Research on the Application of User Participation in Subway Service Design: Nudge Theory Perspective

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Abstract. In recent years, people have put forward higher requirements for the service environment quality of the rail transit system. In the White Paper on the Development of Capital Smart Metro (2020 Edition), it is mentioned to establish "joint construction, joint governance and sharing, and build a new pattern of urban rail governance". It can be seen that in the aspect of subway service design, the government, subway companies and other parties have made different attempts and explorations. In this context, this paper tries to explore the actual implementation of this concept in the subway service design from the perspective of service marketing, and at the same time, explores the application of user participation in Beijing subway service design based on the Nudge theory. On the basis of a large number of literature reading, this paper innovatively combines Nudge theory, user engagement, and subway services, and distributes questionnaires to collect data, and concludes that the four dimensions of independent variable Nudge theory: Priming nudges, Salience nudges, Default nudges and Social nudges all have a positive promoting effect on the three dimensions of dependent variable user participation: information sharing, cooperative behavior, and interpersonal interaction, which proves that the Nudge theory has a very broad prospect in subway services.

Key words: Nudge theory, user participation; subway service design

1. Introduction

In order to coordinate the contradiction between urban space resources and the growth of urban residents' traffic demand, cities begin to pay attention to improving the public happiness index[1].At the same time, the practical experience at home and abroad shows that improving the design of urban rail transit service facilities such as subway can play a positive role in solving the problem of urban congestion and improving the public happiness index. The travel experience and behavior of passengers are influenced by the subway service design and service environment. First, the level of subway service design, including service process, service content, service logo, will affect the satisfaction and experience of the service environment, in different scenarios, the same service will have different evaluation and experience, such as time and station. Therefore, subway services should also strive to improve the service level and constantly optimize the service to ensure that all passengers have a better user experience.

On November 12,2020, the White Paper on the Development of The Capital Smart Metro (2020 edition) was released at the Capital Smart Metro Technology Seminar. Among them, "jointly building, jointly governing and sharing, and building a new pattern of urban rail governance" is listed as one of the "eight key points" in the next construction of a new mode of the subway

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operation in the capital. Therefore, the concept of co-construction, co-governance and shared governance in the service design of Beijing subway has been officially emerged: to build a new mode of modern operation and management with digitalization, information and intelligence, and to strengthen the concept of co-governance, and work with all participants to "jointly build, jointly governance and sharing" to jointly cultivate transportation civilization[2].

In addition, the passengers as the object of the service process, is to work together participants, is also the final result of the enjoyment, the participation of subway users means that social members share social responsibility and achievements, it provides each user to the local government or the opportunity to express opinions, in order to maintain their own interests. It also provides an opportunity for each user to show and contribute their talents, in line with the common interests of the society, so this kind of citizen users voluntarily participate in public service design under the guidance of the government and social organizations is the need of co-construction and co-governance, but also the need of sharing. Therefore, under the framework of co-construction, co-governance and sharing, this paper selects users (passengers) as the research variable.

2. Literature Review

2.1 The application of Nudging in subway service design

This paper believes that Nudging is a small intervention strategy to the environment of the Nudger to change the behavior decisions of the Nudgee, thus achieving the expected goal of promoting the healthy development of individuals and society. In addition, the application of the Nudging in the subway service environment is mainly reflected in the environmental conditions, spatial layout and functions, as well as signs, symbols and artificial items.

Environmental conditions refer to those environmental characteristics that fill people's facial features. People can perceive environmental conditions through individual and overall dimensions, including light and color, sound, temperature and smell[3]. Chen Shuo pointed out in his research that the subway space can play an important role through the color contrast, and promote and guide the orderly flow of people in the space[4]; The lighting design in the subway creates various lighting effects to enrich the visual experience of users, increase passenger satisfaction, and achieve the humanized effect of Nudging[5]. The application of music in subway mainly includes suggestive music and background music in subway broadcasting system, which not only provides accurate and timely information and good riding atmosphere for passengers, but also an important means of train operation control, disaster prevention and alarm. And the taste of subway station cleaner may also promote passengers to maintain good hygiene habits, and also remind passengers to keep the subway train and station hygiene.

In terms of spatial layout and function, most subway stations have generally promoted self-service. Based on the Nudging principle of prediction errors, some devices have set up a "forcing function", such as setting a tilt surface to prevent passengers from forgetting to take the card, etc., which provide a humanized choice for predictable errors[6]. In addition, the subway seat arrangement usually does not hinder the comfortable conversation between passengers and their companions, which achieves the purpose of startup Nudging.

Logns, symbols and artificial goods are another important dimension in service environment design. In the service environment, the design of many symbols is conveyed as a clear or implied signal, and then guide customers and convey service information[3]. In the field of public transportation, the reasonable setting of signs plays an important role in road finding and information guidance. The logo design of Xi'an Metro pays attention to the color highlight and pays attention to the standardization. It adopts the design of "one line and one color", which divides the lines connected in all directions through different colors, with distinctive characteristics, while the internal environment of the line maintains visual unity[7].

Scholars have proposed different Nudging classification methods. Referring to the classification methods of scholars, this paper divides the Nudging into four types[8]: Priming nudges[9,10], Salience nudges[11], Default nudges[12,13] and Social nudges[14,15]. The following is the example of food consumption areas to analyze the classification of Nudging.

2.2 Classification of user participation dimensions

Different scholars also have different criteria for dividing the dimension of customer participation. In the early stage of customer participation research, some scholars regarded customer participation as a one-dimensional variable[16]. However, with the gradual development of the theory, most scholars agree that the information of customer participation cannot be more comprehensively reflected in only one dimension of research, so the customer participation is regarded as a multidimensional variable. Several of the more well-known criteria are that Silpakit & Fish points out that customer participation is consumer participation in spiritual, physical and emotional forms[17]. Ennew & Binks believes that there are three dimensions of customer participation, namely information sharing, responsible behavior and interpersonal interaction. Among them, information sharing mainly refers to consumers who clearly convey their demand information to merchants; responsibility behavior refers to the service content completed in the participation process; interpersonal interaction mainly refers to the interaction between customers and enterprises[18]. This article uses Ennew & Binks.

2.3 The connection between Nudge theory and user participation

Based on the previous research of many scholars in the two fields of Nudging and user participation, the author finds that the literature discussing the relationship between the two is very rare. However, as far as the Nudge theory is concerned, it can be seen from its definition that the research subject is the behavior that affects people. As one of the behavior research, user participation is also the result variable more affected by external factors. Therefore, the author assumes that the means of Nudging are also applicable to the research that promotes user participation. In addition, from the perspective of user participation, from the perspective of psychological cognition in assistant theory, although previous studies in the public service field did not directly connect user participation and Nudging, many studies started from how to make people make better behaviors, which coincides with the purpose of Nudging. In the study of public service design, the public perception of public service is generally accompanied by a cognitive process composed of feeling, perception, imagination and thinking[19]In turn, there will be a series of behaviors such as identification, following or participation, so the theories of Nudging environmental conditions, spatial layout and functions, as well as signs, symbols and artificial goods can be used in the service process, but there is little research in this aspect, which can be added in this paper.

3. Theoretical models and computations

3.1 Proposal of the hypothesis

Combined with the above for because, the variable dimension division and determination, and the design of the scale, the Nudge theory of user participation factors study qualitative relationship concept model, namely the revised scale in the form of "Nudge theory" four types of Nudging dimension as an independent variable, assuming that the user participation dimension information sharing, cooperation behavior, interpersonal interaction are positive influence, see the model in Figure 1.

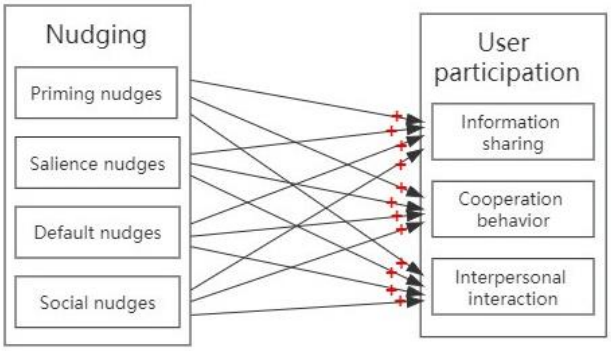

Figure 1. The hypothesis model

3.2 Measurement method of user participation level

In the literature of Gao Enxin and Wang Xinwei (2021), the author found the four frameworks of Nudging strategies for the behavioral insight group designed by two scholars[19]. According to this framework, the author finds out the corresponding relationship with the dimension of independent variable division in this paper, links the corresponding relationship to the service scene of subway, sorts out the service pain points of these seven links, and thus obtains the scale of independent variable Nudge in this paper. In reading the relevant literature of user (customer) participation, the author found that there are many mature scales worth reference and reference, and finally chose Qixingtong (2020)[20]. The scale formed in its research and the item are modified combined with the subway scenario.

For the dependent variable and the degree of user participation in the construction of subway service environment, the measurement method we adopt is: give the corresponding score to each item of the user participation part of the questionnaire, get the average score of each item according to the questionnaire data, and finally calculate the score value of the three dimensions of user participation.

This paper selected a monthly average number of subway passengers as the main respondents, plans to use the questionnaire star app online questionnaire collection, item design using Likert level 5 scale: independent variable Nudge theory measurement from 1~5 increasing (from "very against" to "very for"), the degree of user participation measurement from 1~5 increasing (from "very against" to "very for")[21].

4. Empirical Study

During the survey, 218 questionnaires were distributed on the WeChat app using the questionnaire star software. Among them, there were 17 questionnaires that took the subway less than 5 times in recent month, questionnaires with too low time (less than 100 seconds), and questionnaires with continuous selection (the same degree of 5 consecutive questions), which were considered as invalid after consideration. Finally, 201 valid questionnaires were screened out. Empirical analysis is as follows:

First, the paper makes statistics on the background information part of the questionnaire, and the basic characteristics of the respondents are mainly shown as follows:

(1) In the questionnaire survey, 47.76% men and 52.25% women. The sex ratio of the sample approached the overall sex ratio of the society.

(2) The age of the respondents is mainly under 55 years old, among which the people under 35 years old account for nearly 50%. They are generally young, with a high acceptance degree of new things and a low rejection rate of the questionnaire survey.

4.1 Reliability and Validity analysis

As shown in the following table, the reliability statistics are made on the 26 items in the questionnaire, and the α value is 0.958, which is far above 0.8. It can be seen that the overall reliability of the questionnaire is very good.

The analysis results are shown in Table 1, whose KMO value is 0.934, greater than the accepted level of 0.7, and the approximate chi-square value in Bartlett's sphericity test is 1277.708, Sig. For 0.000, less than 0.05, the validity is relatively good.

Table 1. Reliability and Validity analysis of the questionnaire

Clone of Bach, Alpha		number of terms
.958		26
Number of KMO sampling suitability quantities.		.934
Bartlett sphericity test	Approximate chi square	1277.708
	free degree	66
	conspicuousness	.000

4.2 Correlation analysis

The correlation between the four Nudge theory types and the three user engagement dimensions is explored below, and the results are shown in Table 2(95% confidence):

Table 2. Statistical table of sample correlation analysis results

	Priming nudges	Salience nudges	Default nudges	Social nudges
Pearson correlation	.808**	.812**	.799**	.729**

information sharing	Sig.(Double tail)	.000	.000	.000	.000
	The number of cases	201	201	201	201
cooperation behavior	Pearson correlation	.764**	.787**	.793**	.727**
	Sig.(Double tail)	.000	.000	.000	.000
	The number of cases	201	201	201	201
interpersonal interaction	Pearson correlation	.794**	.791**	.779**	.731**
	Sig.(Double tail)	.000	.000	.000	.000
	The number of cases	201	201	201	201

As can be seen from the table, there is a significant positive correlation between each dimension of the Nudge theory and the three user participation dimensions (the Sig value is less than 0.05).

4.3 Regression analysis

This section uses linear regression to explore the causal relationship between the four dimensions of the independent variable and the three dimensions of user participation. The results of the regression analysis with information sharing under user participation as the dependent variable are shown in Table 3:

Table 3. Results of the regression analysis with information sharing as the dependent variable

model	R	R square	Adjusted R square	Error in the standard estimation	Debin Watson
1	.883[a]	.779	.775	.3612	2.138

model		quadratic sum	free degree	mean square	F	conspicuousness
1	regression	90.171	4	22.543	172.754	.000[b]
	residual	25.576	196	.130		
	amount to	115.747	200			

model	Unstandardized coefficients		Standardization coefficient	t	conspicuousness	Collinearity statistics	
	B	Standard error	Beta			tolerance	VIF
(constant)	.361	.084		4.283	.000		
Priming nudges	.297	.060	.300	4.958	.000	.309	3.241
Salience nudges	.227	.059	.255	3.873	.000	.261	3.832
Default nudges	.213	.048	.269	4.401	.000	.302	3.308
Social nudges	.123	.040	.158	3.048	.003	.417	2.398

The regression equation is:

$$\text{Information sharing} = 0.297 * \text{Priming nudges} + 0.227 * \text{Salience nudges} + 0.213 * \text{Default nudges} + 0.123 * \text{Social nudges} + 0.361. \quad (1)$$

The variables that have a significant impact on the information sharing of dependent variables include Priming nudges, Salience nudges and Default nudges, and the dimension of Social nudges is not significant. Moreover, there was no autocorrelation between the variables, and the model had a good fit and significance.

Thus, H1, H2, H3 and H4 are assumed to hold.

The results of the regression analysis with cooperative behavior as the dependent variable are shown in Table 4:

Table 4. Results of the regression analysis with information sharing as the dependent variable

model	R	R square	Adjusted R square	Error in the standard estimation	Debin Watson
1	.861[a]	.741	.735	.4682	2.206

model		quadratic sum	free degree	mean square	F	conspicuousness
1	regression	122.699	4	30.675	139.961	.000[b]
	residual	42.957	196	.219		
	amount to	165.656	200			

model	Unstandardized coefficients		Standardization coefficient	t	conspicuousness	Collinearity statistics	
	B	Standard error	Beta			tolerance	VIF
(constant)	.110	.109		1.005	.316		
Priming nudges	.229	.078	.194	2.957	.003	.309	3.241
Salience nudges	.239	.076	.225	3.153	.002	.261	3.832
Default nudges	.308	.063	.325	4.909	.000	.302	3.308
Social nudges	.203	.052	.218	3.879	.000	.417	2.398

The regression equation is obtained:

$$\text{Cooperation behavior} = 0.229 * \text{Priming nudges} + 0.239 * \text{Salience nudges} + 0.308 * \text{Default nudges} + 0.203 * \text{Social nudges} + 0.110. \quad (2)$$

Thus, H5, H6, H7, and H8 are all assumed to be true.

The results of the regression analysis with interpersonal interaction as the dependent variable are shown in Table 5:

Table 5. Results of the regression analysis with information sharing as the dependent variable

model	R	R square	Adjusted R square	Error in the standard estimation	Debin Watson
1	.867[a]	.751	.746	.4610	2.073

model		quadratic sum	free degree	mean square	F	conspicuousness
1	regression	125.642	4	31.411	147.786	.000b
	residual	41.658	196	.213		
	amount to	167.300	200			

model	Unstandardized coefficients		Standardization coefficient	t	conspicuousness	Collinearity statistics	
	B	Standard error	Beta			tolerance	VIF
(constant)	-.015	.107		-.141	.888		

Priming nudges	.342	.076	.288	4.483	.000	.309	3.241
Salience nudges	.243	.075	.227	3.248	.001	.261	3.832
Default nudges	.243	.062	.255	3.931	.000	.302	3.308
Social nudges	.185	.052	.198	3.590	.000	.417	2.398

It can be concluded:

$$\text{Interpersonal interaction} = 0.342 * \text{Priming nudges} + 0.243 * \text{Salience nudges} + 0.243 * \text{Default nudges} + 0.185 * \text{Social nudges} - 0.015 \quad (3)$$

Thus, H9, H10, H11, and H12 are all assumed to be valid.

Based on the above analysis, the final hypothesis model of this study is shown in Figure 2:

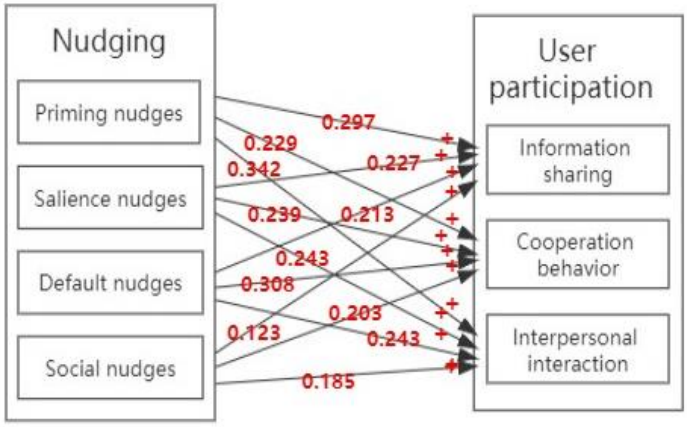

Figure 2. Final hypothesis model structure

5. Conclusion and Suggestion

Through the literature review, starting from the Nudging theory, through the empirical research, understand the participation of subway passengers in the subway service, and finally draw the following conclusions:

(1) As a tool to influencing people's behavior, Nudging theory is very suitable for application to subway service scenarios. The Nudge theory can effectively influence and regulate the behavior of subway users, and the research and application of this theory in the field of domestic public transportation are in the initial stage, which has a broad application prospect.

(2) Effectively promote the level of user participation in the subway service, which can improve the satisfaction and happiness of subway passengers, and also help the subway company to better recover feedback and improve the level of subway service.

(3) The Nudge theory has a positive impact on user participation in subway services. Among them, Priming Nudging has the most significant impact on interpersonal interaction under the dimension of user participation, and Social Nudging has the least significant impact on the dimension of information sharing.

There are still some shortcomings in the study:

(1) In this paper, only the questionnaire survey method was used in the empirical analysis, but it is difficult to intuitively feel the emotional and psychological state of the respondents, and it is not easy to collect other information besides the questionnaire. Later scholars can collect more intuitive and reliable data information, such as observing passenger behavior, live interview method and even experimental method.

(2) Domestic research on Nudge theory is in the initial stage and rapid development period, and the research on user participation in research tends to mature period and slow development period. The research of this paper will be affected by this objective environment and be relatively simple. Due to the independent variable in the field of public services especially in the subway public research literature is relatively scarce, the paper in the initial questionnaire scale design has great uncertainty, but after preliminary research data correction, has a lot of improvement.

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