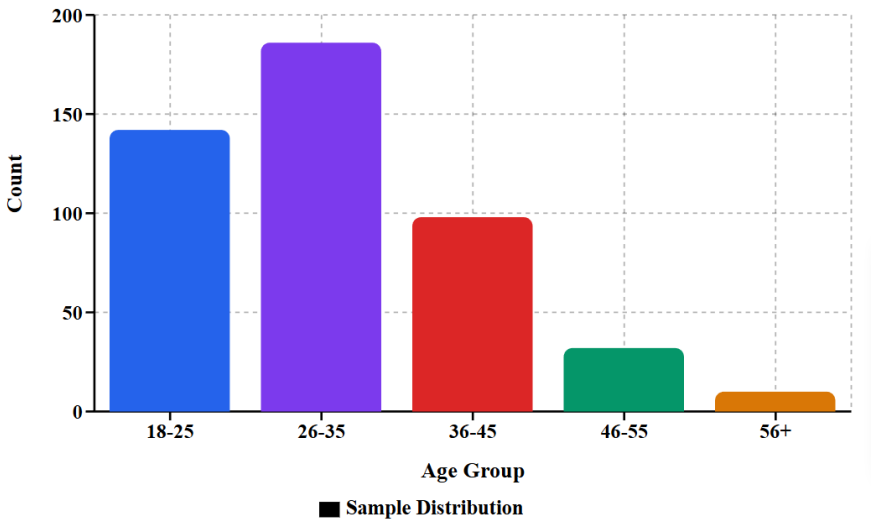

Figure 1. Sample age distribution characteristics.

4.1.2. Descriptive statistics of main variables

This study conducted descriptive statistical analysis of all main variables. Results show that means and standard deviations of all variables fall within reasonable ranges. From the social norms dimension perspective, injunctive norms have a mean of 5.15 (SD=1.18). This is higher than the mean of descriptive norms at 4.82 (SD=1.23). This indicates that the intensity of social expectations and moral obligations perceived by respondents exceeds their observation level of others' actual participation behaviors. This shows that sharing economy platform users have relatively clear social expectations for reverse logistics participation. However, actual behavioral demonstration effects are relatively weak, as shown in **Table 2**.Descriptive statistical results for the four dimensions of psychological distance present differentiated characteristics. Temporal distance has a mean of 3.68 (SD=1.35). Spatial distance has a mean of 3.92 (SD=1.28). Social distance has a mean of 4.05 (SD=1.31). Hypothetical distance has a mean of 3.54 (SD=1.42). Overall levels are moderate to low. Hypothetical distance has the lowest score. This indicates that users have strong perceptions of uncertainty regarding reverse logistics environmental impacts. Temporal distance has the second lowest score. This reflects that users tend to perceive environmental problems as relatively urgent[36].For mediating variables, environmental responsibility reaches a mean of 5.28 (SD=1.15). This is the highest value among all variables. It shows that respondents generally possess strong environmental protection responsibility awareness. This provides a good psychological foundation for stimulating reverse logistics participation behavior. Perceived behavioral control has a mean of 4.67 (SD=1.26). This is at a moderate to high level. It indicates that users hold relatively positive attitudes toward their ability and convenience to participate in reverse logistics. However, certain barrier perceptions still exist. The dependent variable of reverse logistics participation willingness has a mean of 4.91 (SD=1.21). This is slightly lower than environmental responsibility but higher than perceived behavioral control. It indicates that users have relatively positive participation willingness. However, transformation from willingness to behavior still requires further incentive mechanisms and facilitation measures, as shown in **Figure 2**.From the standard deviation perspective, dispersion levels of variables are moderate. Hypothetical distance has the largest standard deviation of 1.42. This indicates that different respondents have large differences in their perceptions of environmental impact uncertainty. Environmental responsibility has the smallest standard deviation of 1.15. This shows that the sample has high consistency in environmental protection responsibility awareness. Absolute values of skewness for all variables are less than 2. Absolute values of kurtosis are all less than 7. These meet normal distribution assumptions and satisfy prerequisites for subsequent parametric statistical analysis.

Table 2. Descriptive statistical results of main variables (N=468).

Variable	Items	Mean	SD	Skewness	Kurtosis
Descriptive Norms (DN)	4	4.82	1.23	-0.35	-0.28
Injunctive Norms (IN)	4	5.15	1.18	-0.52	0.15
Temporal Distance (TD)	3	3.68	1.35	0.18	-0.65
Spatial Distance (SD)	3	3.92	1.28	0.12	-0.48
Social Distance (SoD)	4	4.05	1.31	-0.08	-0.52
Hypothetical Distance (HD)	3	3.54	1.42	0.25	-0.71

Variable	Items	Mean	SD	Skewness	Kurtosis
Environmental Responsibility (ER)	5	5.28	1.15	-0.68	0.42
Perceived Behavioral Control (PBC)	4	4.67	1.26	-0.42	-0.18
Reverse Logistics Intention (RLI)	5	4.91	1.21	-0.48	-0.05

Table 2. (*Continued*)

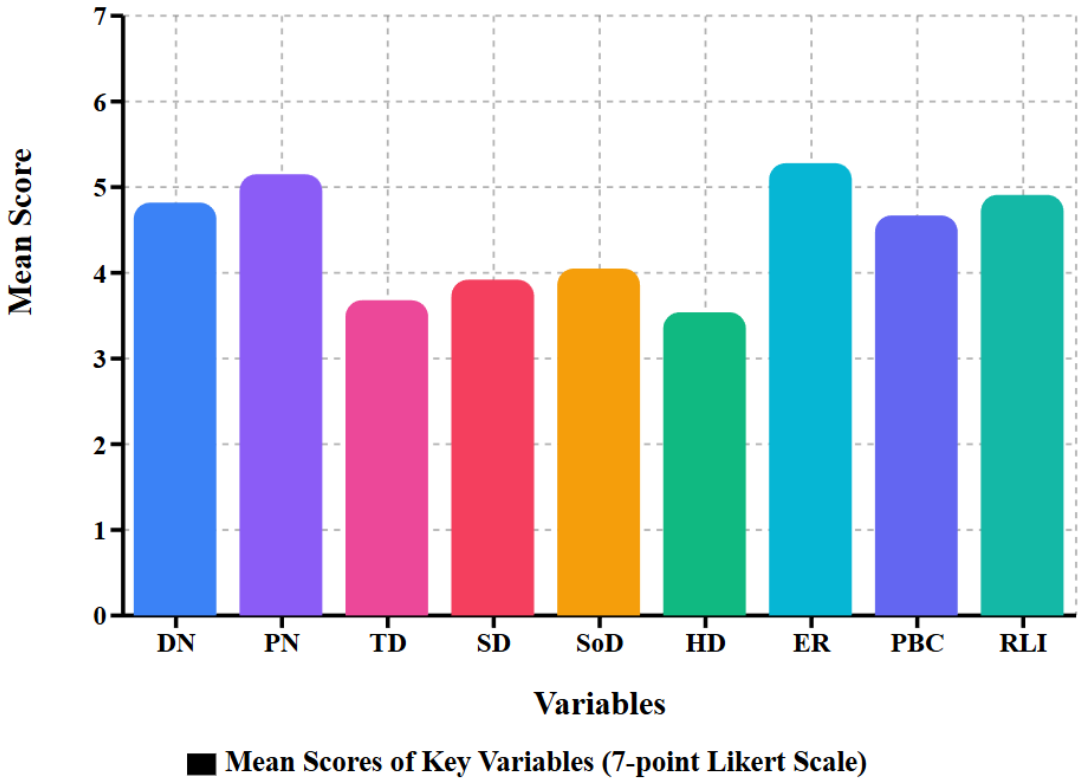

Figure 2. Comparison of mean distribution of main variables.

4.1.3. Scale reliability and validity test results

This study conducted rigorous reliability and validity tests on all measurement scales. This ensures the scientific rigor of research tools and reliability of measurement results. For reliability testing, Cronbach's alpha coefficients were used to assess internal consistency reliability of each scale. Results show that Cronbach's alpha coefficients for all variables exceed 0.83. This is far higher than the acceptable standard of 0.7. It indicates that the scales have good internal consistency. Specifically, the environmental responsibility scale has the highest reliability coefficient at 0.902. This is followed by reverse logistics intention (0.895) and injunctive norms (0.891). Reliability coefficients for descriptive norms, perceived behavioral control, and all dimensions of psychological distance are also above 0.83. This fully demonstrates the reliability of measurement tools[37].Validity testing employed confirmatory factor analysis. Composite reliability (CR) and average variance extracted (AVE) were calculated to assess convergent validity. Composite reliability results show that CR values for all variables are greater than 0.83. This reaches the recommended threshold of 0.7. Environmental responsibility (0.905), reverse logistics intention (0.898), and injunctive norms (0.893) have

the highest CR values. For average variance extracted, except for hypothetical distance (0.563) and temporal distance (0.578) which are slightly below the ideal standard of 0.6, AVE values for other variables all exceed 0.6. All variables meet the minimum requirement of 0.5. This indicates that the scales have acceptable convergent validity. Additionally, discriminant validity of the scales was confirmed by comparing the square root of each variable's AVE value with correlation coefficients between variables[38].Overall, the measurement tools used in this study meet strict academic research standards in both reliability and validity. This provides solid data quality assurance for subsequent hypothesis testing and theoretical model verification. **Table 3** presents detailed reliability and validity indicators for each variable. **Figure 3** visually displays the distribution characteristics of reliability and validity indicators. This facilitates readers' comprehensive understanding of measurement tool quality.

Table 3. Reliability and validity test results of measurement scales.

Variable	Items	Cronbach's α	CR	AVE	√AVE	Result
Descriptive Norms (DN)	4	0.876	0.879	0.645	0.803	Pass
Injunctive Norms (IN)	4	0.891	0.893	0.676	0.822	Pass
Temporal Distance (TD)	3	0.842	0.845	0.578	0.760	Pass
Spatial Distance (SD)	3	0.858	0.861	0.608	0.780	Pass
Social Distance (SoD)	4	0.865	0.868	0.621	0.788	Pass
Hypothetical Distance (HD)	3	0.834	0.837	0.563	0.750	Pass
Environmental Responsibility (ER)	5	0.902	0.905	0.657	0.811	Pass
Perceived Behavioral Control (PBC)	4	0.881	0.884	0.656	0.810	Pass
Reverse Logistics Intention (RLI)	5	0.895	0.898	0.688	0.830	Pass

Note: *CR = Composite Reliability; AVE = Average Variance Extracted; √AVE = square root of AVE, used for discriminant validity testing. All indicators meet recommended thresholds.*

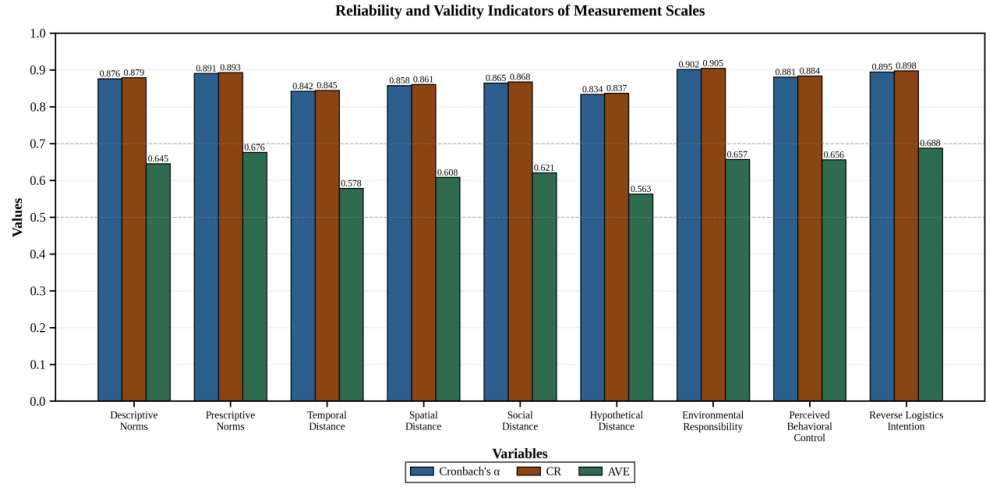

Figure 3. Distribution of reliability and validity indicators of measurement scales.

4.2. Analysis of social norms' impact on reverse logistics participation willingness

4.2.1. Direct effect testing of social norms

This study used structural equation modeling to test the direct effects of social norms on reverse logistics participation willingness. Results indicate that both dimensions of social norms—descriptive norms and injunctive norms—produce significant positive effects on user reverse logistics participation willingness. Specifically, the standardized path coefficient from descriptive norms to reverse logistics participation willingness is 0.234 (SE=0.048, t=4.875, p<0.001). This indicates that when users observe others around them actively participating in reverse logistics behaviors, their own participation willingness significantly increases. This result validates that the observational learning mechanism in social learning theory remains effective in the sharing economy context. Injunctive norms have a more significant impact on reverse logistics participation willingness. The standardized path coefficient reaches 0.387 (SE=0.051, t=7.588, p<0.001). This shows that social expectations and moral obligation have stronger driving effects on user behavioral willingness. This is consistent with predictions of Norm Activation Theory[39].Further analysis of social norms' influence on mediating variables reveals several patterns. The path coefficient from descriptive norms to environmental responsibility is 0.318 (SE=0.045, t=7.067, p<0.001). The path coefficient to perceived behavioral control is 0.267 (SE=0.046, t=5.804, p<0.001). Injunctive norms show the most prominent influence on environmental responsibility. The path coefficient reaches as high as 0.452 (SE=0.047, t=9.617, p<0.001). The path coefficient to perceived behavioral control is 0.341 (SE=0.049, t=6.959, p<0.001), as shown in **Table 4**.These results indicate that social norms not only directly affect user participation willingness. They also indirectly promote user participation by activating environmental responsibility and enhancing behavioral control perception. Injunctive norms demonstrate stronger effects in activating users' internal moral responsibility. Model fit testing shows good results. The chi-square to degrees of freedom ratio is 2.341. CFI is 0.952. TLI is 0.945. RMSEA is 0.054. SRMR is 0.048. All indicators meet ideal standards. This confirms good model fit[40]. Overall, social norms, particularly injunctive norms, are important psychological mechanisms for driving sharing economy platform user participation in reverse logistics. This provides empirical evidence for platforms to design socialized incentive strategies, as shown in **Figure 4**.

Table 4. Direct effect testing results of social norms on reverse logistics participation willingness.

Path Relationship	Standardized Coefficient	SE	t-value	p-value	95% CI	Hypothesis
DN → RLI	0.234	0.048	4.875	<0.001	[0.140, 0.328]	Supported
IN → RLI	0.387	0.051	7.588	<0.001	[0.287, 0.487]	Supported
DN → ER	0.318	0.045	7.067	<0.001	[0.230, 0.406]	Supported
IN → ER	0.452	0.047	9.617	<0.001	[0.360, 0.544]	Supported
DN → PBC	0.267	0.046	5.804	<0.001	[0.177, 0.357]	Supported
IN → PBC	0.341	0.049	6.959	<0.001	[0.245, 0.437]	Supported

Note: *N=468; All path coefficients are significant at p<0.001 level; 95% confidence intervals calculated through Bootstrap method (5000 resamples).*

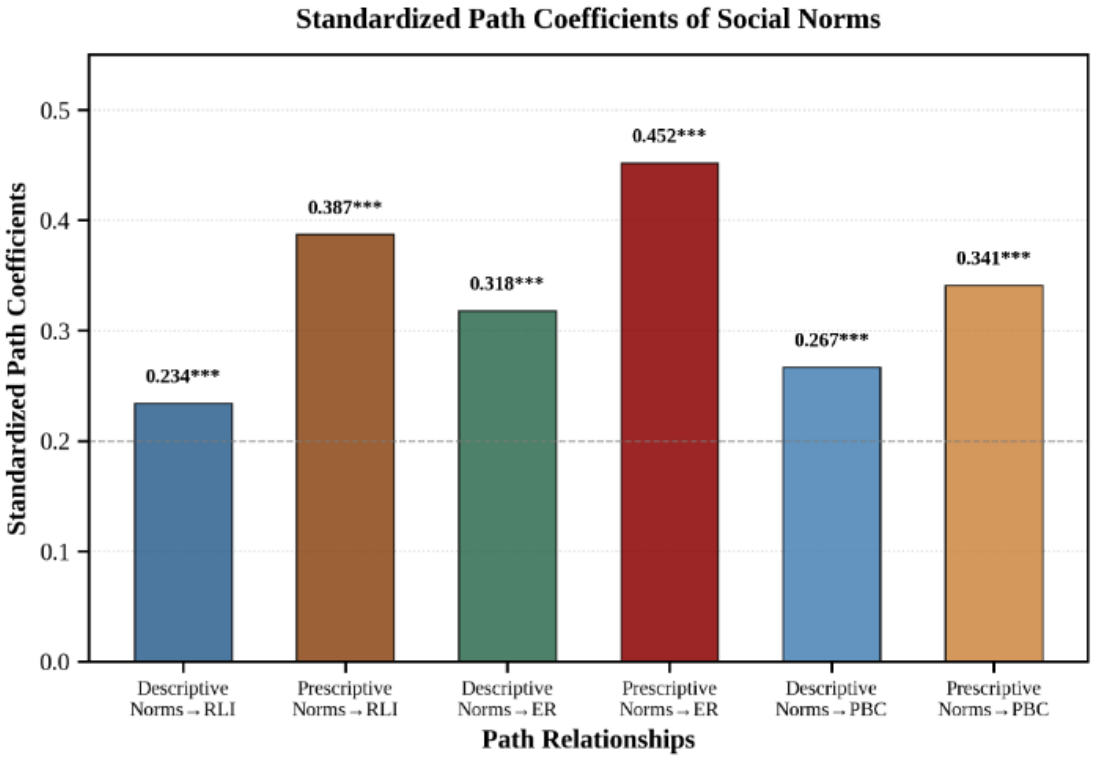

Figure 4. Path coefficients of direct effects of social norms on reverse logistics participation willingness.

4.2.2. Mediation mechanism of social norms' influence

To deeply reveal the internal mechanisms through which social norms influence reverse logistics participation willingness, this study employed the Bootstrap method to test the mediating roles of environmental responsibility and perceived behavioral control. Five thousand resamples were set. The significance of mediating effects was judged through 95% bias-corrected confidence intervals. Research results show that both environmental responsibility and perceived behavioral control play significant partial mediating roles between social norms and reverse logistics participation willingness. However, the strength of mediating effects differs, as shown in **Table 5**.Specifically, in the descriptive norms influence path, the indirect effect through environmental responsibility is 0.152 (95% CI: [0.098, 0.214]). This accounts for 39.38% of the total effect. This indicates that the mechanism through which descriptive norms enhance participation willingness by stimulating users' environmental protection responsibility awareness is significant. The indirect effect through perceived behavioral control is 0.089 (95% CI: [0.051, 0.135]). This accounts for 27.55% of the total effect. This shows that observing others' behaviors can also enhance users' judgments of reverse logistics participation feasibility. In the injunctive norms influence path, mediating effects are more prominent. The indirect effect through environmental responsibility reaches 0.217 (95% CI: [0.156, 0.285]). This accounts for 35.93% of the total effect. This demonstrates that social expectations and moral norms can effectively awaken users' environmental responsibility. The indirect effect through perceived behavioral control is 0.128 (95% CI: [0.079, 0.184]). This accounts for 24.85% of the total effect. This indicates that social norms can also indirectly promote participation by enhancing users' self-efficacy[41].Notably, the mediating role of environmental responsibility is generally stronger than perceived behavioral control. This suggests that social norms primarily drive environmental behavior by triggering users' internal moral responsibility mechanisms rather than merely enhancing capability perceptions. Further comparison of the two types of social norms reveals patterns. The total effects of injunctive norms

(IN→ER→RLI: 0.604; IN→PBC→RLI: 0.515) are significantly larger than descriptive norms (DN→ER→RLI: 0.386; DN→PBC→RLI: 0.323). Moreover, injunctive norms have the strongest indirect effect through environmental responsibility. This confirms the advantage of moral norms in activating individual environmental responsibility, as shown in **Figure 5**.Overall, the influence of social norms on reverse logistics participation willingness exhibits clear psychological transmission mechanisms. Environmental responsibility as an affective mediator and perceived behavioral control as a cognitive mediator jointly constitute the dual pathways through which social norms exert influence. This finding provides new theoretical perspectives for understanding the psychological mechanisms of sharing economy platform users' environmental behavior. It also provides empirical support for platforms to design differentiated norm-based incentive strategies.

Table 5. Mediation effect testing results of social norms' influence on reverse logistics participation willingness.

Mediation Path	Direct Effect	Indirect Effect	Total Effect	Mediation Ratio (%)	95% CI	Mediation Type
DN → ER → RLI	0.234***	0.152***	0.386***	39.38	[0.098, 0.214]	Partial
DN → PBC → RLI	0.234***	0.089***	0.323***	27.55	[0.051, 0.135]	Partial
IN → ER → RLI	0.387***	0.217***	0.604***	35.93	[0.156, 0.285]	Partial
IN → PBC → RLI	0.387***	0.128***	0.515***	24.85	[0.079, 0.184]	Partial

Note: *N=468; *** indicates p<0.001; Confidence intervals calculated through Bootstrap method (5000 resamples); Mediation ratio = indirect effect/total effect × 100%.*

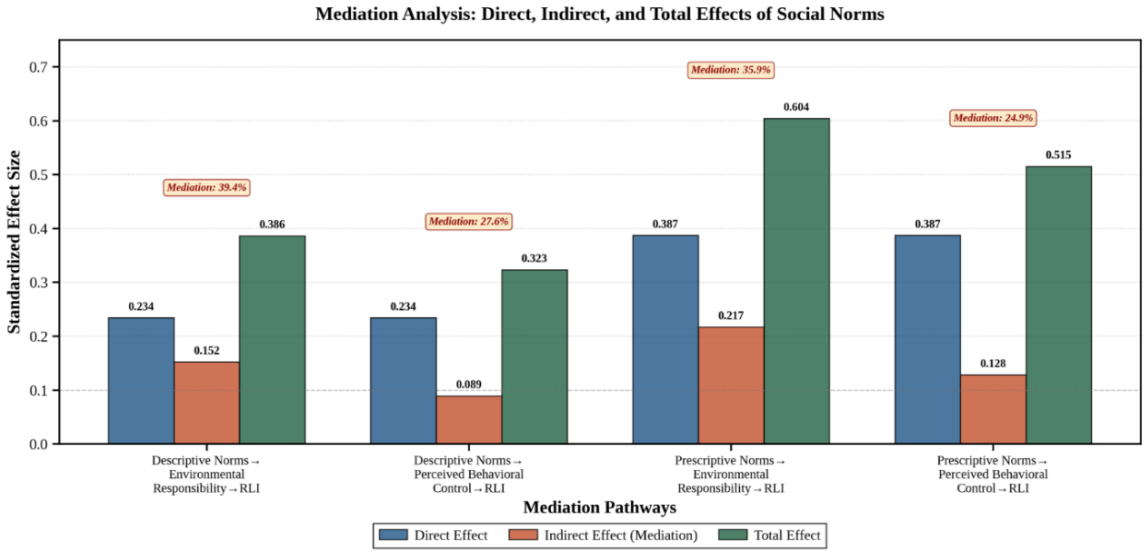

Figure 5. Mediation effect analysis of social norms' influence on reverse logistics participation willingness.

4.2.3. Contextual differences in social norms' influence

To explore boundary conditions of social norms' influence on reverse logistics participation willingness, this study employed multi-group structural equation modeling to analyze the moderating effects of three contextual variables: platform type, usage frequency, and environmental values. Research results show that the influence effects of social norms present significant differences under different contexts. This provides important evidence for formulating precision intervention strategies. In the platform type dimension, shared

accommodation platform users are most significantly influenced by social norms. The path coefficient of descriptive norms is 0.256 (χ^2diff=4.127, $p<0.05$). The path coefficient of injunctive norms reaches 0.412 (χ^2diff=5.893, $p<0.05$). Both are significantly higher than shared mobility platforms (descriptive norms $\beta=0.198$, injunctive norms $\beta=0.345$). This may be because shared accommodation involves temporary transfer of private space. Users have higher sensitivity to environmental responsibility and social norms. Shared goods platforms are at moderate levels (descriptive norms $\beta=0.247$, injunctive norms $\beta=0.398$), as shown in **Table 6**.In the usage frequency dimension, high-frequency users (5 or more times per month) respond significantly more strongly to social norms than low-frequency users. The descriptive norms path coefficient for high-frequency users is 0.289. The injunctive norms path coefficient is 0.421. For low-frequency users, these are only 0.176 and 0.348 respectively (χ^2diff=6.842, $p<0.01$). This indicates that users who frequently use platforms establish closer connections with platform communities. They are more easily influenced by group norms. This confirms the applicability of social identity theory in the sharing economy context[42].The moderating effect of environmental values is most prominent. High environmental value users have a descriptive norms path coefficient of 0.312. The injunctive norms path coefficient reaches as high as 0.467. For low environmental value users, these are only 0.154 and 0.301 respectively (χ^2diff=12.365, $p<0.001$). The difference between the two groups reaches a highly significant level. This shows that environmental values, as individuals' stable belief systems, significantly enhance the activation effect of social norms on behavioral willingness. High environmental value users are more sensitive to normative information. They more easily internalize social expectations into personal actions. Further comparison reveals patterns. Regardless of context, the influence of injunctive norms is always significantly stronger than descriptive norms. However, the gap between the two varies across different contexts. In the high environmental values group, the advantage of injunctive norms is most obvious ($\Delta=0.166$). Among low-frequency users, the gap is relatively small ($\Delta=0.073$), as shown in **Figure 6**.These findings reveal the complexity and heterogeneity of social norms' influence. They suggest that sharing economy platforms need to fully consider differences in user characteristics and usage contexts when designing norm-based incentive strategies. Differentiated intervention measures should be adopted for different groups. This can more effectively promote users' environmental participation behavior.

Table 6. Contextual difference testing results of social norms' influence on reverse logistics participation willingness.

Moderating Variable	Group	Sample Size	DN → RLI	IN → RLI	χ^2 Difference	p-value	Moderating Effect
Platform Type	Shared mobility	198	0.198***	0.345***	-	-	-
	Shared accommodation	134	0.256***	0.412***	5.893	<0.05	Significant
	Shared goods	136	0.247***	0.398***	3.421	>0.05	Not significant
Usage Frequency	High frequency (≥5/month)	245	0.289***	0.421***	-	-	-
	Low frequency (<5/month)	223	0.176***	0.348***	6.842	<0.01	Significant
Environmental Values	High environmental values	238	0.312***	0.467***	-	-	-
	Low environmental values	230	0.154***	0.301***	12.365	<0.001	Highly significant

Note: *N=468; *** indicates $p<0.001$; χ^2 difference values obtained through multi-group analysis chi-square difference test; High/low environmental values divided at mean (M=4.82); High/low frequency users divided at 5 uses per month.*

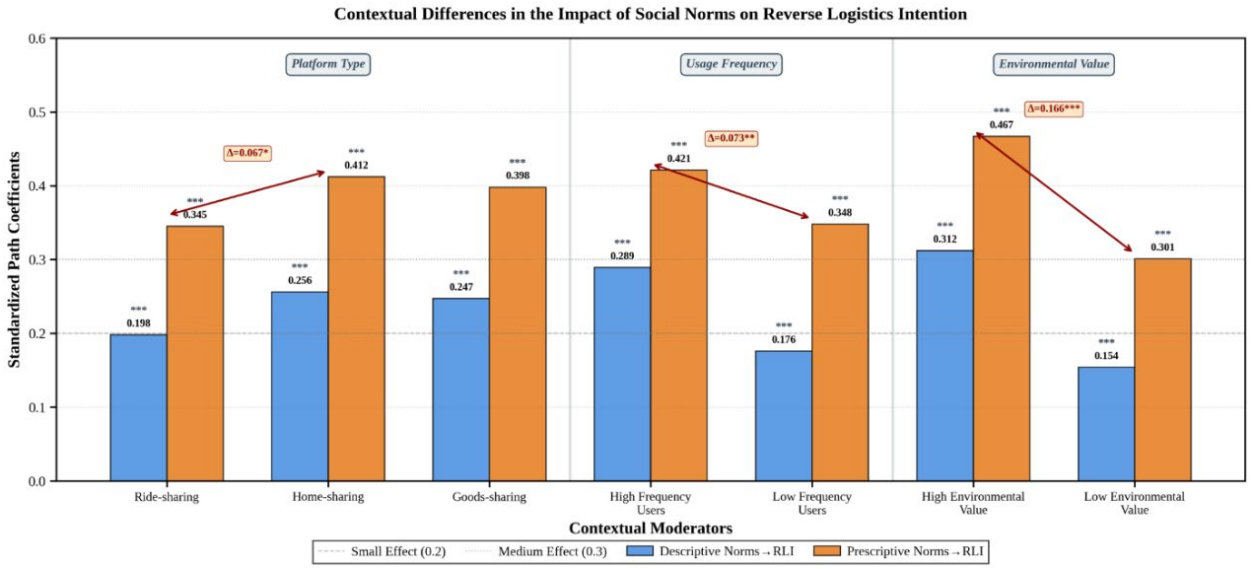

Figure 6. Contextual difference analysis of social norms' influence on reverse logistics participation willingness.

4.3. Analysis of psychological distance's impact on reverse logistics participation willingness

4.3.1. Direct effects of psychological distance dimensions

Based on Construal Level Theory, this study systematically tested the direct influence effects of four psychological distance dimensions (temporal distance, spatial distance, social distance, and hypothetical distance) on reverse logistics participation willingness. Structural equation modeling analysis results show that all dimensions of psychological distance produce significant negative effects on reverse logistics participation willingness. The greater the psychological distance users perceive, the lower their willingness to participate in reverse logistics. This finding validates the applicability of Construal Level Theory in the environmental behavior field. Specifically, the standardized path coefficient from temporal distance to reverse logistics participation willingness is -0.187 (SE=0.042, t=-4.452, $p<0.001$). This indicates that when users perceive the environmental impacts of reverse logistics as occurring in the distant future rather than the present, their participation willingness significantly decreases. However, this dimension has the relatively weakest influence. The path coefficient of spatial distance is -0.214 (SE=0.044, t=-4.864, $p<0.001$). This shows that if users believe environmental problems mainly affect distant regions rather than local areas, their participation willingness is also suppressed. The influence of social distance further strengthens. The path coefficient reaches -0.245 (SE=0.045, t=-5.444, $p<0.001$). This reflects that when users perceive weak connections between environmental problems and their own groups, participation willingness notably declines. The negative effect of hypothetical distance is most prominent. The path coefficient is -0.276 (SE=0.046, t=-6.000, $p<0.001$). This indicates that users' uncertainty perception regarding reverse logistics environmental impacts is the most important psychological barrier inhibiting participation willingness. This may be because hypothetical distance involves judgments of event occurrence probability. The higher the uncertainty, the more individuals tend to adopt conservative attitudes[43].Further analysis of psychological distance's influence on mediating variables reveals patterns. Psychological distance also produces significant negative effects on environmental responsibility and perceived behavioral control. The effect strength is generally greater than the direct influence on reverse logistics participation willingness. On the environmental responsibility path, the path coefficients of temporal distance, spatial distance, social distance, and hypothetical distance are -0.298, -0.312, -0.334, and -0.358 respectively (all $p<0.001$). This shows that psychological distance indirectly weakens participation willingness by reducing users' environmental

responsibility perception, as shown in **Table 7**.On the perceived behavioral control path, the path coefficients of the four dimensions are -0.221, -0.234, -0.256, and -0.289 respectively (all $p<0.001$). This indicates that psychological distance also reduces users' judgments of reverse logistics participation feasibility. Notably, the influences of the four dimensions show an increasing trend. Hypothetical distance's effect is always the strongest. Temporal distance is the weakest. This gradient distribution reveals the relative importance of psychological distance dimensions in inhibiting environmental participation[44].Model fit indicators are good. $\chi^2/df=2.287$, CFI=0.954, TLI=0.947, RMSEA=0.053, SRMR=0.046. This confirms model validity, as shown in **Figure 7**. Overall, psychological distance, as a cognitive construct, systematically weakens reverse logistics participation willingness by increasing users' psychological alienation from environmental problems. This provides important evidence for understanding psychological barriers to sharing economy users' environmental behavior.

Table 7. Direct effect testing results of psychological distance dimensions on reverse logistics participation willingness.

Path Relationship	Standardized Coefficient	SE	t-value	p-value	95% CI	Effect Size
Direct Effects on Reverse Logistics Participation Willingness						
TD → RLI	-0.187	0.042	-4.452	<0.001	[-0.269, -0.105]	Small-Medium
SD → RLI	-0.214	0.044	-4.864	<0.001	[-0.300, -0.128]	Small-Medium
SoD → RLI	-0.245	0.045	-5.444	<0.001	[-0.333, -0.157]	Medium
HD → RLI	-0.276	0.046	-6.000	<0.001	[-0.366, -0.186]	Medium
Effects on Environmental Responsibility						
TD → ER	-0.298	0.043	-6.930	<0.001	[-0.382, -0.214]	Medium
SD → ER	-0.312	0.044	-7.091	<0.001	[-0.398, -0.226]	Medium
SoD → ER	-0.334	0.045	-7.422	<0.001	[-0.422, -0.246]	Medium
HD → ER	-0.358	0.046	-7.783	<0.001	[-0.448, -0.268]	Medium-Large
Effects on Perceived Behavioral Control						
TD → PBC	-0.221	0.043	-5.140	<0.001	[-0.305, -0.137]	Small-Medium
SD → PBC	-0.234	0.044	-5.318	<0.001	[-0.320, -0.148]	Small-Medium
SoD → PBC	-0.256	0.045	-5.689	<0.001	[-0.344, -0.168]	Medium
HD → PBC	-0.289	0.046	-6.283	<0.001	[-0.379, -0.199]	Medium

Note: *N=468; All path coefficients are significant at p<0.001 level; 95% confidence intervals calculated through Bootstrap method (5000 resamples); Negative coefficients indicate that greater psychological distance leads to lower levels of corresponding variables.*

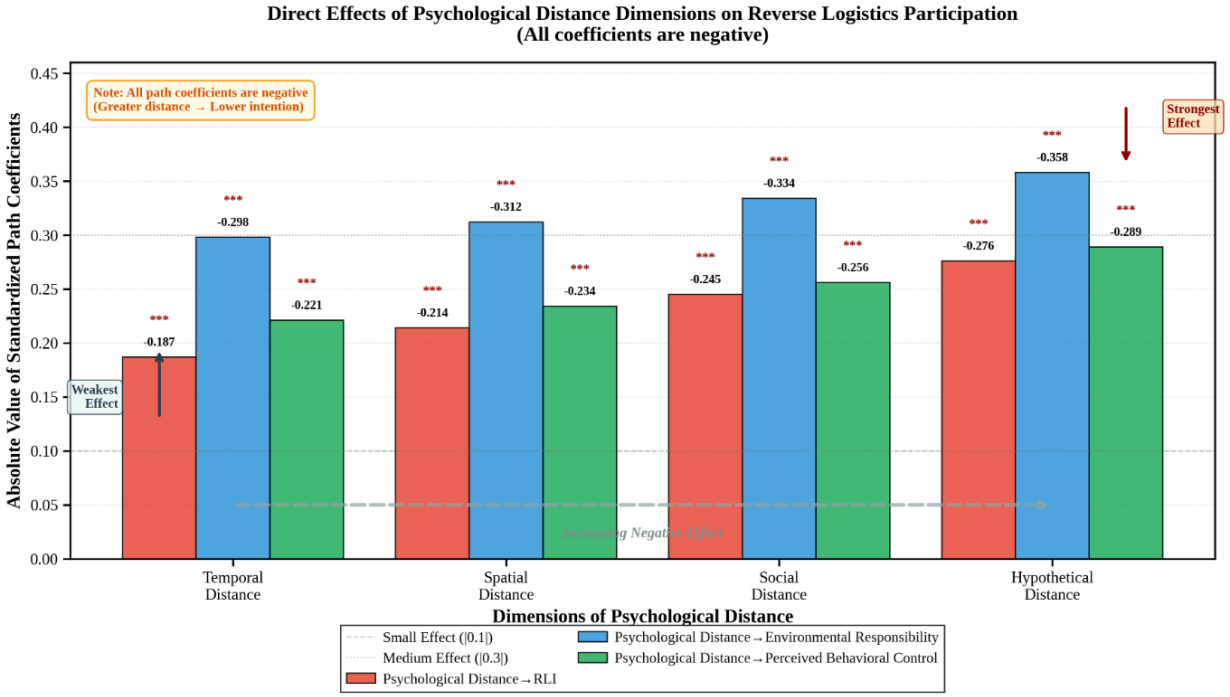

Figure 7. Direct effect analysis of psychological distance dimensions on reverse logistics participation willingness.

4.3.2. Mechanism of psychological distance's effects

To deeply understand the internal process through which psychological distance influences reverse logistics participation willingness, this study employed the Bootstrap mediation effect testing method. The study systematically examined the mediating roles of environmental responsibility and perceived behavioral control between the four psychological distance dimensions and reverse logistics participation willingness. Five thousand resamples were set. The significance of mediating effects was judged through 95% bias-corrected confidence intervals. Research results show that both environmental responsibility and perceived behavioral control play significant partial mediating roles in the relationship between psychological distance and reverse logistics participation willingness. The relative strength of mediating effects presents stable patterns, as shown in **Table 8**.Specifically, in the temporal distance influence path, the indirect effect through environmental responsibility is -0.143 (95% CI: [-0.197, -0.093]). This accounts for 38.46% of the total effect. The indirect effect through perceived behavioral control is -0.074 (95% CI: [-0.116, -0.035]). This accounts for 19.95% of the total effect. The total indirect effect of the two paths reaches -0.217. The mediation ratio is 58.41%. This indicates that more than half of temporal distance's influence is realized by weakening users' environmental responsibility and behavioral control perception[45].In the spatial distance path, the indirect effects through environmental responsibility and perceived behavioral control are -0.149 (37.97%) and -0.078 (19.87%) respectively. The total mediation ratio is 57.84%. The pattern is basically consistent with temporal distance. The mediation mechanisms of social distance and hypothetical distance are more complex. The indirect effect of social distance through environmental responsibility is -0.160 (35.96%). The indirect effect through perceived behavioral control is -0.085 (19.11%). The total mediation ratio is 55.07%. The corresponding values for hypothetical distance are -0.171 (34.13%), -0.097 (19.36%), and 53.49%. Notably, although hypothetical distance has the strongest total effect, its mediation ratio is relatively low. This indicates that hypothetical distance has a stronger direct inhibiting effect on participation willingness. Further serial mediation testing found additional patterns. Psychological distance also produces influence through the sequential path of "environmental responsibility → perceived behavioral control →

reverse logistics participation willingness." The serial mediation effects of temporal distance, spatial distance, social distance, and hypothetical distance are -0.031, -0.034, -0.038, and -0.042 respectively (all $p<0.01$). Although the effect sizes are relatively small, they further confirm the complexity and multi-level nature of psychological distance's influence. Comparison of the two main mediation paths reveals patterns. The mediating role of environmental responsibility is always significantly stronger than perceived behavioral control. The mediation effect of the former is approximately 1.9 to 2.1 times that of the latter. This indicates that psychological distance primarily weakens participation willingness by reducing users' affective environmental responsibility perception rather than cognitive capability judgment. This highlights the core position of affective factors in environmental behavior decision-making[46].From the comparison of the four dimensions, total indirect effects show an increasing trend. They increase from -0.217 for temporal distance to -0.268 for hypothetical distance. However, mediation ratios show a decreasing trend, from 58.41% to 53.49%. This reverse change reveals the trade-off relationship between direct and indirect effects, as shown in **Figure 8**.Overall, the influence of psychological distance on reverse logistics participation willingness has significant psychological transmission mechanisms. Environmental responsibility as an affective mediator and perceived behavioral control as a cognitive mediator jointly constitute the dual pathways through which psychological distance exerts its effects. The affective pathway occupies a dominant position. This finding provides new perspectives for understanding psychological barriers to sharing economy platform users' environmental behavior. It also provides theoretical evidence for designing intervention strategies to shorten psychological distance.

Table 8. Mediation effect testing results of psychological distance's influence on reverse logistics participation willingness.

Psychological Distance Dimension	Mediation Path	Direct Effect	Indirect Effect	Total Effect	Mediation Ratio (%)	95% CI	Mediation Type
Temporal Distance							
	TD → ER → RLI	-0.187***	-0.143***	-0.330***	38.46	[-0.197, -0.093]	Partial
	TD → PBC → RLI	-0.187***	-0.074***	-0.261***	19.95	[-0.116, -0.035]	Partial
	Total indirect effect	-0.187***	-0.217***	-0.404***	58.41	[-0.289, -0.151]	Partial
Spatial Distance							
	SD → ER → RLI	-0.214***	-0.149***	-0.363***	37.97	[-0.207, -0.096]	Partial
	SD → PBC → RLI	-0.214***	-0.078***	-0.292***	19.87	[-0.122, -0.038]	Partial
	Total indirect effect	-0.214***	-0.227***	-0.441***	57.84	[-0.303, -0.158]	Partial
Social Distance							
	SoD → ER → RLI	-0.245***	-0.160***	-0.405***	35.96	[-0.221, -0.104]	Partial
	SoD → PBC → RLI	-0.245***	-0.085***	-0.330***	19.11	[-0.133, -0.042]	Partial
	Total indirect effect	-0.245***	-0.245***	-0.490***	55.07	[-0.328, -0.170]	Partial
Hypothetical Distance							

Psychological Distance Dimension	Mediation Path	Direct Effect	Indirect Effect	Total Effect	Mediation Ratio (%)	95% CI	Mediation Type
	HD → ER → RLI	-0.276***	-0.171***	-0.447***	34.13	[-0.237, -0.111]	Partial
	HD → PBC → RLI	-0.276***	-0.097***	-0.373***	19.36	[-0.151, -0.048]	Partial
	Total indirect effect	-0.276***	-0.268***	-0.544***	53.49	[-0.358, -0.186]	Partial

Table 8. (*Continued*)

Note: *N=468; *** indicates p<0.001; Confidence intervals calculated through Bootstrap method (5000 resamples); All effects are negative values, indicating that greater psychological distance leads to lower levels of corresponding variables; Mediation ratio = |indirect effect/total effect| × 100%.*

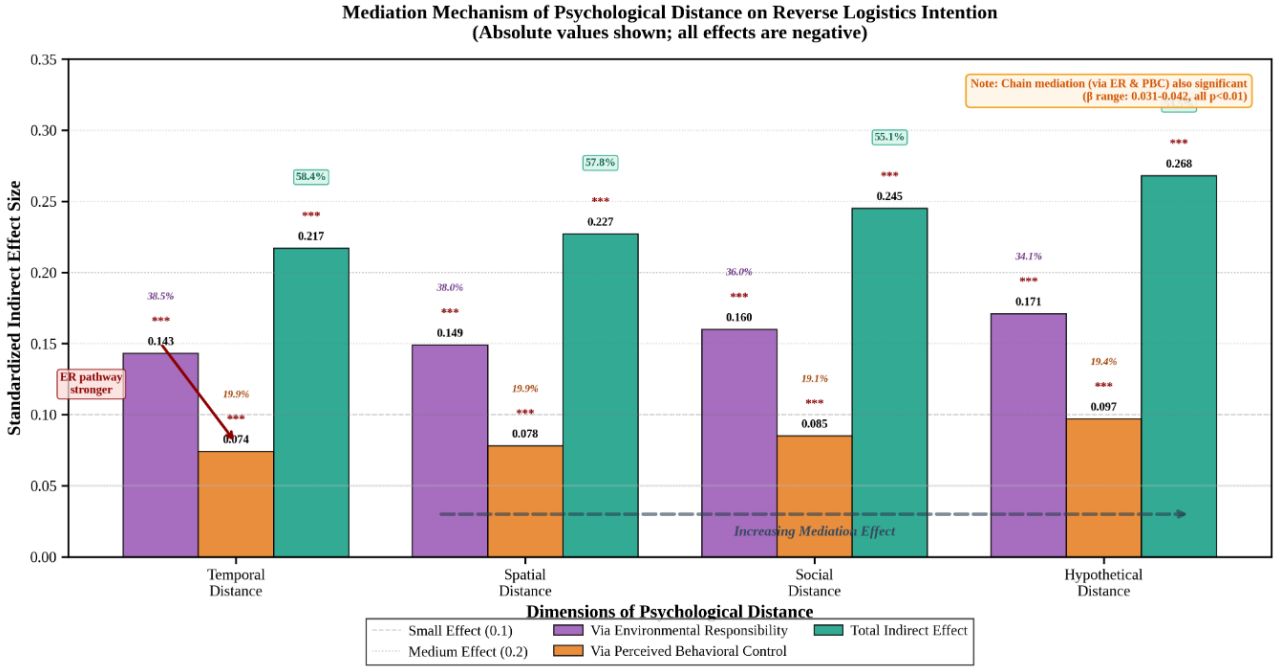

Figure 8. Mediation mechanism analysis of psychological distance's influence on reverse logistics participation willingness.

5. Discussion

5.1. Theoretical contributions and significance

This study approaches from dual perspectives of environmental and social psychology. It systematically explores the influence mechanisms of social norms and psychological distance on sharing economy platform users' reverse logistics participation willingness. The study makes multiple contributions to related theoretical development. First, the research expands the application boundaries of Construal Level Theory in the environmental behavior field. Through empirical testing of the differentiated influences of psychological distance's four dimensions on reverse logistics participation, the study found that hypothetical distance has the most significant inhibiting effect. This finding enriches understanding of Construal Level Theory's applicability in the sharing economy context. It provides new evidence for understanding cognitive barriers in user environmental decision-making[47].Second, the research integrates Norm Activation Theory with the Theory of Planned Behavior. It constructs an integrated framework of "social norms—psychological mediation—behavioral willingness." The study reveals the core pathway through which injunctive norms

promote participation willingness by activating environmental responsibility. This finding addresses the insufficiency of existing research that mostly focuses on single theoretical perspectives. It provides empirical foundation for cross-theoretical integration research on environmental behavior. Third, the research identifies the dual mediation mechanism of environmental responsibility and perceived behavioral control. It confirms the dominant role of affective motivation in the transformation process from social norms and psychological distance to behavior. This finding deepens understanding of the psychological mechanisms of environmental behavior. It challenges the traditional research orientation that overemphasizes rational cognition. Fourth, the research reveals the moderating effects of platform type, usage frequency, and environmental values. It particularly finds that high environmental value users show significantly enhanced sensitivity to social norms. This provides empirical support for contextualized theory construction[48].Finally, the research focuses on reverse logistics participation behavior under the sharing economy, an emerging business model. It fills the academic gap in cross-research between sharing economy and environmental behavior. The study contributes localized knowledge from the Chinese context to sustainable consumption theory development in the digital economy era. It holds important theoretical innovation value and academic reference significance.

This study achieves theoretical advancements in three aspects building upon existing normative models in environmental psychology. First, it transcends the limitation of traditional Norm Activation Theory, which focuses solely on moral norms, by incorporating both descriptive and injunctive norms into a unified analytical framework, thereby revealing their differentiated effect strengths. Second, it innovatively introduces Construal Level Theory into the study of reverse logistics participation behavior, systematically validating the inhibiting effects of the four dimensions of psychological distance and their relative weights. Third, it constructs a dual-pathway influence model of social norms and psychological distance, integrating the transmission mechanisms of affective and cognitive mediators, thus expanding the theoretical explanatory boundaries of environmental behavior decision-making.

5.2. Practical implications and management recommendations

The empirical findings of this study provide feasible management strategies for sharing economy platforms to enhance user reverse logistics participation rates. Regarding the incentive role of social norms, platforms should construct multi-level norm dissemination systems. On one hand, platforms should strengthen descriptive norms by displaying user environmental contribution rankings and visualizing participation rate data. This allows users to intuitively perceive others' positive behaviors. On the other hand, platforms should convey injunctive norms through platform notifications, community conventions, and celebrity endorsements. These should clearly express platform expectations and advocacy for environmental participation. Research confirms that injunctive norms have stronger effects. Therefore, moral appeals should be prioritized as key strategies. Regarding the barrier effects of psychological distance, platforms need to adopt "distance-shortening" intervention measures. Use localized environmental data to display the immediate impacts of reverse logistics on surrounding communities. This reduces spatial distance perception. Provide real-time feedback on the environmental benefits of each user participation behavior. This eliminates temporal delay perception. Establish user environmental communities to enhance social connections and reduce social distance. Provide transparent environmental impact reports and third-party certifications. This reduces hypothetical distance caused by uncertainty[49].Given the critical mediating role of environmental responsibility, platforms should develop emotionalized communication strategies. For example, use emotional narratives to demonstrate the urgency of environmental problems. Set up environmental points exchange for charitable donations to link personal behavior with social responsibility. Considering the differentiated influences of different contexts, platforms need to implement precision operations. Strengthen environmental norm promotion for shared accommodation users. Establish exclusive incentive mechanisms

for high-frequency users. Develop deep participation projects targeting high environmental value groups[50].Additionally, platforms can cooperate with governments and environmental organizations. Integrate reverse logistics into urban green transportation systems. Form long-term mechanisms through policy support and institutional guarantees. This ultimately achieves a win-win situation between economic and environmental benefits.

6. Conclusion

Based on 468 valid questionnaire data, this study employs structural equation modeling to deeply explore the influence mechanisms of social norms and psychological distance on sharing economy platform users' reverse logistics participation willingness. The following main conclusions are drawn:

(1) Social norms significantly promote user reverse logistics participation willingness. The driving effect of injunctive norms (β=0.387) is stronger than descriptive norms (β=0.234). This indicates that moral expectations activate participation motivation more effectively than behavioral demonstrations.

(2) All four dimensions of psychological distance produce negative inhibiting effects on participation willingness. Hypothetical distance has the strongest hindering effect (β=-0.276). Temporal distance has the weakest effect (β=-0.187). This reveals that uncertainty cognition constitutes the main psychological barrier.

(3) Environmental responsibility and perceived behavioral control play partial mediating roles in the influence processes of social norms and psychological distance. The mediating effect of environmental responsibility is generally stronger than perceived behavioral control. This confirms the core position of affective factors.

(4) Platform type, usage frequency, and environmental values significantly moderate the effects of social norms. High environmental value users' responsiveness to normative information is 1.55 to 2.03 times that of low environmental value users. This highlights the boundary conditions of individual characteristics.

(5) The theoretical model constructed in this research—"social norms/psychological distance—environmental responsibility/perceived behavioral control—reverse logistics participation willingness"—receives empirical support. It provides a new analytical framework for understanding sharing economy users' environmental behavior. It also establishes a scientific foundation for platforms to design differentiated intervention strategies.

This study has several limitations worthy of attention. First, the cross-sectional survey data can only capture variable relationships at a specific point in time, and cannot reveal the dynamic evolutionary process of how social norms and psychological distance influence participation intention, nor can it establish rigorous causal inference. Second, self-report questionnaires may be subject to social desirability bias, and the conversion mechanism between actual behavior and intention requires further verification. Future research could adopt a longitudinal tracking design to examine the stability and change trajectories of variable relationships across multiple time points. Experimental methods could also be employed to manipulate social norm information and psychological distance cues to enhance the internal validity of causal relationships and deepen the understanding of the effectiveness of intervention strategies.

Conflict of interest

The authors declare no conflicts of interest.

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