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Article

Analysis of Hotel Water-Use Behavior Based on the MLP-SEM Model

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Abstract: As a representative service industry, the hotel industry has a complex water-use structure and high water consumption. It is of great significance to investigate the mechanisms determining hotel water-use behavior for demand analysis, as this would make it possible to enhance water-use efficiency and enact targeted water-saving measures. Using Spearman's hierarchical correlation coefficient, the multi-layer perceptron (MLP) neural network model, and the structural equation model (SEM), in this study, we explored the mechanism determining hotel consumers' water-use behavior from different dimensions and constructed a typical water-use behavior model based on the MLP-SEM model. In terms of individual water-use behavior, the results showed that individual characteristics, water-conservation awareness, and consumption behavior possessed significant differences regarding their influence on and correlation with various water-use behaviors. The most relevant factors influencing each behavior, namely washing up, hand washing, and drinking, were daily stay in the hotel, education, and income. Gender had the greatest impact on bathing and toilet-flushing water-use behaviors. The importance of daily stay in the hotel was 0.181, which meant that this was the most significant factor influencing the direct water-use behavior of hotel guests. The following factors were identified: hotel type, income, age, and gender. Typical individual characteristics had a significant impact on main water-use behaviors, whereas typical consumption behaviors had no effect. These results can provide a foundation for relevant research in other industries and serve as a basis for a prediction model of water consumption in hotels based on water-use behavior. Furthermore, they provide a basis for the delicate management of water-use behavior in hotels, making it possible to effectively guide the public to consciously adopt water-saving habits, thus improving water efficiency, which could alleviate the shortage of water resources in the long-term.

Keywords: correlation; hotel; multi-layer perceptron neural network model; structural equation model; water-use behavior

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1. Introduction

Water is an indispensable natural resource for human survival as well as social and economic development. With the rapid urbanization of China and continuous improvement in living standards, the proportion of the national economy represented by the service industry has been increasing. In 2015, China's service industry accounted for more than 50% of its gross domestic product (GDP). Pressure for water demand from the rapid development of the service industry has also gradually emerged. In addition, with the improvement in people's living standards, consumer demand for the service industry is increasing, which further increases the pressure on water-resource management. Therefore, strengthening the sustainable use of water resources for the future development of the service industry has become an inevitable trend.

To strengthen water-use management in the service industry, scholars in China and elsewhere have conducted research on water-intake monitoring, management, and demand forecasting [1,2]. As the micro-basis of demand-side management of water resources [3], the study of water-use behavior is of great significance for promoting changes in consumption behavior and water-use modes, improving water-use efficiency, and alleviating water shortages [4]. In recent years, scholars have investigated the factors influencing water-use behavior through large-scale behavioral research and have analyzed the drivers and influencing paths based on statistical models, such as the structural equation model and the LPA analysis method [5,6]. Studies have found that individual characteristics, including gender, age, educational level, income, awareness of water conservation, etc. [7–11], have a great impact on household water-use behavior. Water habits, socioeconomic status, and water-saving technology and equipment also play roles in residents' domestic water-use behavior and demand, whereas the natural environment does not [12–17]. However, past research has mainly focused on the domestic water-use behavior of residents, and little work has been undertaken on the mechanism determining water-use behavior under the influence of different public services and social activities. In recent years, some scholars have proposed that, in contrast to domestic water-use behavior, social activities can affect people's water-use behavior. The conclusions were confirmed in research on college students' water-use behavior, which showed that psychological characteristics were significant factors, along with scenario-moderating factors, while there was no significant correlation with sociodemographic characteristics [18,19].

The hotel industry is a service industry [20] that plays an important role in business and leisure activities. Since 2005, with the rapid growth in China's GDP, the numbers of rooms and beds, among other indicators of hotels above a typical size, have been increasing [21]. As they are part of a typical high-water-consumption service industry, hotels have complex water-use structures. It is estimated that hotel water consumption in 2020 was approximately 1.613 billion m^3, accounting for 1.87% of the country's domestic water consumption. Hotel water is mainly used for guest rooms, catering, fitness, entertainment, cleaning, and greeneries. Studies have shown that there are significant differences in the water-use structures of hotels in different countries. In China, guest rooms consume the most water [22–24]. By analyzing the factors influencing hotel water use, scholars have proposed that there are significant differences in the proportions of water used in hotels with different service qualities and in star-rated hotel rooms [25]. As a result, the water-saving index and the water-use index (WUI) have been proposed to evaluate the efficiency of water use in hotels based on water-use structure analysis, and evaluation and optimization methods for the hotel water-use footprint have been explored from the perspective of the whole life cycle [26–28].

Previous research on hotel water use has mainly focused on four aspects: water-use structure, influencing factors, evaluation of water savings, and resident-based water-use behavior. There is a research gap regarding the behavioral mechanisms that determine hotel water use. Moreover, the current research has mainly looked at significance analyses and has missed multidimensional influencing factors, which has led to the failure to build a typical water-use behavior model based on important factors due to incomplete analysis of indicators. Therefore, this study proposes a multidimensional hypothesis for the first time to research the influencing factors for hotel consumers' water-use behavior and analyzes the mechanism determining water-use behavior, which is of great significance for exploring the potential for hotel water conservation, water management, and water efficiency.

2. Research and Analysis Methods

2.1. Questionnaire

The structure of hotel consumers' water-use behavior was the basis for the design of the questionnaire. Consumer water-use behavior in hotels and other public service spaces is accompanied by the service itself [29]. Based on the type of service, consumers' water-use behavior can be divided into direct and indirect categories (see Figure 1). Direct water-use behaviors include washing, hand washing, bathing, toilet flushing, and drinking, which are mainly controlled by the consumers themselves. However, indirect water-use behaviors, such as water consumption for food and cookware washing, cleaning, and sanitation, occur during the service process; such behaviors have low correlation with consumers. This study mainly focuses on the controlled and highly related water-use behavior of consumers in hotels. Based on the water-use hierarchy constructed by domestic scholars, the water used in toilet flushing mainly considers the water-use efficiency of terminal water appliances [9], whereas drinking, as a basic consumer need, is less affected by individual water-use behavior. Unlike toilet flushing and drinking habits, washing, hand washing, and bathing are more subjectively affected by individual behavior and are therefore considered typical water-use behaviors in hotels.

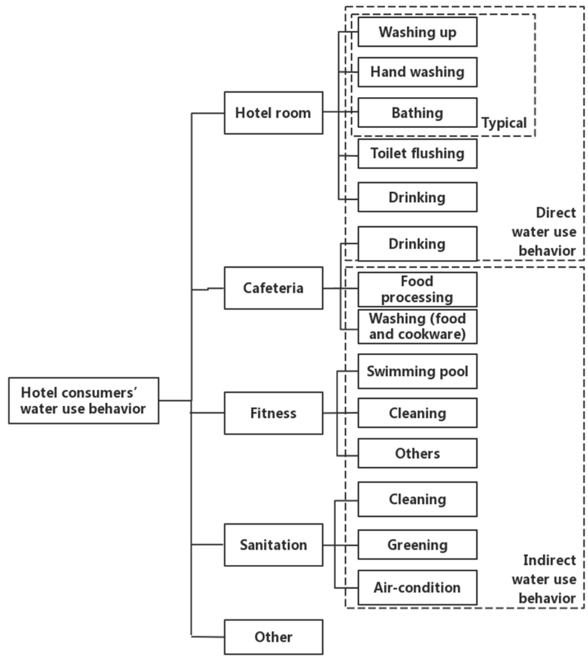

Figure 1. Structure of hotel consumers' water-use behavior.

To cover comprehensive and representative data, and to recover and analyze the questionnaires more easily, this study used web-based questionnaires. The survey questionnaire covered more than 25 provinces in China. As hotel consumers are highly mobile, thereby possessing significantly different features from household water users, regional factors were not considered in this study. As people in hotels come from different walks of life and come in great numbers, the questionnaire for this study included gender, age, income, and other individual characteristics of hotel consumers as well as their water-conservation awareness, consumption behavior, and personal water-use behavior, as detailed in Table 1. The level of water-conservation awareness was analyzed and scored through questions such as "daily water conservation behaviors and perceptions".

Table 1. Questionnaire content of hotel consumers' water-use behavior.

Type	Survey Content
Individual characteristics	Gender, age, education, income, etc.
Water-saving awareness	Degree of water-saving awareness
Consumption behavior	Type of hotel, travel purpose, length of stay in hotel, etc.
Water-use behavior	The single washing time of bathing, washing up, and hand-washing time, toilet-flushing frequency, drinking habits, etc.

A total of 292 valid questionnaires were collected, and the distribution of the valid sample data is shown in Figure 2. The ratio of men to women was 68% to 32%. Most participants were between 36 and 50 years old, accounting for 43% of the total; this was followed by participants between the ages of 21 and 35 and 51 and 60, which accounted for 36% and 17% of the total, respectively. Finally, consumers under 20 years old or above 60 years accounted for less than 3%. Regarding the distribution of education, more than half of the population had an undergraduate degree followed by people with a bachelor's degree (23%) and people with master's and doctorate degrees (more than 14% and 10%, respectively). In terms of income, more than one-fifth of the participants had a monthly income between 3000 and CNY 17,000, and a few participants had incomes below CNY 3000 and higher than CNY 17,000, accounting for 6% and 9%, respectively.

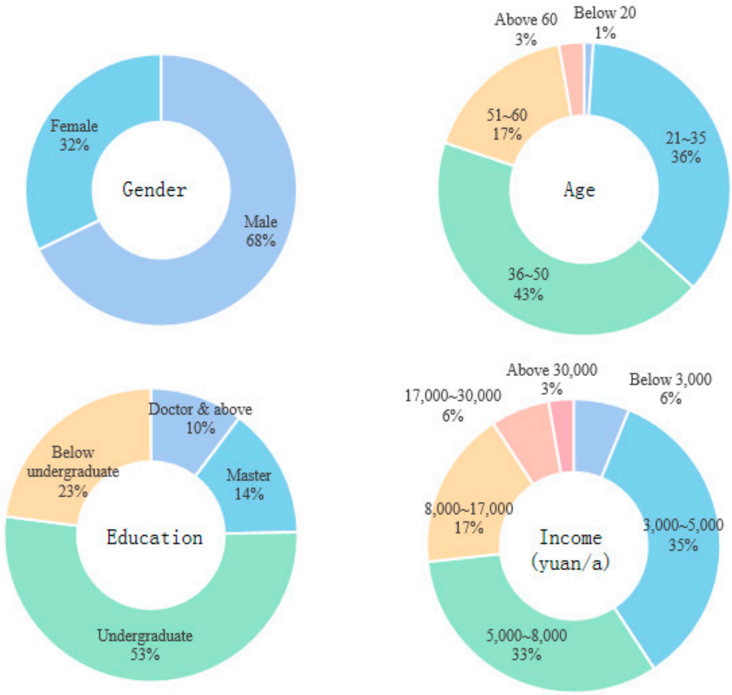

Figure 2. The distribution for sample data regarding gender, age, education, and income.

2.2. Research Methods

2.2.1. Research Hypotheses

To scientifically identify the factors influencing the water-use behavior of different people in the hotel industry and to deeply analyze their response mechanisms, this study identified influencing factors from multiple dimensions, such as single factors (H_{1a}–H_{1h}), multi-factors (H_{2a}), and comprehensive factors (H_{3a} and H_{3b}), and quantitatively analyzed the importance of the multi-factor influencing factors. Consequently, several hypotheses were proposed by referring to a previous study on water-use behavior, as shown in Table 2.

2.2.2. Research Methods

Spearman Rank Correlation Coefficient

The Spearman correlation coefficient is equivalent to the nonparametric form of the Pearson correlation coefficient, which does not require the distribution of variables, and is suitable for ordinal variables or continuous variables that do not follow a normal distribution [30–32]. According to the characteristics of the dependent variable in this study, SPSS software was used to calculate the Spearman rank correlation coefficient to identify the correlation between single hotel consumers' water-use behavior and the research factors, which entailed identifying the correlation coefficient between different factors and a single water-use behavior.

Table 2. Research hypotheses.

S/N	Hypotheses
H_{1a}	Gender significantly affects the water-use behavior of hotel consumers
H_{1b}	Age significantly affects the water-use behavior of hotel consumers
H_{1c}	There are significant effects of the educational level on the water-use behavior of hotel consumers
H_{1d}	Income significantly affects the water-use behavior of hotel consumers
H_{1e}	The degree of awareness of water conservation significantly affects the water-consumption behavior of hotel consumers
H_{1f}	The type of hotel stay significantly affects the water-use behavior of hotel consumers
H_{1g}	Travel purpose significantly affects the water-use behavior of hotel consumers
H_{1h}	The length of daily hotel stay significantly affects the water-use behavior of hotel consumers
H_{2a}	The degree of influence of each influencing factor on different water-use behaviors of hotel consumers is different
H_{3a}	Typical individual characteristics have a significant impact on the typical water-use behavior of hotel consumers
H_{3b}	Typical consumption behavior has a significant impact on the typical water-use behavior of hotel consumers

MLP Neural Network Model

A multi-layer perceptron (MLP) model, also known as a multi-layer feedforward neural network [33], consists of an input layer, hidden layer (one or more layers), and output layer, as shown in Figure 3. It is a neural network trained with an error backpropagation algorithm (BP algorithm) [34], which aims to simulate the structure and function of the nervous system for data processing, constantly adjusting the weights of the chains between the simulated neurons so that the whole network can adapt well to the relationships of the training data [35]. Owing to their strong nonlinear processing ability, high fault tolerance, and self-learning ability, neural systems have been widely applied for the identification and analysis of influencing factors [36–38]. In this study, the MLP model was used to analyze the importance of different influencing factors on water-use behavior. Compared to the analysis of the Spearman correlation coefficient, the MLP model focuses more on considering various factors as a whole to illustrate intrinsic effects.

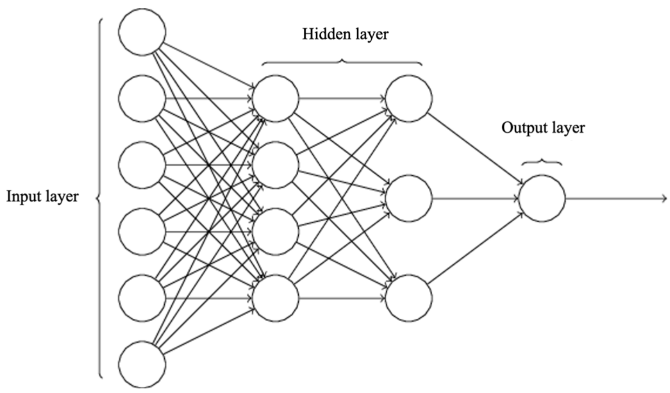

Figure 3. Multi-layer perceptron (MLP) model structure.

Structural Equation Model

The structural equation model is a statistical method based on the covariance matrix of variables to analyze the relationships between variables and is an important tool for multivariate data analysis [39–41]. It is often used to analyze the direct or indirect impact of one variable on another [42]. Structural equation analysis processes multiple dependent variables simultaneously and explains the relationship between variables in combination with methods such as route factor analysis [43]. Therefore, the structural equation model was used in this study to analyze the influence mechanisms by which typical individual characteristics and consumption behaviors influence the typical water-use behavior of hotel consumers and to verify the consistency between the hypotheses (H_{3a}, H_{3b}) and the sample data.

3. Identification and Analysis of Influencing Factors of Hotel Consumers' Water-Use Behavior

3.1. Identification of Single-Factor Influencing Factors

The Spearman correlation coefficient was used to analyze the correlation among individual characteristics, water-saving awareness, consumption behavior, and water-use behavior of hotel consumers; the results are shown in Table 3. There were significant differences based on gender in terms of washing up, bathing, and toilet flushing, and female consumers had a higher water-use behavior duration or frequency than male consumers. There were age-dependent differences in terms of toilet flushing; the frequency among older consumers was higher than that among younger consumers. Education had a significant impact on bathing and drinking and had a certain correlation with hand washing and toilet flushing. Income was positively correlated with water drinking and toilet flushing, and the correlation with drinking was significant. There was no significant correlation between the degree of water-conservation awareness and the hotel type. Travel purpose had a significant impact on drinking and for consumers on business travel: drinking > leisure tourism > visiting relatives and friends. The daily hotel stay had a general impact on the water-use behaviors of hotel consumers, and there were significant differences in other water-use behaviors.

Table 3. Identification of influencing single factors of hotel consumers' water-use behavior.

Type		Washing-Up Time	Hand-Washing Time	Bathing Time	Toilet-Flushing Frequency	Drinking Habit
Individual characteristics	Gender	0.143 **	0.081	0.304 ***	0.272 ***	0.041
	Age	0.075	0.075	0.046	0.107 *	0.074
	Education	0.053	0.105 *	0.153 ***	0.111 *	0.183 ***
	Income	0.03	0.068	0.067	0.125 **	0.216 ***
Water-saving awareness	Degree of water-saving awareness	−0.026	0.005	−0.004	0.061	−0.005
Consumption behavior	Type of hotel	−0.084	−0.004	0.096	0.082	0.074
	Travel purpose	0.009	0.001	0.004	0.01	−0.202 ***
	Daily stay in the hotel	0.152 ***	0.095	0.238 ***	0.209 ***	0.11 *

Note: ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

3.2. Identification of Influencing Multi-Factors and Quantitative Analysis of Importance

Of the 292 sample data points, 202 training and 90 test samples were randomly selected to construct the MLP neural network model of hotel consumers' water-use behavior. In this model, the input layer variables were gender, age, education, income, water-saving awareness, hotel type, travel purpose, and daily stay at the hotel. For all the water-use behaviors, the number of hidden layers was one, and the number of hidden layer units was five, three, five, five, and four, respectively. The Receiver Operating Characteristic (ROC) analysis uses the actual hotel water-use behavior of the sample individuals as the criterion for determining the optimal solution point. Using the probability of the sample case classification results given by the model as the classification judgment basis, the ROC curve is obtained. The fitness of the model was judged according to the sensitivity (1-specificity) of the classification test, as shown in Figure 4, and the area under each curve is shown in the table. The results show that the area under the curve was greater than 0.5, indicating that the fitting model was effective.

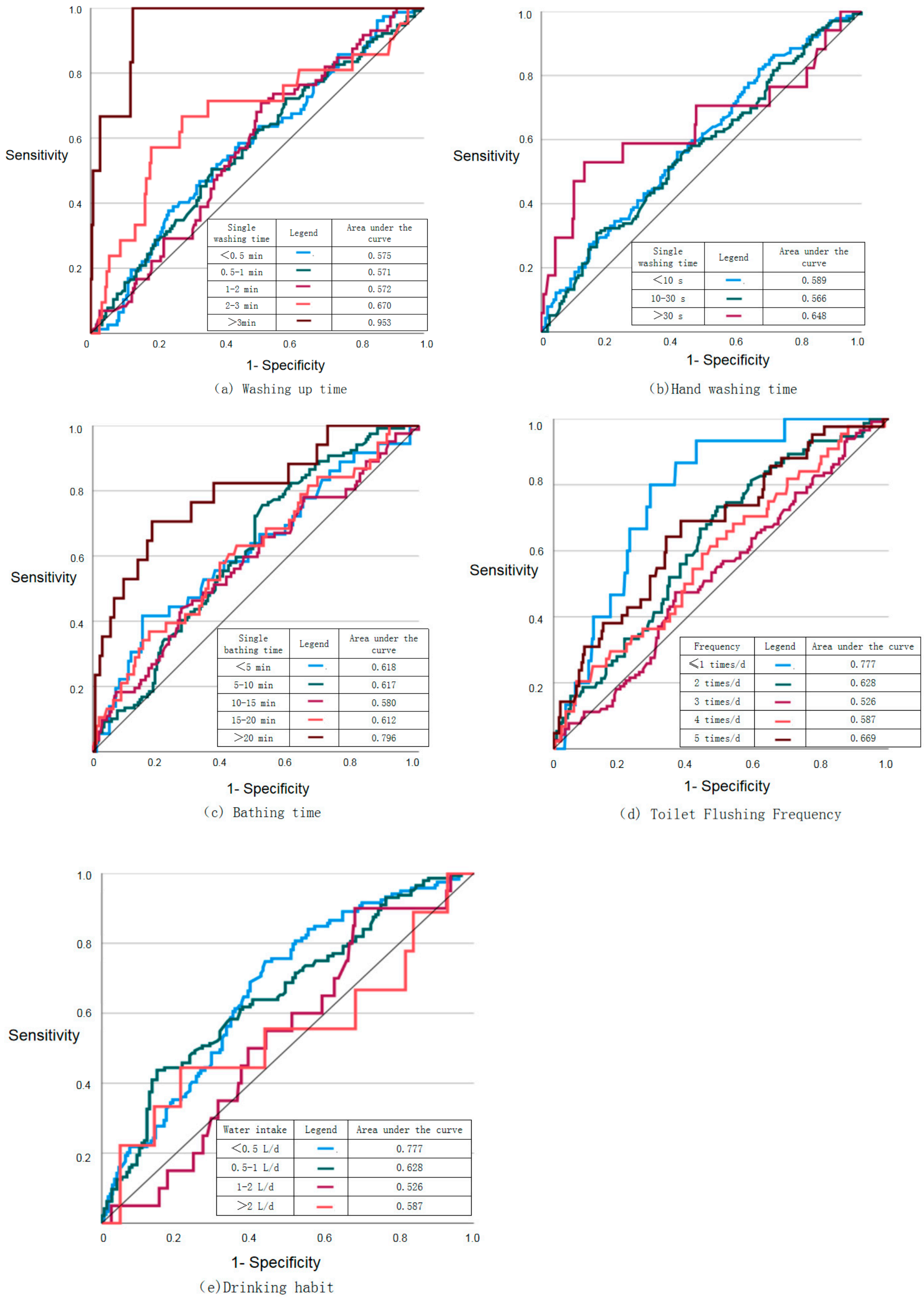

Figure 4. Receiver Operating Characteristic (ROC) curve of the MLP neural network model for the water-use behavior of hotel consumers: (**a**) Washing-up time; (**b**) Hand-washing time; (**c**) Bathing time; (**d**) Toilet-Flushing Frequency; and (**e**) Drinking habit.

The constructed neural network model of hotel consumers' water-use behavior was applied to quantitatively analyze the importance of various influencing factors on different water-use behaviors, as shown in Table 4. According to the analysis results, the degree of the influencing factors differs for the water-use behaviors of hotel consumers. Daily stay in hotels was the most important factor for washing up, hand washing, and bathing. The importance of the other influencing factors varied significantly. The second most influential factors on these behaviors were education, income, and gender. The order of importance of toilet flushing frequency was income > gender > education > daily stay in the hotel >

age > travel purpose > degree of water-saving awareness > hotel type. Drinking habits were more significantly influenced by income than other factors, with gender having the least impact.

Table 4. Importance of influencing factors of water-consumption behavior in the hotel.

Type		Washing-Up Time		Hand-Washing Time		Bathing Time		Toilet-Flushing Frequency		Drinking Habit	
		Importance	Normalization Importance	Importance	Normalization Importance	Importance	Normalization Importance	Importance	Normalization Importance	Importance	Normalization Importance
Individual characteristics	Gender	0.138	82.9%	0.076	38.6%	0.172	86.2%	0.165	80.1%	0.047	14.4%
	Age	0.118	70.9%	0.123	62.3%	0.081	40.8%	0.128	62.4%	0.142	43.1%
	Education	0.152	91.4%	0.082	41.4%	0.143	72.0%	0.141	68.5%	0.072	22.0%
	Income	0.118	71.1%	0.150	76.1%	0.096	48.3%	0.206	100.0%	0.329	100.0%
Water-saving awareness	Degree of water-saving awareness	0.086	51.9%	0.098	49.4%	0.087	43.6%	0.058	28.2%	0.080	24.2%
Consumption behavior	Hotel type	0.099	59.6%	0.145	73.5%	0.108	54.1%	0.046	22.5%	0.103	31.3%
	Travel purpose	0.123	74.3%	0.128	64.7%	0.114	57.5%	0.118	57.4%	0.153	46.4%
	Daily stay	0.166	100.0%	0.198	100%	0.199	100.0%	0.137	66.5%	0.075	22.8%

Overall, the direct water-use behaviors were affected by the duration of the hotel stay, followed by the type of hotel, income, age, gender, education, as well as the degree of water-saving awareness and travel purpose.

As shown in Figure 5, the factors influencing direct water-use behavior are ranked in order of importance as daily hotel stay, type of hotel, income, age, gender, education, degree of water-saving awareness, and travel purpose. Based on the analysis, the most important factor was the daily hotel stay, and the value of its importance was 0.181.

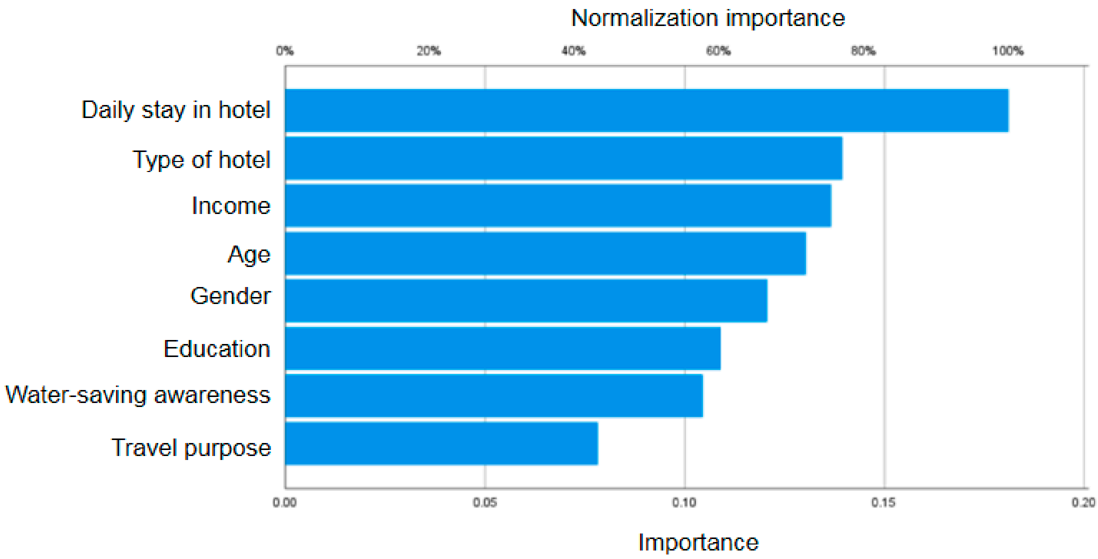

Figure 5. Importance of influencing factors on the comprehensive direct water-use behavior of hotel consumers.

3.3. Identification of Comprehensive Influencing Factors

Based on the above analysis, the typical individual characteristics of gender, age, income, type of hotel, and daily hotel stay were selected to analyze their impact on hotel consumers' water-use behavior using the structural equation model.

A parameter diagram of hotel consumers' typical individual characteristics and typical consumption behaviors on typical water-use behaviors was obtained, as shown in Figure 6. The structural equation model intuitively describes the relationship between latent variables through a path relationship diagram. As the latent variables represent phenomena that could not be directly measured, several relevant explicit variables were selected for interpretation. The latent and explicit variables were expressed as ellipses and squares, respectively. For example, gender, age, and income were selected to express typical individual characteristics.

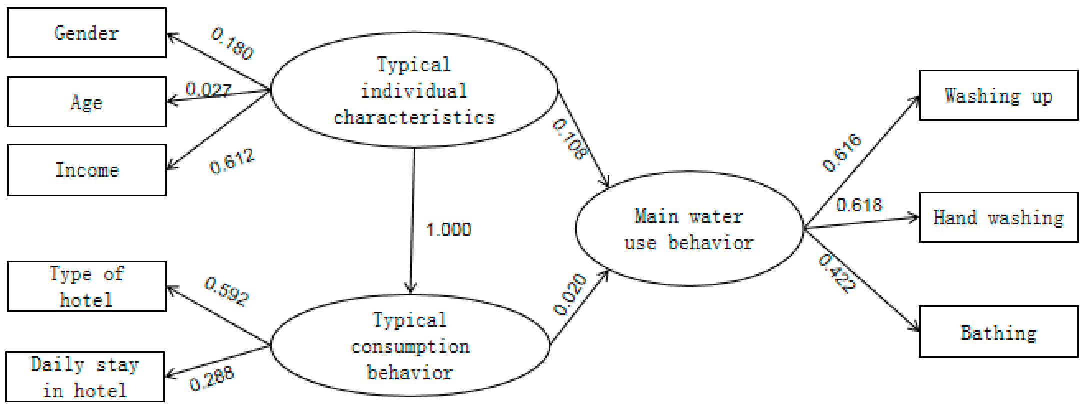

Figure 6. Parameter diagram of typical water-use behavior model of hotel consumers.

The chi-square ratio to the degree of freedom ratio was less than 5 [44], which is within a reasonable range of the evaluation criteria. The chi-square degree of freedom ratio of the fitting index of the model was $x^2/df = 3.962$, which meets the requirements of good model fitting. The regression coefficients between the variables in the constructed structural equation model are listed in Table 5. The significance test ($p < 0.05$) was used to analyze whether there is an influence relationship between the model variables; that is, in the construction of the model, the significance p value of the typical individual characteristics on the main water-use behavior was 0.000 < 0.05, which means that the typical individual characteristics have a significant impact on the main water-use behavior, and the path standardized coefficient was 0.108. The p value of the other paths was greater than 0.05, indicating that these paths were invalid, whereas their typical consumption behavior had no significant impact on the main water-use behavior.

Table 5. Regression coefficient of typical water-use behavior model of hotel consumers.

Factor (Latent Variable)	→	Item (Explicit Variable)	Non-Standardized Coefficient	Standardized Coefficient	Standard Error	*p*
Typical Individual Characteristics	→	Main Water-Use Behavior	0.545	0.108	0.027	0.000 ***
Typical Consumption Behavior	→	Main Water-Use Behavior	0.023	0.020	0.121	0.851
Typical Individual Characteristics	→	Typical Consumption Behavior	4.496	1.000	2.679	0.093 *

Note: *** and * represent significance at the 1% and 10% levels, respectively.

3.4. Hypothesis Test Results

The research hypotheses were tested and analyzed using Spearman's rank correlation coefficient, an MLP neural network model, and a structural equation model. According to the analysis results in Table 5, assuming that H_{2a} and H_{3a} are valid, each influencing factor has a different degree of influence on the water-use behaviors of hotel consumers, and typical individual characteristics have a significant influence on typical water-use behaviors of hotel consumers. H_{1a}, H_{1b}, H_{1c}, H_{1d}, H_{1g}, and H_{1h} were partially valid; gender, age, education, income, travel purpose, and daily stay in hotels had a significant impact on some water-use behaviors; H_{1e}, H_{1f}, and H_{3b} were not valid; and the degree of water-saving awareness and the type of hotel had no significant impact on the typical consumption behavior of hotel consumers.

4. Conclusions

This study proposes the hypothesis that individual characteristics, water-saving awareness, and consumption behavior have different degrees of influence on hotel consumers' water-use behavior. Through the questionnaire, these hypotheses were tested and analyzed using Spearman's rank correlation coefficient, the MLP neural network model, and structural equation model to identify the multi-dimensional influencing factors of hotel consumers' water-use behavior, and the importance of each influencing factor was analyzed. According to the results, the correlation and impact of water-use behavior on individual characteristics, water-saving awareness, and consumption behavior differed. Gender, age, education, income, travel purpose, daily stay in hotels, and other individual characteristics and consumption behaviors significantly affected water-use behaviors. The degree of water-saving awareness and the type of hotel had no significant correlation with the water-use behavior of hotel consumers. The influence degree on different water-use behaviors was quite different, and the direct water-use behavior was most affected by the length of stay in the hotel. From the perspective of comprehensive influencing factors, individual characteristics were the main influencing factors of typical water-use behavior, indicating that the water-use behavior of hotel consumers was less affected by water-saving awareness and consumption behavior.

This study constructed a water-use behavior model for hotel consumers to explore the water-use behavior mechanism, which serves as an important analysis method for water demand-side management and provides a scientific basis for water-resource management and policy formulation in this field. In addition, the model lays the foundation for a water-use predictive model for hotel water consumption based on water-use behavior. The research only focused on hotels and could not illustrate the general mechanism for the entire service industry but could provide a reference for subsequent studies on other industries in terms of the identification of influencing factors and mechanism research on water-use behavior.

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References

1. Song, L. *Outliers Identification of Water Intake Monioring Data in Industrial and Domestic Service Industry Based on LOF and CEEMD*; Hebei University of Engineering: Handan, China, 2021.
2. Chen, M.; Yi, Y.N.; Qin, J. On management of and measures for planned water use management in China. *Water Resour. Dev. Res.* **2022**, *22*, 57–61.
3. Zhong, F.L.; Guo, A.J.; Jiang, D.W.; Yang, X.; Yao, W.G.; Lu, J. Research progress regarding residents' water consumption behavior as relates to water demancmanagement: A literature review. *Adv. Water Sci.* **2018**, *29*, 9.
4. Wegelinschuringa, M. *Water Demand Management and the Urban Poor*; Delft Netherlands International Water & Sanitation Centre: Delft, The Netherlands, 2002.
5. Zhong, F.; Li, L.; Guo, A.; Song, X.; Cheng, Q.; Zhang, Y.; Ding, X. Quantifying the influence path of water conservation awareness on water-saving irrigation behavior based on the theory of planned behavior and structural equation modeling: A case study from northwest China. *Sustainability* **2019**, *11*, 4967. [CrossRef]
6. Addo, I.B.; Thoms, M.C.; Parsons, M. Barriers and drivers of household water-conservation behavior: A profiling approach. *Water* **2018**, *10*, 1794. [CrossRef]
7. Shi, L.; Zhu, Y.; Li, H.; Zhao, Y.; Wang, J.; Wang, L.; Qu, J.; Zhen, L. Simulation of residential water consumption and analysis of water-saving potential in Beijing. *South—North Water Transf. Water Sci. Technol.* **2022**, *20*, 851–861.

8. Nyong, A.O.; Kanaroglou, P.S. A survey of household domestic water-use patterns in rural semi-arid Nigeria. *J. Arid. Environ.* **2001**, *49*, 387–400. [CrossRef]
9. Nauges, C.; Thomas, A. Privately operated water utilities, municipal price negotiation, and estimation of residential water demand: The case of France. *Land Econ.* **2000**, *76*, 68–85. [CrossRef]
10. Dandy, G.; Nguyen, T.; Davies, C. Estimating residential water demand in the presence of free allowances. *Land Econ.* **1997**, *73*, 125–139. [CrossRef]
11. Chen, X.; Xu, J.; Ji, Y. Research on determinant factors in residential water demand. *J. Econ. Water Resour.* **2005**, *25–26*, 73.
12. Zhao, W. An empirical analysis of the factors influencing residential household water consumption-an examination of survey data based on the water consumption behavior of Beijing residents. *J. Arid. Land Resour. Environ.* **2015**, *29*, 137–142. [CrossRef]
13. Lin, R.; Qi, Y.; Fan, H.; Yang, S.; Zhang, C. An analysis of the present situation and influencing factors of household water consumption in Beijing. *China Rural. Water Hydropower* **2021**, 6.
14. Sha, K.; Dorssen, A.V.; Brouwer, S. Enhancing domestic water conservation behaviour: A review of empirical studies on influencing tactics. *J. Environ. Manag.* **2019**, *247*, 867–876.
15. David, S. Water conservation: Theory and evidence in urban areas of the developed world. *Annu. Rev. Environ. Resour.* **2013**, *38*, 227–248.
16. Lee, M.; Berrin, T.; Maribel, B. Urban sustainability incentives for residential water conservation: Adoption of multiple high efficiency appliance. *Water Resour. Manag.* **2013**, *27*, 2531–2540. [CrossRef]
17. Chang, G. Factors influencing water conservation behavior among urban residents in China's arid areas. *Water Policy* **2013**, *15*, 691–704. [CrossRef]
18. Tortella, B.D.; Tirado, D. Hotel water consumption at a seasonal mass tourist destination. The case of the island of Mallorca. *J. Environ. Manag.* **2021**, *92*, 2568–2579.
19. Zhu, J.; Zhao, X.; Zhu, T.; Li, L. Which factors determine students water-saving behaviors? Evidence from China colleges. *Urban Water J.* **2021**, *18*, 860–872. [CrossRef]
20. Du, J. Model analysis of hotel customer satisfaction based on two-factor theory. *Mark. Mod.* **2008**, 40–41.
21. National Bureau of Statistics. *China Statistical Yearbook*; China Statistics Press: Beijing, China, 2021.
22. Antakyali, D.; Krampe, J.; Steinmetz, H. Practical application of wastewater reuse in tourist resorts. *Water Sci. Technol.* **2008**, *57*, 2051–2057. [CrossRef]
23. Gössling, S.; Peeters, P.; Hall, C.M.; Ceron, J.P.; Dubois, G.; Lehmann, L.V.; Scott, D. Tourism and water use: Supply, demand, and security. An international review. *Tour. Manag.* **2012**, *33*, 1–15.
24. Huang, X.; Zhao, T.; Yu, S.; Cao, W.; Wu, D.; Yu, K. Research on China's tertiary industry development and water saving. *China Water Wastewater* **2022**, *38*, 49–56.
25. Bohdanowicz, P.; Martinac, I. Determinants and benchmarking of resource consumption in hotels—Case study of Hilton International and Scandic in Europe. *Energy Build.* **2007**, *39*, 82–95. [CrossRef]
26. Zuo, J.; Liu, C.; Zhang, H. Assessment of water use efficiency of hotels in Beijing Municipality. *China Water Resour.* **2009**, 52–55.
27. Deng, S. Energy and water uses and their performance explanatory indicators in hotels in Hong Kong. *Energy Build.* **2003**, *35*, 775–784. [CrossRef]
28. Wang, Z. *Assessment and Reduction of Water Footprint in Hotel Service Industry: A Case Study of Shanghai*; Tianjin University: Tianjin, China, 2020.
29. Wang, Y.; Chen, Y.; Weng, J.; Jiang, Y. Analysis of the characteristics of urban public domestic water use in Beijing. *Water Wastewater Eng.* **2008**, 138–143.
30. Jiang, Y. *Study on Factor Analysis and Prediction Model of Water Consumption in Typical Public Buildings*; Chongqing University: Chongqing, China, 2021.
31. Li, R.; Yu, N.; Wang, X.; Liu, Y.; Cai, Z.; Wang, E. Model-Based synthetic geoelectric sampling for magnetotelluric inversion with deep neural networks. *IEEE Trans. Geosci. Remote Sens.* **2022**, *60*, 1–14. [CrossRef]
32. Zhu, X.; Xu, Z.; Liu, Z.; Liu, M.; Yin, Z.; Yin, L.; Zheng, W. Impact of dam construction on precipitation: A regional perspective. *Mar. Freshw. Res.* **2022**. [CrossRef]
33. Wu, L.; He, D.; Ai, B.; Wang, J.; Guan, K.; Zhong, Z. Path loss prediction based on multi-layer perceptron artificial neural network. *Chinese J. Radio Sci.* **2021**, *36*, 396–404.
34. Do, M.; Li, J.; Cui, L.; Wei, Y.; Su, H.; Li, C. Application of correlation analysis – Neural network model in water consumption prediction in Ningxia. *Pearl River* **2022**, *43*, 71–77.
35. Gardner, M.W.; Dorling, S.R. Artificial neural networks (the multilayer perceptron)—A review of applications in the atmospheric sciences. *Atmos. Environ.* **1998**, *32*, 2627–2636. [CrossRef]
36. Agatonovic-Kustrin, S.; Beresford, R. Basic concepts of artificial neural network (ANN) modeling and its application in pharmaceutical research. *J. Pharm. Biomed. Anal.* **2000**, *22*, 717–727. [CrossRef] [PubMed]
37. Wang, N.; Li, D. Research on influencing factors of forestry enterprise management performance based on MLP Model. *China For. Econ.* **2019**, 37–40.
38. Li, Y.; Dang, Y.; Tang, R. Analysis of hospotalization expenses and influencing factors of malignant tumor patients based BP neural network model. *China J. Pharm. Econ.* **2022**, *17*, 10–13.

39. Xie, X.; Xie, B.; Cheng, J.; Chu, Q.; Dooling, T. A simple Monte Carlo method for estimating the chance of a cyclone impact. *Nat. Hazards* **2021**, *107*, 2573–2582. [CrossRef]
40. Yin, L.; Wang, L.; Tian, J.; Yin, Z.; Liu, M.; Zheng, W. Atmospheric density inversion based on Swarm-C satellite accelerometer. *Appl. Sci.* **2023**, *13*, 3610. [CrossRef]
41. Liu, Z.; Xu, J.; Liu, M.; Yin, Z.; Liu, X.; Yin, L.; Zheng, W. Remote sensing and geostatistics in urban water-resource monitoring: A review. *Mar. Freshw. Res.* **2023**. [CrossRef]
42. Reisinger, Y.; Turner, L. Structural equation modeling with Lisrel: Application in tourism. *Tour. Manag.* **1999**, *20*, 71–88. [CrossRef]
43. Wu, B. *Pilot study of Structural Equation Modeling*; Tianjin University: Tianjin, China, 2006.
44. Raykov, T.; Marcoulides, G.A. *First Course in Structural Equation Modeling*, 2nd ed.; Routledge: New York, NY, USA, 2006.