

## Optimal Management Strategy for the Deviation of Urban Metro Public Space Development Tendency—Case Study Guangzhou City, China

Xie Qijun<sup>1</sup>, Anong Rungsuk<sup>2</sup>

<sup>1</sup>Ph.D, Candidate, School of Management, Shinawatra University, jeffqijun@163.com

<sup>2</sup>School of Management, Shinawatra University, anong.r@mru.ac.th

### *Abstract*

Based on the existing literature and field observation, the research takes Guangzhou as representative city and its deviation in the development of urban metro public space represented as the research object. It is believed that the deviation is mainly manifested in six dimensions: variables of social demography, details of taking metro, daily stress perception of passengers, perception on humanized design level of metro, perception on integration and intelligent level of metro space, perception on characteristic design and humanistic design level of metro space, and their correlation will be verified through data collection and analysis. The results found that: 1) Stress perception of passengers will lead to a negative predictive effect on passengers' perception on metro public space development trend. 2) Passengers' perception on humanized design level of metro will have positive and active effect on their perception on metro public space development trend. 3) Characteristic design and humanistic design level of metro space will lead to a positive predictive effect on passengers' perception on metro public space development trend. 4) In the process that humanized design level of metro affects passengers' perception on metro public space development trend, characteristic design and humanistic design level of metro space play a mediating role. 5) Passengers' stress perception have moderating effect in the process that humanized design level of metro indirectly affects the passengers' perception on metro public space development trend.

Keywords: Urban metro public space, optimal management strategy, deviation of development tendency.

### **1. Introduction**

The metro has been popularized all over the world and has become the preferred mode of travel in modern cities. Its characteristics such as

large transportation volume, high density of stations, fast operation speed and small impact on the natural environment perfectly dovetails with the urban sustainable development strategy. It successfully transplanted the ground urban transport network to the underground to achieve remodeling of planning and construction, thus establishing the vertical interaction between the ground and the underground, breaking the shackles of previous limited switching between ground transport vehicles, effectively dispersing the flow of people, strengthening the space utilization rate and greatly improving the traffic overload in the central area of the city. A typical supporting case for the above is the TIYUXILU Station of Guangzhou Metro. Metro as an innovative urban form of utilizing underground space is not a replacement but a beneficial supplement to ground cities, providing new ideas for urban land use and space development. On the other hand, it is more and more obvious that high population density has become a trend and space congestion has become an inevitable problem as a large number of people continue to flow into the cities at this stage. The population density of Guangzhou has jumped to about 2,500 people per square kilometer, and some streets in the central city can even reach the scale of 50,000 people per square kilometer. It is incredibly crowded in road traffic and space during the rush hours. Therefore, while expanding the underground in modern cities to solve the space problems in the limited central area of cities, surrounding areas of cities have also been taken into consideration. The rise of satellite cities is the best example. The continuous improvement of underground construction level and metro technology make the city fully capable of closely connecting the central area of the city and the satellite city with the metro as a link, effectively alleviating the tension of urban development space. The combination of “dots and lines” has formed more and more “urban circles”, which is the logic of space development being gradually practiced by the world’s developed countries and China’s first tier cities. Guangzhou is also accelerating the planning and layout of the metro, in the city adding subway lines to disperse the flow of people to suburban lines, around the city cooperating with Foshan and other cities in Pearl River Delta to promote the construction of “GuangFo City” and “Guangdong-Hong Kong-Macao Greater Bay Area” and other metropolitan areas. In a word, for the internal metropolis Guangzhou, the development of the metro perfectly solve the problem of urban traffic congestion and the problem of urban space conflicts. This study intends to explore the deviation in the development of urban metro public space in China based on the development of Guangzhou Metro as a prominent case, and formulate targeted optimization management plans and countermeasures with the support of relevant theories of public management.

### 1.1 Object of study

In order to find answers for the research questions, three research objectives are made as follows:

1.1.1 Study and formulate effective measures to create a humanistic environment for metro public space in Guangzhou.

1.1.2 Put forward systematic solutions for upgrading planning and development of Guangzhou metro.

1.1.3 Put forward countermeasures for integrating local characteristic culture into design of metro public space in Guangzhou.

## 1.2 Research questions

The research aims to find answers for the following three questions:

1.2.1 How to build a better humanized environment in metro public space in Guangzhou from the perspective of public management?

1.2.2 How to correct the deviation between overall planning and development of Guangzhou Metro from the perspective of public management?

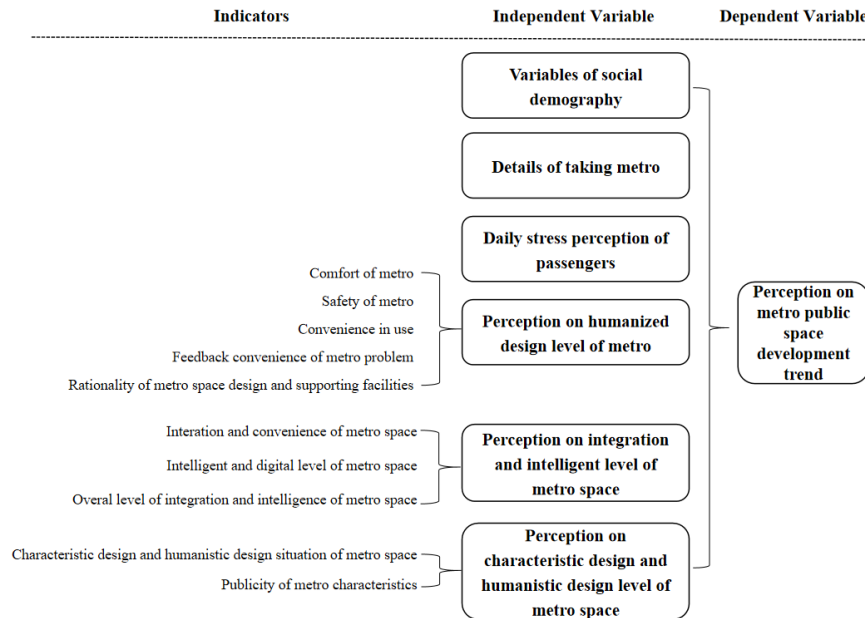
1.2.3 How to create characteristics in metro public space in Guangzhou from the perspective of public management?

## 1.3 Research variables and hypotheses

Independent variables: Through the analysis of literature and real situations, the independent variables are summarized as variables of social demography, details of taking metro, daily stress perception of passengers, perception on humanized design level of metro, perception on integration and intelligent level of metro space, perception on characteristic design and humanistic design level of metro space. Among them, perception on humanized design level of metro is reflected by five indicators, namely metro comfort, safety, convenience in use, feedback convenience of metro problem, rationality of metro space design and supporting facilities; And perception on integration and intelligent level of metro space is reflected by three indicators, namely interaction and convenience of metro space, intelligent and digital level of metro space, and overall level of integration and intelligence of metro space; And perception on characteristic design and humanistic design level of metro space is reflected by two indicators, namely, characteristic design and humanistic design situation of metro space and publicity of metro characteristics.

Dependent variable: Perception on metro public space development trend.

**Figure 1 The Relationship between Indicators, Independent Variables and Dependent Variables**



Based on this, the following research hypothesis is proposed for this study.

H1 The higher level of humanized design of metro, the better development trend of metro public space.

H2 The higher degree of metro space integration and intelligent level, the better development trend of metro public space.

H3 The higher level of characterization design and humanistic design of metro, the better development trend of metro public space.

H4 The lower cost in taking metro, the better development trend of metro public space.

H5 Sociological variables such as gender, age, and income of passengers are related to their perception on the development trend of metro public space.

H6 The stress level of passengers is related to their perception on the development trend of metro public space.

H7 The variables such as humanized design level of metro, characterization design and humanistic design level of metro interact with each other in the process of influencing the development trend of metro public space.

## 2. Research Methodology and Pathways

Based on above facts and reality of the study, this study will be carried out by combining qualitative research methods with quantitative research methods to improve its scientificity and effectiveness. And the qualitative research methods will be carried out through literature research, interview and other methods, while the quantitative research methods will be executed through quantitative analysis techniques such as questionnaire survey.

### 2.1 Questionnaire design

For this study, based on extensive learning of the development of metro public space at home and abroad, combined with the situation and problems of Guangzhou metro public space observed in the field survey, a questionnaire of “Research on the development trend deviation and optimization management strategy of metro public space” can be conducted according to the research objectives after concise summary. In the design of questionnaire, the interview should be further divided according to different age and education. These questionnaires are finally distributed to ordinary passengers to get a large number of first-hand data. Then the author will take Guangzhou as a case to conduct a quantitative analysis on the data obtained to understand the real situation of the development trend of metro public space, and verify the research hypothesis, which also provides realistic social group data for the development and management optimization of metro public space in China in the future. The design of the questionnaire is as follows:

1. Population background of the research: This research is mainly aimed at ordinary passengers, and is divided into main research object categories by gender, age, educational background and monthly income, including the following:

a. Gender

b. Age: 18 years old and below, 19-25, 26-35, 36-45, 46-55 and above 55;

c. Educational background: primary school or junior middle school, senior

high school or polytechnic school, junior college, undergraduate, master degree or above;

d. Monthly income(RMB): 0-3000, 3000-6000, 6000-10000, 10000-15000, 15000-20000 and above 20000.

2. Distribution method of the questionnaire: distributing the questionnaire to the target group on site to tentatively grasp the direction of the survey conclusion as following:

- a. How much attention has been paid to the use of metro public space and the development of metro space;
- b. Preferences and needs of different people on the design of metro public space;
- c. The future trend of development of Guangzhou metro public space and its optimized management.

## 2.2 Questionnaire Design and Reliability Test

The questionnaire used in this study was tested for reliability and validity and has a comparable level of reliability. The specific reliability data are shown in the table below.

**Table 1 Questionnaire Dimensions and Reliability Test**

Type	Dimensions	Cronbach's $\alpha$ of sub-dimension	Cronbach's $\alpha$ of dimension
<b>Variables of social demography</b>	Gender	/	/
	Age	/	
	Educational background	/	
	Average monthly income	/	
<b>Details of taking metro</b>	Main ways of daily commuting	/	/
	Frequency of taking metro	/	
	Expense on metro	/	
	Time of taking metro	/	
<b>Daily stress perception</b>	Perception of life stress	/	0.723
	Perception of working/academic stress	/	
	Perception of lacking time and energy	/	
<b>Perception on humanized design</b>	Comfort	0.754	0.932
	Safety	0.750	

<b>level of metro</b>	Convenience in use	0.747	
	Feedback convenience of metro	0.730	
	Rationality of metro space design and supporting facilities	0.727	
<b>Perception on integration and intelligent level of metro space</b>	Interaction and convenience of metro space	0.814	/
	Intelligent and digital level of metro space	/	
	Overall level of integration and intelligence of metro space	/	
<b>Perception on characteristic design and humanistic design level of metro space</b>	Characteristic design and humanistic design of metro space	0.718	0.847
	Publicity of metro characteristics	0.710	
<b>Perception on metro public space development trend</b>	Space design and service optimization	/	0.727
	Rationality in planning and systematic level in design	/	
	Intelligence and distinctiveness of metro	/	
	Development trend and level of metro	/	

### 3. Data analysis results

#### 3.1 Homologous Deviation Test

In the process of research, data was collected from voluntary answers of respondents. Therefore, in the hypothesis test of variable relations, deviation may incur due to affected factors such as common method effect, social approval expectation, and other factors. For this reason, the questionnaire first requires respondents to answer anonymously to reduce the evaluation anxiety and social approval of the respondents. Then, Harman’s single-factor test was used to confirm the possibility of the influence of homologous deviation through statistical analysis. The results show that the variance interpretation rate of the factor with the largest characteristic root is 29.303% (less than 40% of the critical standard) after performing maximal rotation of variance matrix in the processing of principal component analysis.

**Table 2 Test on Deviation of Common Method**

	Initial Eigenvalue			Extracted loads quadratic sum			Rotating loads quadratic sum		
	Total	Variance Proportion	Cumulative percentage	Total	Variance proportion	Cumulative percentage	Total	Variance proportion	Cumulative percentage
1	16.410	29.303	29.303	16.410	29.303	29.303	5.129	9.158	9.158
2	2.818	5.033	34.336	2.818	5.033	34.336	4.576	8.171	17.329
3	2.132	3.808	38.143	2.132	3.808	38.143	4.519	8.069	25.398
4	1.754	3.133	41.276	1.754	3.133	41.276	3.356	5.992	31.390
5	1.641	2.931	44.207	1.641	2.931	44.207	2.841	5.072	36.463
6	1.500	2.678	46.885	1.500	2.678	46.885	2.484	4.435	40.898
7	1.255	2.242	49.127	1.255	2.242	49.127	2.322	4.146	45.043
8	1.204	2.149	51.276	1.204	2.149	51.276	2.311	4.127	49.171
9	1.175	2.097	53.373	1.175	2.097	53.373	1.738	3.103	52.274
10	1.097	1.959	55.332	1.097	1.959	55.332	1.376	2.457	54.731
11	1.025	1.831	57.163	1.025	1.831	57.163	1.362	2.432	57.163

#### 3.2 Measurement Tool

According to the design concept of the questionnaire and the data characteristics reflected in the follow-up questionnaire data, core indexes of this research are constructed based on five dimensions,



mainly including four core independent variables and one dependent variable, which are briefly explained in this section.

The first is the daily stress perception (hereinafter referred to as “stress perception”). This variable is based on the stress-sensing dimension and adopts the project packaging method, reflecting the respondents’ overall perception of their own stress level. The higher the score of the variable, the greater the self-stress perception of the respondents at ordinary times.

The second is the perception on humanized design level of metro (hereinafter referred to as “humanized design level of metro”). This variable is based on the perception dimension of humanized design level of metro. After dealing with the problem of reverse design, by using the project packaging method, five sub-indexes of metro comfort, safety, convenience in use, feedback convenience of metro problem, rationality of metro space design and supporting facilities, which are further combined into variable of humanized level of metro. The higher the score of this variable, the more the respondents recognized the level of humanized design of Guangzhou Metro.

The third is the perception on integration and intelligent level of metro space (hereinafter referred to as “integration and intelligent level of metro space”). Based on the perception dimension of integration and intelligent level of metro space, after dealing with the problem of reverse design, the project packaging method is adopted to construct three sub-indicators of interaction and convenience of metro space, intelligent and digital level of metro space, and overall level of integration and intelligence of metro space, which are further combined into variable of integration and intelligent level of metro space. Among them, the intelligent and digital level of metro space is done by using a dichotomous scale to unify it with other variables. The higher the score of this variable, the more the respondents recognized the integration and intelligent level of Guangzhou metro space development.

The fourth is the perception of characteristic design and humanistic design level of metro space (hereinafter referred to as “characteristic design and humanistic design level of metro space”). Based on the perception dimension of characteristic design and humanistic design level of metro space, after dealing with the problem of reverse design, the project packaging method is adopted to first construct two variables of characteristic design and humanistic design situation of metro space, and publicity of metro characteristics, which are combined into variable of characteristic design and humanistic design level of metro space. The higher the score of this variable, the more the respondents recognized the characteristic design and humanistic design situation of metro space, and publicity of metro characteristics of Guangzhou metro space development.

The explained variable is the perception on metro public space development trend (hereinafter referred to as “metro public space development trend”), which is based on the perception dimension of metro space development trend and constructed by using the project packaging method after dealing with the problem of reverse design. This index measures the rationality of the development trend of Guangzhou metro public space and the gap between the actual condition of metro space and self expectation of respondents, and reflects the overall feelings of passengers about the optimization level of space design and service of Guangzhou metro, rationality in planning and systematic level in design, metro intelligence and characteristics, metro development trend and development level.

### 3.3 Mean Value Analysis of Core Variables

Descriptive statistics are made in this part based on the questionnaire data of the respondents by describing the score of each evaluation index with the mean value of the core variable, and analyzing the advantages and disadvantages of the metro space in each dimension.

**Table 3 Description of Mean Value of Core Variables**

Core Variables	Sub-evaluation index	Sub-dimension		General dimension	
		Mean	SD	Mean	SD
Stress perception	/			3.487	0.807
Humanized design level of metro	Comfort	3.671	0.749	3.572	0.554
	Safety	3.154	0.389		
	Convenience in use	3.695	0.730		
	Feedback convenience of metro	3.665	0.727		
	Rationality of metro space design and supporting facilities	3.674	0.726		
Integration and intelligent level of metro space	Interaction and convenience of metro space	3.706	0.703	2.826	0.432
	Intelligent and digital level of metro space	2.346	1.155		
	Overall level of integration and	2.424	0.773		

	intelligence of metro space				
<b>Characteristic design and humanistic design level of metro space</b>	Characteristic design and humanistic design of metro space	3.680	0.747	3.495	0.565
	Publicity of metro characteristics	3.309	0.522		
<b>Metro public space development trend</b>	/			6.516	1.090

The mean value of variable of stress perception is 3.487, which is at a high level, reflecting that most passengers taking Guangzhou metro feel great pressure in their life, study and work. On the whole, the mean value of humanized design level of metro evaluation index is 3.572, which is at a high level, reflecting that the humanization level of the space design of Guangzhou metro is well recognized by the respondents; Among the five sub-dimensions, the mean value of metro safety is the smallest, meaning that most passengers taking Guangzhou metro think that the metro safety (such as metro stability) needs to be further improved, while the mean value of evaluation index of other dimensions is higher, reflecting that the respondents are quite satisfied with the comfort of Guangzhou metro, the function of guiding signs, supporting equipment of metro such as AED, and the quality of the staff of the metro system, and the working concept of “people-oriented” is well reflected in metro space.

The overall mean value of the evaluation index for the integration and intelligent level of metro space is 2.826, which is the smallest of all core variables, reflecting that most passengers think that there’s still large room for improvement for the integration and intelligent level of metro space, among which the mean value of the index of interation and convenience of metro space is high, meaning that the convenience degree in mobile payment, interchange, mobile phone interconnection and other aspects of Guangzhou metro are well recognized by passengers. However, the mean values of the two indexes of intelligent and digital level of metro space, and overall level of integration and intelligence of metro space are very low, and their standard deviations are relatively large, reflecting that the respondents are not well known about some advanced technologies in the metro such as automatic linkage between equipment, digital reading function, intelligent customer service machine, and that there is a large gap between the intelligent level and digital level of Guangzhou metro and the expectation of passengers; And the relatively large standard deviation reflects the large difference in passengers’ understanding on the advanced technology of metro space.

The overall mean value of the evaluation index of characteristic design and humanistic design level of metro space is 3.495, which is at a high level, reflecting that the characteristic design and humanistic design of metro space in Guangzhou and publicity work of metro cultural elements are quite recognized by passengers, and the design of Guangzhou metro can meet the aesthetic needs of passengers.

The mean value of the evaluation index of metro public space development trend is 6.516, reflecting that the rationality of the current development trend of Guangzhou metro public space is well recognized by passengers. And the passengers believe that the gap between the development of metro space and their own expectations will be further narrowed in the future and are optimistic about the future development in aspects such as optimization in space design and service of Guangzhou metro, planning rationality and design systematization, metro intelligence and characteristic development.

### 3.4 The Empirical Analysis

In this section, the perception of satisfaction with the development trend of metro space is taken as the explained variable, while stress perception, humanized design level of metro, integration and intelligent level of metro space, characteristic design and humanistic design level of metro space, as well as the frequency of taking the metro, the time spent on metro per day, and the cost of taking metro per week are taken as the explanatory variables, and sociodemographic variables (including gender, age, educational background, and monthly income) are taken as the control variables to make the least squares regression. The fitting result is shown in the following table.

**Table 4 The Fitting Result of the Least Squares Regression**

	B	SE	t	sig
Stress perception	-0.159	0.052	-3.071	0.002
Humanized design level of metro	0.71	0.108	6.556	0
Integration and intelligent level of metro space	-0.133	0.094	-1.417	0.157
Characteristic design and humanistic design level of metro space	0.505	0.107	4.736	0
Frequency of taking metro	0.074	0.049	1.506	0.133
Cost of taking metro every week	-0.037	0.041	-0.9	0.369
Time spent on metro every day	0.007	0.033	0.207	0.836

Gender	0.024	0.081	0.293	0.77
Age	0.03	0.029	1.004	0.316
Education	0.03	0.039	0.77	0.442
Income	-0.038	0.032	-1.209	0.227
(Constant)	2.944	0.466	6.318	0
R <sup>2</sup>		0.584		
F		23.673***		

Note: \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

It is shown that the R<sup>2</sup> of the above model reaches 0.584 and the equation passed the F test, indicating that the model fitting result is good. From coefficients of each variable, it is clear to see that the three core variables of stress perception, humanized design level of metro, characteristic design and humanistic design level of metro space pass the t-test at the sig. of 0.05, while the regression coefficients of other variables fail to pass the t-test at the sig. of 0.05.

From the model, it can be seen that the regression coefficient of stress perception is -0.159, which is significant at the sig. of 0.05, showing that the stress perception of the respondents will have reversed and negative effect on metro public space development trend; For those with high level of stress perception (such as people with high working and life pressure), they are more likely to feel that metro public space development trend in Guangzhou is far from their expectation.

The regression coefficient of humanized design level of metro is 0.71, which is significant at the sig. of 0.05, indicating that the perception of humanized design level of metro will have positive and active effect on their perception of metro public space development trend; When passengers feel that the design of the metro space is very humanized (like that the metro is very comfortable and safe), they tend to believe that metro public space development trend in Guangzhou is positive and consistent with their expectation.

The regression coefficient of characteristic design and humanistic design level of metro space is 0.505, which is significant at the sig. of 0.05, indicating that the perception of characteristic design and humanistic design level of metro space will have positive effect on their perception of metro public space development trend; When passengers feel that the design of Guangzhou metro space is distinctive and well absorbed the humanistic elements and historical elements and great publicity has

been conducted in this aspect, they tend to be more positive about the perception on metro public space development trend in Guangzhou.

The the coefficient of core variable of integration and intelligent level of metro space fails in t-test. This may be due to the fact that passengers' perceptions on the integration level, technological level and intelligent level of metro space at current stage tend to be similar, and most of the passengers' cognitive data are the same, resulting in that the variable is not significant when fitting.

The three variables of frequency of taking metro, the money spent on metro per week and the time of taking metro per day represent the cost of passengers taking the metro (time cost and money cost), and their regression coefficients are not significant.

The regression coefficients of the four variables of social demography of passengers' gender, age, educational background and income fail to pass the t-test, therefore the demographic characteristics of different passengers are not significantly affect their perception on the development trend of metro public space.

#### **4. Research Findings**

Based on the questionnaire data of "Optimal Management Strategy for the Deviation of Urban Metro Public Space Development Tendency", this study explores the influencing factors and mechanism of perception on metro public space development trend by using the ordinary least squares method and other methods, and gets the following findings:

1. Stress perception of passengers will lead to a negative predictive effect on passengers' perception on metro public space development trend; compared with those with low perception on life, working or other pressure, people with higher pressure would have lower perception on metro public space development trend.

2. Passengers' perception on humanized design level of metro will have positive and active effect on their perception on metro public space development trend; passengers with high recognition to the level of humanized design of Guangzhou metro public space tend to believe that metro public space development trend is positive and active.

3. Characteristic design and humanistic design level of metro space will lead to a positive predictive effect on passengers' perception on metro public space development trend. When passengers feel that the characteristics of Guangzhou metro space is distinctive and the humanistic design is in high level, they tend to believe that metro public space development trend is positive and active.

4. In the process that humanized design level of metro affects passengers' perception on metro public space development trend,

characteristic design and humanistic design level of metro space play a mediating role. In the process that humanized design level of metro affects passengers' perception on metro public space development trend, there are two significant influence paths. One is the direct influence caused by the independent variable (humanized design level of metro), and the other the indirect influence caused by the independent variable through the influence of the intermediate variable (characteristic design and humanistic design level of metro space).

5. Passengers' stress perception have moderating effect in the process that humanized design level of metro indirectly affects the passengers' perception on metro public space development trend, reflecting in the fact that when the the intermediate variable of characteristic design and humanistic design level of metro space affects the passengers' perception on metro public space development trend, passengers' stress perception plays a significant moderating role.

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