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The Gap between Willingness and Behavior: The Use of Recycled Water for Toilet Flushing in Beijing, China

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Abstract: Promoting the use of recycled water is an effective way to solve the problem of urban water shortage. In order to promote the utilization of recycled water, this study identified the influential factors determining the differences between willingness and behavior to use recycled water for toilet flushing. Binary logistic regression models of willingness and behavior were analyzed and the data came from 1195 Beijing residents in communities where recycled water was available for toilet flushing. The results are as follows: First, the proportion of those willing to use recycled water (92%) was significantly higher than those who actually did so (35.2%); thus, higher willingness to use recycled water did not necessarily lead to higher using behavior. Second, different factors influenced willingness and behavior, with the willingness mainly influenced by cognitive and attitudinal factors, and the behavior dependent on external environmental factors such as the convenience of installation and promotion measures. Third, the convenience of the installation of recycled water facilities is the most important factor influencing both willingness and behavior, and inconvenient facilities are the main factor hindering the use of recycled water.

Keywords: recycled water; willingness; behavior; theory of planned behavior

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1. Introduction

As cities continue to expand in size and urban populations continue to grow, the public demand for water is also growing rapidly [1]. It is predicted that, by 2050, at least a quarter of the world's population will live in countries and regions with water shortages [2]. In urban areas where industry and population are relatively concentrated, the mismatch between supply and demand for water resources is particularly prominent, and the limitations imposed by water resources on social and economic development have become an important issue [3]. With the recent acceleration of urbanization, the water crisis in China is intensifying. Over three-quarters of the more than 660 cities in China are facing water shortages, with more than 100 of them facing severe shortages [4]. Megacities, which are pioneers in urban development, also face various ecological and environmental problems caused by water resource shortages [1]. At present, an important solution for water shortages is increasing the existing water supply with alternative water sources, and people have gradually realized that recycled water can supply a stable alternative [5,6].

Recycled water as a stable and reliable alternative water source in cities is of great significance to relieve pressure on urban water resources and has been widely used in many countries and regions [7]. The current state-of-the-art allows recycled water to be used for a variety of purposes, including drinking [8]. However, even if the technique to produce recycled water is adequate, the investment is in place, and the safety measures are reasonable, a recycled water project may fail as a result of public opposition [9,10]. Researchers have become aware that the biggest obstacle to the promotion of recycled water use is not a technical issue, but rather the public's psychological acceptance [11]. For example, in the 1990s, a project for the use of recycled water for drinking in the U.S. city

of San Diego, California failed as a result of large-scale protests [10]. In 2006, a project in Australia for the use of recycled water to replenish reservoirs was terminated after strong opposition from communities [9].

In China, the reuse of sewage is still in its infancy, with inadequate and unbalanced development and a low utilization rate. In 2019, about 75 billion cubic meters of urban sewage was discharged in China, but less than 10 billion cubic meters of sewage was reused, illustrating the huge potential for sewage reuse [12]. In megacities such as Beijing and Tianjin (in northern China), severe water shortages are among the biggest obstacles to sustainable economic development, and recycled water has become an important alternative water resource [13]. At present, recycled water use in cities is mainly limited to urban greening, waterscape filling, road cleaning, fire water, car washing, and toilet flushing, among other uses [14]. In some cities, although residents do not object to the use of recycled water, there is a lack of practical use because of inadequate facilities [15].

1.1. Predictors of Recycled Water Use Behavior

Previous studies have shown that demographic variables such as gender, age, education, income, and religion are associated with the acceptance of recycled water [14,16,17]. A previous study has suggested that men are more likely to use recycled water than women, because they are more receptive to risky technologies [18]. Some previous studies have found a negative correlation between age and willingness to use recycled water [17,19], while another found a positive correlation [20]. Some studies have suggested that, the higher the level of education, the higher the acceptance of recycled water use [16,21,22]. Previous studies have also found a positive correlation between income level and acceptance of recycled water [23,24]. Different studies found that participants were more willing to use recycled water if it would lower their water bills [24,25]. When people mentioned the benefits of recycled water, they first associated it with "environmental protection", "sustainability", "water conservation", and so on and believed that promoting recycled water would be good for environmental protection [26,27]. If people think something can bring more benefits, then they will also think it entails a lower level of risk, which leads to higher acceptance [28]. A previous study found that greater belief in the benefits of recycled water was positively correlated with its acceptance [29]. Some studies have shown that the potential health risk was the main concern for users, and the perception of a higher health risk was associated with a lower willingness to use recycled water [30] and a less actual use behavior [31,32]. Researchers have found that, the higher the level of trust in the government and water supply authorities, the lower the risk perception and the greater the acceptance of recycled water [33]. Past experience with recycled water was found to be associated with higher willingness to use it [21]. Previous studies have investigated the relationship between self-perceived knowledge level and acceptance and concluded that greater knowledge or awareness is associated with increased recycled water acceptance [34,35]. Public acceptance is also influenced by other people's opinions, social norms, information disclosure, and other external context factors [36–38]. Previous studies have found that environmental education and publicity or disclosure of water information from authorities or the media can influence the acceptance of recycled water [35,39]. Experimental studies comparing informed and uninformed participants concluded that providing truthful information about recycled water increased participants' knowledge and acceptance of recycled water [40–42]. It has also been shown that people express a desire for more information, especially about recycled water treatment processes [43]. The more promotion events there are in the community, the more knowledge and stimulation residents receive, and the more likely people are to use recycled water [44]. The adoption of incentives can induce specific behavioral change among residents and encourage environmentally friendly or recycled water use behavior [24,45].

1.2. Theoretical Review

The theory of planned behavior (TPB) is an influential theoretical model for studying environmental behavior. It was proposed by Ajzen and has been fully studied and empirically tested in the field of environmental behavior [46]. TPB proposes that a person's behavior can be driven by his/her behavioral intention, which depends on attitudes, subjective norms, and perceived behavioral control [47]. Attitude refers to whether an individual believes the consequences of behavior are positive or negative, social norms refer to the influence of the supportive behaviors of other important people, and perceived behavioral control refers to the evaluation of various factors that promote or inhibit behaviors [48]. Instead of focusing only on the influence of attitudes on behavior, as in the past, TPB incorporates the influence of the social external context and extends to the actual factors that prevent people from behaving in a certain way [49]. Few studies have used the TPB to explain the factors influencing the acceptance of recycled water use and explored in depth the practical factors that prevent people from using recycled water.

The attitude–behavior–context (ABC) theory suggests that environmental behavior is the result of the interaction between environmental attitude variables and the external context [50]. When the external context is highly favorable or unfavorable, it may significantly promote or prevent environmental behavior. ABC confirms that internal attitudinal factors and external contextual factors jointly influence behavior and verifies the moderating effect of context factors on the relationship between environmental attitude and behavior. People's behavioral decisions or intentions are determined by their perception of objects, which is affected by the surrounding environment. According to social cognitive theory (SCT), context plays a mediating and coordinating role among personal consciousness, external context, and behavior. Consciousness has a direct influence on individual behavior, while individual consciousness is primarily influenced by external context [51]. These theories provide a theoretical basis for studying the relationship between the willingness to use recycled water and the behavior of using it. Through analysis of individual behavior, studies have found that an individual's willingness is the subjective probability of engaging in a specific behavior, which manifests as the willingness to participate [52]. Willingness is the psychological expression of an individual's behavior and the prelude to behavior [53]. Researchers believe that there is a significant correlation between willingness and behavior. Willingness influences actual behavior in two ways: commitment derived from willingness and the realization process of willingness [54]. When willingness reaches the threshold of actual behavior, actual behavior can be realized.

1.3. Scope of the Present Study

The behavior of using recycled water is a decision made by the behavioral main body after the identification of various factors, and it is restricted and controlled by various social environments. What are the factors that affect residents' willingness to use recycled water? What are the factors that affect the actual behavior of using recycled water? Is there a gap between willingness and behavior? These are all realistic problems encountered in the process of promoting recycled water usage.

To promote the utilization of recycled water, this study identified the influential factors determining the differences between willingness and behavior to use recycled water for toilet flushing. The focus of this study is thus on how to effectively transform willingness to use recycled water into the behavior of actually using it. By analyzing binary logistic regression models of willingness and behavior, this study found the factors influencing urban residents' willingness to use recycled water, their actual usage behavior, whether there are differences in the factors influencing the willingness to use and behavior, and whether there are differences in the importance of the influential factors. Based on TPB, Figure 1 illustrates a framework for the formation of the behavior of using recycled water.

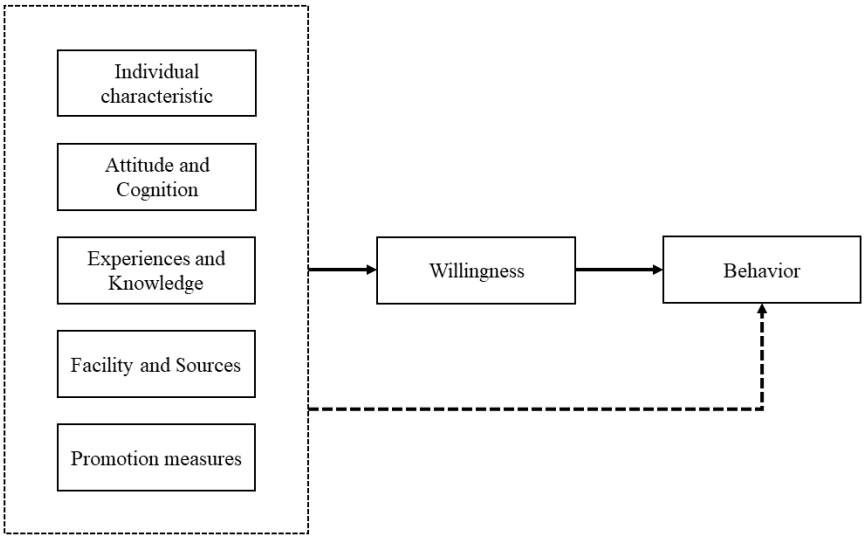

Figure 1. Mechanism model of the effect of factors influencing the willingness and behavior of using recycled water.

2. Methods

The data used in this study are from a questionnaire survey conducted from June to August 2021, which involved urban residents in Beijing, China. The questionnaire included a survey assessing individuals' willingness and behavior related to recycled water use for household toilet flushing, the factors influencing willingness and behavior, and a brief survey about what people think of using recycled water for flushing. After that, we used the assessment of willingness and behavior as dependent variables and the influential factors as independent variables to construct a binary logistic regression model. The influential factors of willingness and behavior to use recycled water were further discussed by analyzing the model.

2.1. Data Collection

Beijing is a city with a high population density, with a prominent water shortage problem. Natural water sources are not sufficient to supply daily water for such a large city, and there is an urgent need for alternative water sources. Inland cities with little rain are not suitable for rainwater reuse and seawater desalination, so sewage recycling is the best solution. In this regard, Beijing is typical of most inland cities in northern China. Taking Beijing as the research object for recycled water use behavior can also play a demonstrative role for other cities that are vigorously developing recycled water use programs. Beijing is among the cities with the highest output and longest use time for recycled water in China. Beijing began to use recycled water on a large scale in 2003. At present, recycled water accounts for nearly 30% of Beijing's total annual allocation of water resources, and recycled water has become a stable and reliable "second water source" in the city. The main uses include landscaping, car washing, road cleaning, and toilet flushing. However, the utilization of recycled water for toilet flushing is low, and there is much room for improvement. Centralized systems have obvious advantages for densely settled populations in terms of security, reliability, stability, and economic feasibility [13]. However, some studies have suggested that centralized systems are expensive, because they require large-scale distribution networks, high investment costs, and high operational and maintenance requirements, among other costs [55]. As a result, municipal centralized water treatment systems and distributed treatment systems throughout communities have become the main sources of recycled water for toilet flushing in Beijing. Domestic and industrial wastewaters are the main sources for recycling. The price of tap water for households is 4 RMB (the legal tender of the People's Republic of China) per cubic meter, while the price of recycled water for household toilet flushing is only 1 RMB per cubic meter.

Urban residents in Beijing aged 18 years and older were selected as participants. All participants came from communities that provide recycled water for toilet flushing, and self-built houses and collective housing were not included. In total, the survey collected 1659 questionnaires. Previous research has shown that willingness is the psychological manifestation of individual behavior and the prelude of behavior occurrence [54]. This study focuses on the transformation from willingness to behavior, and does not explore the behavior of participants who have unwillingness but engage in the behavior of recycled water use in depth. Therefore, the questionnaires from participants who were obliged by the community or landlord to use recycled water for flushing were excluded (N = 235). After excluding these and the questionnaires with missing answers, 1195 valid questionnaires were obtained. The individual characteristics of the participants and residents of Beijing city are shown in Table 1. The table indicates that the gender, age, level of education, and monthly per capita income profiles of the sample roughly accord with known characteristics of Beijing's population (the data come from China's seventh national census on 1 November 2020; the population of permanent residents in Beijing is 21.89 million), and it shows the social-demographic diversity of the participants.

Table 1. Demographic characteristics.

	Participants			**Residents in Beijing**	
	Options	**Number**	**Proportion (%)**	**Options**	**Proportion (%)**
Gender	Male	517	43.3	Male	49.6
	Female	678	56.7	Female	50.4
Age	18–30 years	360	30.1	20–29 years	14.9
	31–40 years	393	32.9	30–39 years	21.2
	41–50 years	250	20.9	40–49 years	14.7
	51–60 years	121	10.1	50–59 years	14.8
	Over 60 years	71	5.9	60 years and above	19.7
Level of education	Secondary school	60	5.0	Secondary school	27.7
	High school	166	13.9	High school	21.3
	Vocational training /undergraduate degree	820	68.6	Vocational training /undergraduate degree	42.7
	Postgraduate degree and above	149	12.5	Postgraduate degree and above	8.3
Monthly per capita income	Less than 2000 RMB *	41	3.4	2116 RMB	20.0
	2000–5000 RMB	234	19.6	3738 RMB	20.0
	5000–10,000 RMB	478	40.0	5330 RMB	20.0
	10,000–20,000 RMB	319	26.7	7335 RMB	20.0
	More than 20,000 RMB	123	10.3	12,160 RMB	20.0

* The legal tender of the People's Republic of China.

2.2. Variable Selection

This study used 15 factors for modeling, each of which falls into one of five general categories: individual characteristics (gender, age, level of education, monthly per capita income); attitude and cognition (pricing concerns, perceived benefits, health risk perception, trust in the authorities); experience and knowledge (experience in using recycled water, knowledge level); facility and sources (easy installation, source of recycled water); and promotion measures (promotion event, incentives, information disclosure). The first three categories belong to internal factors, while the latter two belong to external factors. The willingness and behavior of using recycled water for toilet flushing were selected as the dependent variables. Table 2 shows the variable definitions and their statistical descriptions.

Table 2. Variable definition and results of descriptive analysis.

Categories	Variables	Meaning and Rating	Mean	SD
Dependent variables	Willingness	Are you willing to use recycled water for toilet flushing? No = 0, Yes = 1	0.92	0.27
	Behavior	Are you using recycled water for toilet flushing? No = 0, Yes = 1	0.35	0.48
Individual characteristic	Gender	Male = 0, Female = 1	1.57	0.50
	Age	18–30 years = 1, 31–40 years = 2, 41–50 years = 3, 51–60 years = 4, Over 60 years = 5	2.29	1.17
	Level of education	Secondary school = 1, High school = 2, Vocational training /undergraduate degree = 3, Postgraduate degree and above = 4	2.89	0.67
	Monthly per capita income	Less than 2000 RMB = 1, 2000–5000 RMB = 2, 5000–10,000 RMB = 3, 10,000–20,000 RMB = 4, More than 20,000 RMB = 5	3.21	0.98
Attitude and cognition	Pricing concerns	Do you think the low price of recycled water is attractive? No = 0, Yes = 1	0.72	0.45
	Perceived benefits	Do you think promoting recycled water is beneficial? Not at all = 1, No = 2, Normal = 3, A little = 4, A lot = 5	3.92	1.01
	Health risk perception	Do you think recycled water is a health risk? Not at all = 1, No = 2, Normal = 3, A little = 4, A lot = 5	2.12	1.08
	Trust in the authorities	Do you trust the authorities that operate and manage recycled water? No = 1, Normal = 2, A little = 3, A lot = 4	2.90	0.82
Experiences and knowledge	Experiences	Have you ever used recycled water for flushing elsewhere? Not certain = 1, No = 2, Yes = 3	1.93	0.89
	Knowledge	What is your level of knowledge about recycled water? Not at all = 1, No = 2, Normal = 3, A little = 4, A lot = 5	2.91	1.10
Facility and sources	Easy installation	Do you think installing recycled water facilities is convenient? No = 0, Yes = 1	0.57	0.50
	Sources of the recycled water	Where does the recycled water in your community come from? Not certain = 1, Municipal services = 2, Community treatment system = 3	1.88	0.94
Promotion measures	Promotion event	Have you ever participated in a promotion event? Never = 1, Occasionally = 2, Often = 3	1.63	0.63
	Incentives	Is there any reward for using recycled water? Not certain = 1, No = 2, Yes = 3	1.71	0.66
	Information disclosure	How do you get information about recycled water? No public information = 1, Do not know how to query = 2, Readily accessible = 3	1.81	0.69

As shown in the above table, individual characteristics selected for the study included gender, age, level of education, and monthly per capita income. Attitudinal and cognitive factors include concern about the price of recycled water, perceived benefits of promoting recycled water, perceived health risks of flushing with recycled water, and the degree of trust in the authorities that operate and manage recycled water (government departments and water treatment enterprises). Factors that influence recycled water use also include experience in using recycled water for toilet flushing in any location and knowledge of recycled water. Facility and sources refer to whether the facilities for recycled water flushing are easy to install and whether the recycled water is provided by a distributed treatment system of communities or by a municipal centralized treatment system. The promotion measures include the frequency of recycled water promotion events, incentives for flushing toilets with recycled water, and the disclosure of information related to recycled water.

2.3. Data Analysis

In this study, binary logistic regression was used to analyze the influence of internal and external factors on individuals' willingness and behavior to use recycled water. The model is established as Equation (1).

$$\text{Logit}(p) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_i X_i \quad (1)$$

where $p = 0/1$ is the dependent variable, representing the willingness to use recycled water (0 = no willingness, 1 = willing to use) and the behavior of using recycled water (0 = do not use, 1 = currently use). α is the constant term, β_i is the regression coefficient related to the *i*th predictor variable X_i, and X_i is the independent variable—that is, all individual internal factors and external context factors.

After establishing the model, the goodness-of-fit test was applied for the two regression models (of willingness and behavior). The Hosmer and Lemeshow test was used to assess the goodness-of-fit of the regression models. When the *p*-value is not less than 0.05, it is considered that the information in the current data has been fully extracted and the model fit is good.

After testing the goodness-of-fit of the logistic regression models, for each combination of independent variables, the probability of the occurrence of an outcome event can be obtained. If the probability of the event is greater than or equal to 0.5, the event is judged to have occurred by logistic regression. If the probability is less than 0.5, the event is considered non-existent. Therefore, compared with the real situation, the prediction effect of the logistic regression model can be evaluated.

3. Results and Analysis

According to the survey data, 92.0% of the 1195 participants said they were willing to use recycled water for toilet flushing, but only 35.2% actually did so. Compared with the high willingness to use recycled water for flushing, the proportion of people who actually use recycled water is relatively low, and there is a gap between willingness and behavior. To explore the causes of this gap, it is necessary to further analyze the factors influencing willingness and behavior and incorporate variables into the regression models. Table 3 shows the effects of each influential factor on the willingness and behavior of using recycled water for flushing. In the table, β is the regression coefficient of the models. The *p*-value determines whether the coefficient of a variable is significant; the results are not statistically significant when $p < 0.05$. Exp (B) means the odds ratio will be multiplied by the value of Exp (B) with an increase of 1 on the predictor. The models will then be analyzed in depth by the category of influential factors. Table 4 shows the goodness-of-fit using the Hosmer and Lemeshow test for the two regression models. The *p*-values for the willingness model and behavior model are 0.615 and 0.974, respectively, which means both the willingness model and the behavior model have good fitting effects ($p > 0.05$). Table 5 shows the predictive ability of the models. The results show that the models have 92.6% accuracy in classification for willingness and 79.3% accuracy in classification for behavior. More specifically, 98.5% of participants who have willingness were predicted by the willingness model to be willing to use recycled water, and 24.0% of participants with no willingness were predicted to be not willing to use recycled water; 75.1% of participants who display recycled water use behavior were predicted by the behavior model to display that behavior, and 81.7% of participants who do not display the behavior of using recycled water were predicted not to display that behavior.

Table 3. Factors influencing the willingness and behavior of using recycled water for flushing.

Variables	Willingness			Behavior		
	β	*p*	Exp (B)	β	*p*	Exp (B)
Gender	0.087	0.740	1.091	0.207	0.203	1.230
Age	−0.072	0.513	0.931	−0.376 ***	0.000	0.687
Education	0.222	0.242	1.249	0.194	0.156	1.214
Monthly per capita income	0.016	0.912	1.016	−0.033	0.717	0.968
Pricing concerns	0.876 **	0.001	2.401	−0.005	0.977	0.995
Perceived benefits	0.716 ***	0.000	2.046	−0.003	0.975	0.997
Health risk perception	−0.490 ***	0.000	0.613	−0.199 *	0.013	0.819
Trust in authorities	0.369 *	0.026	1.447	−0.205	0.068	0.815
Experience	0.115	0.507	1.122	−0.104	0.271	0.901
Knowledge	0.160	0.215	1.173	0.245 **	0.004	1.278
Easy installation	1.320 ***	0.000	3.743	2.755 ***	0.000	15.713
Sources of the recycled water	−0.133	0.381	0.875	0.436 ***	0.000	1.547
Promotion event	−0.034	0.893	0.966	0.066	0.659	1.068
Incentives	0.037	0.873	1.037	0.416 ***	0.001	1.516
Information disclosure	−0.064	0.770	0.938	0.092	0.456	1.097
Constant term	−1.664			−3.882		

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 4. Goodness-of-fit using the Hosmer and Lemeshow test for regression models.

	Willingness			Behavior		
Step	**Chi-Square**	**Df**	**Sig.**	**Chi-Square**	**Df**	**Sig.**
[1]	6.286	8	0.615	2.213	8	0.974

[1] The cutoff value is 0.500.

Table 5. Predictive ability of the regression models.

Willingness				Behavior			
Observed	**Predictor**		**Percentage Correct**	**Observed**	**Predictor**		**Percentage Correct**
	No	**Yes**			**No**	**Yes**	
No	23	73	24.0	No	632	142	81.7
Yes	16	1083	98.5	Yes	105	316	75.1
Overall Percentage			92.6	Overall Percentage			79.3

3.1. Individual Characteristic

Participant gender has no significant influence on the willingness and behavior of flushing with recycled water, but has a coincident effect on both willingness and behavior. Women were more likely than men to use recycled water for toilet flushing and were more willing to use it. According to the survey, 90.9% of men were willing to use recycled water for flushing, which is slightly lower than the rate for women (92.8%). The percentage of men who used recycled water to flush toilets was 33.1%, slightly lower than that for women (36.9%).

Age has no significant influence on the willingness to use recycled water for flushing, but the influence on behavior passes the significance test (β = −0.386). The older people get, the less likely they are to use recycled water for flushing. This suggests that older people are less likely than younger people to use recycled water for flushing. According to the statistical results, 44.4% of people aged 18–30 years use recycled water for toilet flushing, followed by those aged 31–40 years (39.9%), and only 12.7% of people aged over 60 years use recycled water for flushing. The older people are, the greater the gap between their willingness and behavior, perhaps because they do not know how to install recycled water

flushing equipment or because it is not convenient to change the recycled water equipment because of the limitations of age.

Educational level has no significant effect on willingness or behavior, but both willingness and behavior move in the same direction. The results showed that, the higher the level of education, the higher the willingness to use recycled water, with more use behavior; a total of 93.0% of people with vocational training or an undergraduate degree said they were willing to use recycled water for flushing, followed by those with a postgraduate degree or above (92.6%), while the proportion was the lowest (78.3%) among those with a secondary school degree or below. For behavior, 40.3% of participants with a postgraduate degree or above were using recycled water to flush toilets, followed by 37.1% of the participants with vocational training or an undergraduate degree, and only 18.3% of the participants with a secondary school degree or below were using recycled water.

The effects of monthly per capita income on usage willingness and behavior are not significant. The statistics show that people with a higher income have higher willingness than people with a lower income, and people with a middle income have more actual use behavior than people with either a high or low income. Of the participants with a monthly per capita income of 10,000–20,000 RMB, 42.6% used recycled water for flushing, while the proportion was 34.1% and 19.5% for participants with an income of more than 20,000 RMB and less than 2000 RMB, respectively.

3.2. Attitude and Cognition

The effect of pricing concerns related to recycled water on the willingness to use recycled water was significant at the 0.01 level ($\beta = 0.806$), but there was no significant difference in the use behavior model. This result indicates that the willingness of participants who think the price of recycled water is attractive is 2.239 times greater than that of those who do not think so. The statistics reveal that 95.8% of the participants who think the price of recycled water is attractive are willing to use recycled water for flushing, which is significantly higher than those who do not think so (82.1%).

The perceived benefits of using recycled water had a significant effect on the willingness to use it ($\beta = 0.647$), but had no significant effect on behavior. The result showed that the willingness of participants who perceived that there would be benefits from using recycled water is 1.91 times that of participants who did not. The stronger the perceived benefit of using recycled water, the greater the willingness to use it.

The influence of health risk perception on the willingness to use recycled water was significant at the 0.001 level ($\beta = -0.474$). It also had a significant effect on the usage behavior at the 0.05 level ($\beta = -0.196$). The lower the health risk perception, the greater the willingness to use recycled water and the greater the likelihood of usage behavior. Conversely, the higher the health risk perception, the lower both the willingness and behavior. Health risk perception is thus one of the most important factors that affect the willingness and behavior of using recycled water.

Trust in the authorities that operate and manage recycled water has a significant effect on the willingness to use recycled water at the 0.05 level ($\beta = 0.351$), but has no significant effect on use behavior. The willingness to use recycled water among those who trusted authorities was 1.45 times stronger than among those who did not. In other words, the higher the level of trust, the stronger the willingness to use recycled water. According to the statistical results, only 65.8% of the "distrustful" participants were willing to use recycled water for flushing, while 95.2% of the "relatively trusting" and 97.3% of the "very trusting" participants were willing to use recycled water for flushing.

3.3. Experience and Knowledge

The experience of using recycled water for toilet flushing had no significant effect on willingness and behavior: 86.1% of "never used" participants were willing to use recycled water, which is modestly below the 90.9% and 96.4% of those who were not certain and those who have used recycled water, respectively. Only 22.3% of the "never used"

participants used recycled water for flushing, which is lower than those who were "not certain" (31.5%) and those who had used recycled water elsewhere in the past (46.7%). In general, people with experience in using recycled water were more willing to use recycled water for toilet flushing and had more actual use behavior than people with no prior experience in using it.

The level of knowledge about recycled water has no significant effect on participants' willingness to use, but has a significant effect on their behavior (β = 0.245), which indicates that, the more they know about recycled water, the more likely they are to use it. According to the results, 70.3% of participants who knew "a lot" were using recycled water, while 41.2% of participants who knew "a little" and 39.4% of participants with "normal" level of knowledge were using recycled water, but only 25.1% of the "did not know" participants and 18.0% of the "completely did not know" participants were using recycled water. It could also be that those who used recycled water for flushing may have taken the initiative to learn more about recycled water, and thus improve their level of knowledge, as this variable does not play a significant role in the willingness to use recycled water.

3.4. Facility and Sources

The convenience of installing the facilities for household recycled water flushing has a significant effect on the willingness to use recycled water (β = 1.337), as well as a significant effect on the behavior of using recycled water (β = 2.806), which indicates that the intensity of willingness among participants who thought installation was convenient is 3.81 times that of those who did not. Participants who thought it was convenient to install facilities were 15.71 times more likely to use recycled water than those who thought it was inconvenient. The more convenient the installation of recycled water facilities, the stronger the participants' willingness to use and the greater the use behavior. Only 6.0% of the participants who thought installation was inconvenient used recycled water for flushing, while 57.7% of the participants who thought installation was convenient used recycled water for flushing. The convenience of the installation of facilities largely explained the difference between usage and non-usage, and it significantly changes the chances that residents will use recycled water for flushing. This variable is one of the main reasons for the gap between willingness and behavior.

Knowing whether the recycled water comes from the municipal water supply or community treatment has no significant influence on willingness, but has a significant influence on behavior (β = 0.442); participants who knew the source of the recycled water were 1.556 times more likely to use recycled water than those who did not. Only 16.6% of the participants who did not know the source of recycled water used it for toilet flushing, which was significantly lower than for the community (57.4%) and municipal (53.3%) sources. Residents who did not know the source of recycled water thus may not have considered using it or may have an indifferent attitude, or it may be that the residents who use recycled water for flushing take the initiative to learn more about the source of the recycled water.

3.5. Promotion Measures

Promotion events had no significant effect on the willingness and behavior to use recycled water for toilet flushing. For willingness, 88.8% of the participants who had "never" participated in a promotion event were willing to use recycled water, compared with 94% of those who had "occasionally" participated in such events and 97.9% of those who had "often" participated in such events. As for behavior, only 26% of those who "never" participated in a promotion event used recycled water, while 37.8% of those who "occasionally" participated in a promotion event and 71.1% of those who "often" participated in a promotion event used recycled water. As can be seen, more promotion events could improve the likelihood of the residents using recycled water.

Incentives had no significant effect on the willingness to use recycled water for flushing, but had a significant effect on behavior (β = 0.416), and the possibility of those with

incentives using recycled water for toilet flushing was 1.52 times higher than that of those without such measures. Furthermore, 66.4% of the participants with incentives used recycled water for flushing, which is much higher than those without incentives (38.6%) and those who were not certain (22.4%). Incentives are another major reason for the gap in willingness and behavior. Previous studies have shown that offering incentives can enhance the public's positive evaluation of and willingness to participate in environmental protection activities and that it has a highly positive impact on encouraging the public to engage in environmental protection activities.

Information disclosure had no significant influence on willingness and behavior. The analysis revealed that 57.4% of the participants who chose "information is readily accessible" were using recycled water for flushing, while only 31.9% and 30.2% of the participants who chose "no public information" and "do not know how to query", respectively, were using recycled water for flushing. This suggests that enhancing the disclosure of recycled water information can improve people's use behavior.

4. Discussion

4.1. Overview of Findings

As can be seen from the results, the most important factor influencing the willingness to use recycled water for toilet flushing is the convenience of installing recycled water facilities, followed by price concerns, perceived benefits, health risk perception, and trust in authorities in the category of attitude and cognition. SCT suggests that personal attitude and perception are constantly changing and are easily affected by the external environment. The convenience of installing facilities is one of the most important external environmental factors that, together with other internal factors, affect the willingness to use recycled water. The influence of attitude and cognition on the willingness to use recycled water is more direct and obvious, and these results are consistent with previous studies [56].

For the behavior of using recycled water for flushing, the convenience of installing recycled water facilities is also the most influential factor, followed by other external environmental factors such as the source of recycled water and incentives, as well as internal factors including age and knowledge level. These factors are also the main reasons for the gaps between willingness and behavior. The convenience of the installation of recycled water facilities largely determines whether residents who are willing to use recycled water will actually use it, just as the behavior described by the TPB is not only affected by attitude, but also by various practical factors that promote or inhibit the behavior. The convenience of the installation of recycled water facilities is one of the key factors that can promote or inhibit usage behavior. The ABC theory has verified the regulating effect of contextual factors on the relationship between environmental attitude and behavior. In this study, the inconvenience of installing recycled water facilities greatly hinders the use of recycled water in the household, and the use of recycled water can be greatly promoted by improving adverse external environmental factors. Similarly, residents' understanding of the sources of recycled water and the provision of incentives are also practical external factors that can promote the use of recycled water. By analyzing the correlation coefficient between willingness and behavior, a previous study demonstrated the gap between willingness and behavior directly and suggested that the willingness, and its corresponding goals, time stability, individual execution, and other factors, have a combined effect in the transformation from willingness to behavior. Meanwhile, an individual's behavior can be affected by personal experience, habits, and external factors [57]. Thus, willingness and behavior do not always coincide. It is possible that actual behavior cannot be achieved owing to the influence of external conditions—that is, the transformation from willingness to behavior is blocked, or the individual's ability to act is limited. As this study shows, the older people are, the less likely they are to use recycled water. This may be because the participants' behavioral ability is limited by age, which hinders the conversion from willingness to behavior. The elderly may also know less about recycled water; thus, relevant information could be made available to them through traditional means of public dissemination of

information, such as newspapers, television news, and community promotional activities. Behavior may also be limited by physical fitness; thus, the elderly could be provided with convenient installation of flushing facilities and a follow-up one-stop service maintenance management mode. A detailed example of suggestions for improving the use of recycled water for toilet flushing is as follows: establishing dedicated spots in the community that can be used to promote recycled water; as well as helping community members to more easily apply onsite for the installation of recycled water facilities, especially those who are not familiar with online applications. The dedicated spot would be able to provide incentives on the spot to attract other community members to use recycled water. In future maintenance, the spot can be run by the property management of the community, ensuring the timely repair and maintenance of the recycled water equipment.

The relationship between the level of knowledge and behavior can be explained as follows: the higher the level of knowledge, the more likely people are to use recycled water—that is, knowledge promotes people's use of recycled water, which is consistent with the conclusion of previous studies. It is also possible, however, that this significant effect is due to people using recycled water and, therefore, actively learning more about it. Information disclosure and media publicity have a better regulating effect on individuals' environmental cognition and behavior. Information from different sources may lead to different levels of trust, which can influence the behavioral decisions of individuals or groups. Overall, increased knowledge has a positive effect on the willingness and behavior of using recycled water. The existence of gaps between willingness and behavior is inevitable because there are always factors that promote or hinder behavior. At present, there is a high willingness to use recycled water for flushing in China, and the actual low utilization rate may be temporary. With the improvement of external environmental factors, the actual utilization rate of recycled water for flushing is bound to increase.

The questionnaire showed that 35.2% of participants were using recycled water, but only 14.0% of the users said they were satisfied with it. In the surveys, we found that 6.9% of those who were using recycled water indicated that the cost of replacing leaky recycled water pipes and damaged water meters is very high; 10.0% of users said that the water quality is not good, and that the odor and color of water is peculiar; 10.2% of users said that daily life is affected by frequent damage to the recycled water system; 16.9% of the users said that the water pressure is not sufficient in upper level housing; 11.9% of users said that recycled water pipes are more likely to leak than tap water pipes; and 12.6% of users said that toilets are easy corroded by recycled water. In light of these problems, it is suggested that government departments and recycled water enterprises should ensure the water pressure for recycled water, enhance the supervision of water quality, improve the quality of recycled water pipes and equipment, and strengthen follow-up maintenance work.

4.2. Research Significance

The establishment of regression models is of great practical significance, because no study has looked at what causes the huge gaps between the willingness to use recycled water and the actual behavior. Although previous studies have explored the factors influencing willingness to use [58] or behavior of using recycled water [35], the factors driving the conversion from willingness into behavior remain unknown. This study thus provides guidance for government policy-makers and managers of recycled water enterprises, explores what factors lead to the current low actual utilization rate of recycled water for flushing, and proposes strategies to improve recycled water use behavior.

This study was only carried out in communities that already provide recycled water for flushing in Beijing. There are many communities in Beijing and other Chinese cities that do not provide recycled water. Both the laying of recycled water pipelines and the establishment of small treatment systems in communities require the joint promotion of the government and recycled water enterprises. Because the survey was conducted only in Beijing, the findings may not be applicable to other cities in China, as the main problem in most cities is that recycled water from water treatment plants cannot reach residential

areas, and it is costly to re-install recycled water pipes. Nevertheless, this study provides some models for the influence of individual internal factors and external environmental factors on the willingness and behavior of using recycled water, with a special focus on the reasons for the gap between willingness and behavior. This will help promote the use of recycled water in the future.

5. Conclusions

Using recycled water instead of tap water for flushing can effectively relieve urban water shortages. The survey results show that urban residents in China have a high willingness to use recycled water for toilet flushing, but the actual utilization rate is low, and the recycled water produced has not been effectively utilized. Through logistic regression analysis, this study compared the factors influencing urban residents' willingness to use recycled water and their use behavior to find out the reasons for the huge gap between willingness and behavior. The following conclusions can be drawn from the analysis. First, there are differences between urban residents' willingness and behavior to use recycled water for toilet flushing, and the willingness is much higher than actual use. Higher willingness does not necessarily lead to more use. Second, the factors influencing willingness and behavior, as well as the importance of these factors, differ. Attitudinal and cognitive factors show a great influence on willingness, while external factors such as convenience of installation facilities and promotion measures have a great influence on behavior. Third, the most important factor influencing willingness and behavior is the convenience of installing recycled water facilities, which is also the main reason for the gap between willingness and behavior.

Based on these findings, we propose three suggestions. First, to promote the conversion of willingness into behavior, it is necessary to provide more convenient access to the installation of recycled water facilities, especially for the elderly. Second, strengthening residents' knowledge of recycled water would be conducive to promoting its use. Knowledge appears to have a positive impact on both willingness and behavior to use recycled water, and behavior is more highly associated with a higher level of knowledge. The authorities should improve public information about recycled water, hold more promotional activities, and provide water-saving education to increase people's knowledge of recycled water. Third, establishing an attractive reward mechanism is suggested. Incentives is an important factor affecting use behavior, and behavior can be promoted through economic incentives or prizes. Not only are short-term incentives such as gifts and cash prizes needed to encourage residents to install facilities, but longer-term incentives such as free service and discounted equipment are also needed to maintain current use behavior and increase overall participation.

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