Research on the standardized layout of epidemic prevention facilities in shopping malls based on regression analysis

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Abstract. Epidemic prevention and control facilities are an important part of the work of COVID-19 prevention and control. However, the chaotic arrangement of epidemic prevention and control facilities has seriously affected the quality of epidemic prevention and control work and people's satisfaction. Moreover, shopping malls are places with more human traffic in cities, so the standardized layout of epidemic prevention facilities is particularly important. Based on the above two considerations, in this paper, people's satisfaction with epidemic prevention facilities and China's epidemic prevention policy requirements are collected and analyzed. The data in shopping malls, and explores a standardized layout of epidemic prevention facilities in shopping malls by means of multivariate nonlinear analysis. And in the end, the number of facilities with the highest satisfaction of people in each place is obtained, combined with the requirements of epidemic prevention, a standardized layout of epidemic prevention facilities is obtained. The application of this type of standardized layout can improve people's satisfaction with the epidemic prevention policy.

Keywords: COVID-19, Multiple Nonlinear Regression Analysis, Epidemic Prevention Facilities.

1. Introduction

Since the outbreak of the new crown epidemic in December 2019, it has had a great impact on people's daily life and the operation of society. It shows the characteristics of global development, comprehensive impact, serious degree, long time and great uncertainty.

Although the epidemic situation in China has been controlled to a certain extent at this stage, new cases will still occur from time to time in various places, and the prevention and control of the epidemic still needs to be further optimized [1]. shopping malls are commonly used leisure and entertainment places in human daily life, and relatively speaking, the space is relatively closed and the passenger flow is large, and people's communication and contact are correspondingly more. The source of infection of many outbreaks is shopping malls. Therefore, certain attention should be paid to the standardized and rational layout of epidemic prevention facilities in shopping malls.

In order to ensure the effective implementation of epidemic prevention work, a large number of epidemic prevention facilities and epidemic prevention management methods have been added to the shopping mall. The current epidemic prevention and control policies are mainly divided into three sections: shopping mall environment, facility operation management and personal hygiene protection [2].

However, this requirement only provides a policy explanation for epidemic prevention, and the layout of epidemic prevention facilities has not been effectively thought and planned [3]. This has led to the confusion in the layout of epidemic prevention facilities to a certain extent, and some epidemic prevention facilities have been duplicated or missing, and a relatively standardized layout system has not been formed. As a result, people are dissatisfied with the use of overly complex and repetitive epidemic prevention facilities, which has a negative impact on epidemic prevention and control to a certain extent.

In order to explore this situation, the solution idea is divided into three parts. First, select shopping malls of similar size in the city as the research objects, and conduct questionnaires and interviews within the shopping malls to obtain a basic attitude of people towards the current epidemic prevention facilities and the subjective feelings of typical people;

Secondly, classify the space, crowd and facilities in the shopping mall, investigate and count the basic conditions of each part, obtain the quantitative relationship between each part through quantitative processing, and obtain a regression analysis result of satisfaction and facility layout;

Finally, based on people's satisfaction and the epidemic prevention needs of shopping malls, the reasonable arrangement of epidemic prevention facilities in various spaces is carried out. On the premise of ensuring the epidemic prevention needs of the policy, improve people's satisfaction as much as possible, reduce the duplication or lack of settings of various epidemic prevention facilities, and obtain a more standardized layout.

2. Research methods

2.1 Classification Principles

The attributes of the research object, the targets that need to be classified are divided into three categories:

I. Classification of epidemic prevention facilities.

As a variable in this study, epidemic prevention facilities need to be classified and counted, and their impact on crowd activities should be classified.

II. Classification of space types.

As the object of this survey, shopping malls have different types of spaces, which need to be classified according to the function and nature of the space.

III. Classification of the crowd.

In order to understand the improvement needs of various spaces in the shopping mall more specifically, a detailed plan can be obtained for the classification and statistics of the crowd.

2.2 Likert scale

Likert scale is a psychological response scale, which is often used in questionnaires and is the most widely used scale in current survey research. In the survey of people's identity, the degree of identity of the respondents can be divided into five levels, and different levels can be assigned to obtain a quantifiable identity value [4]. On the one hand, an intuitive horizontal comparison can be made for different object recognition degrees, and on the other hand, the data can be quantified for further analysis.

2.3 Multiple Nonlinear Regression Analysis

Multivariate nonlinear regression analysis refers to a nonlinear regression model that includes two or more variables. It can explore the joint influence of multiple factors to find the optimal solution, so as to determine the most suitable situation for variables [5].

The application of the multiple nonlinear regression method can be divided into the following four steps:

I. The researcher determines the types of variables that affect the dependent variable, and obtains data on independent variables and dependent variables through surveys;

II. The researchers observed the data and obtained the form of multivariate nonlinear regression through preliminary analysis, so as to construct the relevant model;

III. The researchers imported SPSS software to perform nonlinear regression analysis to obtain parameter estimates;

IV. According to the current situation, the researcher obtains the optimal solution under the required situation.

The multivariate nonlinear regression analysis can usually obtain the optimal solution under ideal conditions. In the specific operation, it is necessary to combine the actual situation to obtain the relative optimal solution in the actual operation.

3. Result and discussion

3.1 Classification of research objects

3.1.1 Epidemic prevention facilities

In preliminary observations, it was found that the anti-epidemic facilities in shopping malls can be roughly divided into three categories:

I. Pictograms, as a facility to guide people's behavior, are usually set up in obvious locations to regulate people's actions in the area, and people will not interact directly with such facilities;

II. Mandatory facilities, such as temperature monitors and health code inspection facilities, people must interact with them before entering the mall, and can only enter after meeting the screening standards of such facilities;

III. Non-mandatory facilities, such as automatic disinfection facilities, are convenient for people to carry out real-time self-protection, and people can choose to use or not use such facilities during their activities in the mall.

3.1.2 Types of space in shopping mall

After the shopping mall is observed and analyzed, the types of spaces can be divided into four types:

I. The entrance space is set at the entrance and exit of the shopping mall to manage the entry and exit of the crowd;

II. Transportation space which are connecting various areas of the shopping mall;

III. In the atrium space, there is a large and elevated area inside the shopping mall, where events are held or crowds are gathered;

IV Store space, after entering the mall, more detailed division is carried out inside the mall, and the independent space of each store is obtained. (Due to the particularity of the store space, each store has different attributes, and it is difficult to obtain a universal design method. The layout design should be combined with the functions of the store itself, so it is omitted in this design.)

3.1.3 Crowd in shopping mall

In order to obtain clearer and more targeted data, the population is classified from two perspectives;

From the perspective of crowd attributes, it is divided into three categories: shopping mall managers, store staff and customers;

In terms of age, it is divided into four categories: children, youth, middle-aged and elderly.

3.2 The basic information of the mall

According to the above classification of venues, select representative shopping malls in Chongqing, taking Times Shopping Mall, Jinsha Shopping Mall and Beicheng Shopping Mall as examples. Conduct on-the-spot investigations on the four types of spaces in the shopping mall, count the various facilities in different spaces, and obtain the basic information of the site.

Select 10 or 15 spaces as samples in various types of spaces, and finally get the following summarized in Table 1 to 3.

Table1. Entrance information statistics

	Pictograms	Mandatory	Voluntary
Entrance1	4	2	5
Entrance2	5	1	3
Entrance3	3	2	4
Entrance4	4	3	4
Entrance5	2	1	1
Entrance6	3	1	4
Entrance7	2	2	5
Entrance8	4	1	4

Entrance9	4	2	4
Entrance10	6	3	6

Table2. Traffic space information statistics

	Pictograms	Mandatory	Voluntary
Traffic space1	3	0	3
Traffic space2	4	0	3
Traffic space3	6	0	4
Traffic space4	5	0	1
Traffic space5	2	0	1
Traffic space6	5	1	3
Traffic space7	1	0	1
Traffic space8	2	0	1
Traffic space9	4	0	4
Traffic space10	6	0	6
Traffic space11	3	1	3
Traffic space12	1	0	2
Traffic space13	2	0	3
Traffic space14	2	0	2
Traffic space15	3	0	2

Table3. Atrium information statistics

	Pictograms	Mandatory	Voluntary
Atrium1	4	1	4
Atrium2	3	0	4
Atrium3	4	0	5
Atrium4	3	1	5
Atrium5	3	0	6
Atrium6	3	1	3
Atrium7	5	0	6
Atrium8	2	0	4
Atrium9	4	0	6
Atrium10	2	0	2
Atrium11	3	1	4
Atrium12	2	0	1
Atrium13	2	0	5
Atrium14	3	0	5
Atrium15	1	0	2

3.3 The satisfaction of people

When collecting statistics on space facilities on the spot, questionnaires are set up for distribution at the same time, and a certain number of questionnaires are distributed in each space. When 50 valid questionnaires are obtained, the collection of crowd information for the space is stopped.

In the setting of the questionnaire, people's satisfaction is divided into five standards: very dissatisfied, dissatisfied, average, satisfied, and very satisfied, and the satisfaction score is given from low to high.

After the relevant data is collected, the above distribution method is used to quantify the satisfaction of each space person, and the satisfaction of each type of space person is obtained as shown in Table 4.

Table4.Crowd Satisfaction in Various Spaces

Number	Satisfaction	Number	Satisfaction	Number	Satisfaction
Entrance1	3.8	Traffic space1	4.3	Atrium1	4.2
Entrance2	4.3	Traffic space2	4.4	Atrium2	4.2
Entrance3	3.6	Traffic space3	3.6	Atrium3	4.1
Entrance4	3.2	Traffic space4	3.8	Atrium4	4.1
Entrance5	3.8	Traffic space5	3.7	Atrium5	4.3
Entrance6	4.2	Traffic space6	3.2	Atrium6	3.9
Entrance7	3.5	Traffic space7	3.5	Atrium7	3.9
Entrance8	4.5	Traffic space8	3.5	Atrium8	4
Entrance9	3.8	Traffic space9	4.2	Atrium9	3.8
Entrance10	3.5	Traffic space10	3.8	Atrium10	3.7
		Traffic space11	3.2	Atrium11	4.1
		Traffic space12	3.5	Atrium12	3.7
		Traffic space13	3.6	Atrium13	3.8
		Traffic space14	3.6	Atrium14	4.1
		Traffic space15	3.8	Atrium15	3.6

3.4 Multiple Nonlinear Regression Analysis

3.4.1 Model construction

After the above two data are synthesized, in order to determine the form of the model, first draw a scatter plot to get the general trend of the function. And the satisfaction levels of people corresponding to different epidemic prevention facilities in various types of spaces are shown in Figure 1 to 3.

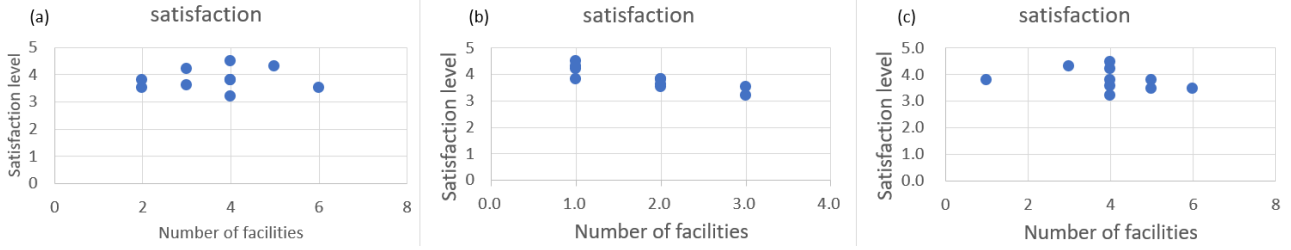

Figure1.Entrance space scatter plot (a) Pictograms, (b) Mandatory facilities, (c) Non-mandatory facilities

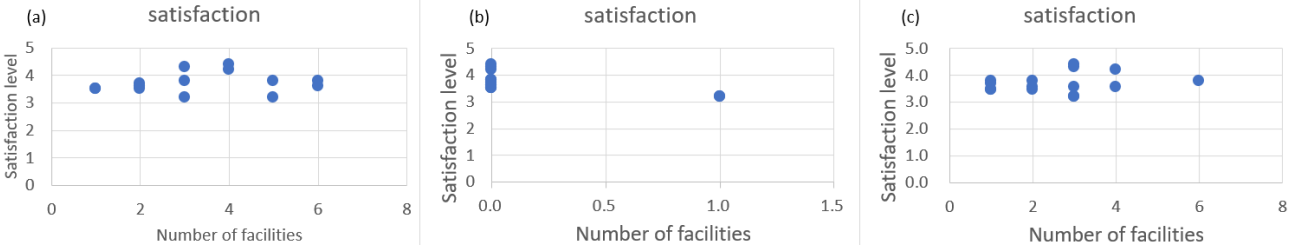

Figure2.Traffic space scatter plot (a) Pictograms, (b) Mandatory facilities, (c) Non-mandatory facilities

Figure3.Atrium space scatter plot(a) Pictograms, (b) Mandatory facilities, (c) Non-mandatory facilities

It can be seen from the above scatter plot that the overall trend of the function is in the form of a quadratic function. According to the intuitive analysis of the above scatter plot, the three variables are integrated into the same nonlinear fitting expression:

$$y_{(sat)}=a+b*P+c*M+d*V+e*P^2+f*M^2+g*V^2+h*P*M+i*P*V+j*M*V \quad (1)$$

(a, b, c, d, e, f, g, h, i, j are parameters, P, M, V represent Pictograms, mandatory, voluntary)

Finally, the mathematical model used in the research was constructed, the data was imported into the relevant analysis software, and the parameters were determined in the next step [6].

3.4.2 Determination of parameters

According to the collected relevant data and the function model obtained from the analysis, the information of the three types of spaces is deeply processed in SPSS, and the allowable parameter estimates within the error range are obtained through multiple nonlinear regression analysis, as shown in Table 5.

Table5.Prediction of various spatial parameters

Entrance space		Traffic space		Atrium space	
Parameter	Estimate	Parameter	Estimate	Parameter	Estimate
a	3.210	a	2.630	a	2.768
b	-1.695	b	0.640	b	0.519
c	3.660	c	-2903.877	c	-4108.209
d	0.210	d	0.124	d	0.211
e	0.209	e	-0.089	e	-0.082
f	0.050	f	-2903.877	f	4107.325
g	0.134	g	-0.014	g	-0.025
h	-0.100	h	0.049	h	0.184
i	0.159	i	0.008	i	0.005
j	-1.028	j	1935.579	j	0.070

According to the obtained parameter estimates, which are brought into the above obtained expressions, the optimal solution in the theoretical case can be obtained.

3.4.3 Selection of the optimal solution

In order to obtain the optimal solution in the theoretical case, the partial derivative of each variable is performed on the expression, and the expression is obtained:

$$d\,y/d\,P=b+2eP+hM+iV \quad (2)$$

$$d\,y/d\,M=c+2fM+hP+jV \quad (3)$$

$$d\,y/d\,V=d+2gV+iP+jM \quad (4)$$

(a, b, c, d, e, f, g, h, i, j are parameters as shown above)

When the results of the above expressions are all 0, the optimal solution in the theoretical case can be obtained. Use Slover to perform the following calculations on the three expressions, and the theoretical values are as the Table 6.

Table 6. Predicted placement results of various facilities

	Pictograms	Mandatory	Voluntary
Entrance space	3.145	1.583	3.410
Traffic space	3.661	0.000	1.500
Atrium space	3.900	0.500	5.418

After the obtained data is tracked and analyzed, it can be seen that in the theoretical case:

I When people in the entrance space are most satisfied with the epidemic prevention facilities, there should be 3 pictograms, 1~2 mandatory epidemic prevention facilities, and 3~4 non-mandatory facilities;

II When people in the traffic space are most satisfied with the epidemic prevention facilities, 3~4 pictograms should be set up, no mandatory epidemic prevention facilities should be set up, and 1~2 non-mandatory facilities should be set up;

III When people in the atrium space are most satisfied with the epidemic prevention facilities, there should be 4 pictograms, 0~1 mandatory epidemic prevention facilities, and 5~6 non-mandatory epidemic prevention facilities.

3.5 Crowd opinion collection

The statistics collected by the questionnaire are collected, and the age structure of the population of the three surveyed spaces is obtained, as follows:

I. In the entrance space, children account for 12%, young people account for 42%, middle-aged people account for 38%, and elderly people account for 8%;

II. In the transportation space, children account for 6%, young people account for 47%, middle-aged people account for 44%, and elderly people account for 3%;

III. In the third atrium space, children account for 18%, young people account for 37%, middle-aged people account for 33%, and elderly people account for 12%.

People of different age groups have different needs for the use of facilities due to physical and psychological reasons. By issuing questionnaires and interviews, the needs of various groups of people are counted and sorted out, and the following information is summarized:

I. Due to their young age, the most important way to obtain information is through shapes and colors. In their use of pictograms, warning language and words have less impact on them, while obvious colors and interesting graphics have a great impact on them;

In the use of compulsory facilities, children are often troubled by complicated steps, and the corresponding testing steps should be simplified as much as possible;

In the case of non-mandatory facilities, children are usually more willing to use such facilities because they are more active and like to explore things, and the corresponding steps should not be too complicated.

II. Young people and middle-aged people are the most important groups in the venue, and their statistical results are roughly the same. For pictograms, slogans, colors and patterns all have a noticeable effect on them; For the use of non-mandatory facilities, they will use a certain amount for their own safety. However, it should be noted that because the epidemic situation is relatively stable for a certain period of time, young people will have a certain degree of dissatisfaction with the cumbersome and complicated mandatory facilities, and they are more resistant to using mandatory facilities too much.

III. For the elderly. Their body-related functions are in a state of decline, and the color and shape of the pictogram will attract their attention more; Many mandatory and non-mandatory facilities have created a great burden for them due to the cumbersome and complicated steps, and they need a simple and quick arrangement of epidemic prevention facilities.

3.6 Exploration of Standardized Layout

After obtaining the number of facilities with the highest satisfaction in various spaces and the age structure and needs of the population, and on the premise of ensuring that China's epidemic prevention policies are met, the standardized layout of epidemic prevention facilities will be explored and discussed [7].

I. The entrance space is the most important space for epidemic prevention and control in shopping malls [8]. People who enter the shopping mall must be subject to mandatory screening. Those who do not meet the relevant conditions should not be allowed to enter.

Therefore, the mandatory facilities must be arranged in this space. According to the size of the space and other conditions, 1~2 mandatory facilities should be arranged to ensure the screening and differentiation of the crowd, but the steps should also be properly optimized to reduce complex operations;

People's satisfaction is the highest when there are 3 pictograms. In actual operation, they can be added appropriately, and the colors and graphics can be emphasized to ensure that they can play the role of guiding and indicating normally;

In this space, 3 to 4 non-mandatory facilities are set up according to the actual situation, for people's self-cleaning and disinfection.

II. Traffic space, as the space connecting all areas of the shopping mall, has a certain scale of people flow.

The increase of a mandatory facility will produce a large drop in people's satisfaction, so in the traffic space, mandatory facilities should be canceled;

The number of pictograms is more in demand in this type of space, and the arrangement of 3~4 pictograms can guide people's activities in this space and reduce unnecessary contact;

1 or 2 non-mandatory facilities are the best number of layouts in this type of space. Arranging at both ends of the traffic space can meet the needs of people.

III. The regular holding of activities and the functions of recreation and entertainment make the atrium space cause people to stay for a long time, and the proportion of the elderly and children has increased significantly in the crowd structure [9].

Due to the long stay in the space, the time required for the mandatory facilities is usually ignored by people. Combining the epidemic prevention policy and the actual situation, the mandatory facilities can be arranged or not arranged;

Pictograms and optional facilities are more important in the atrium area where people stay for a long time, and the number of their arrangements has increased significantly when people are the most satisfied [10]. According to the analysis, the reasonable arrangement of 4 pictograms and 5~6 non-mandatory facilities in this space can meet the demand.

4. Conclusion

As a recurrent and long-term infectious disease, new coronary pneumonia needs to be prepared for long-term protection. In the process of epidemic prevention, the interference to people's daily life should be reduced, and the normal operation of life should be maintained on the premise of achieving the purpose of protection. The current Chinese epidemic prevention policy does not put forward relevant specifications for the specific layout of facilities. This survey starts from the perspectives of people's satisfaction with facilities and people's needs for facilities. Try to explore how to improve people's satisfaction and needs under the condition of meeting the epidemic prevention policy, and formulate a standardized layout of epidemic prevention facilities to ensure the stability of long-term epidemic prevention and control work. Information is collected in various ways, and then quantitatively processed. Finally, through multivariate nonlinear regression analysis, the most suitable distribution of the number of facilities in each type of space is obtained. The above-mentioned standardized solutions are proposed for the layout of epidemic prevention facilities in shopping malls. It can not only improve people's satisfaction with epidemic prevention facilities, but also improve the work efficiency of epidemic prevention facilities, and improve the standardized layout strategy of epidemic prevention facilities. However, this survey still needs to be improved in the future, and the number of samples collected from shopping malls and population data needs to continue to expand, so as to obtain a more universal layout of standardized epidemic prevention facilities.

References

[1] Xiaoyan Liu, Thoughts on Standardization Helping Local Epidemic Prevention and Control. (eds.) Proceedings of the International Academic Forum on Economic Management Research, pp.15-17.

[2] Hang Liu, Li Li, Xianliang Wang &Lin Wang. Investigation on disinfection measures for community residents to prevent and control the outbreak of novel coronavirus pneumonia. Chinese Journal of Disinfection (06), pp.451-453.

[3] Yuqin Zhang, Lijun Gao, Jinxing Fan, Qi Zhao, Zhenqiang Tang & Jiqi Liu, Investigation on disinfection measures for community residents to prevent and control the outbreak of novel coronavirus pneumonia. Chinese Journal of Disinfection (06), pp.451-453.

[4] Dan Ye, Jiao Wang, Lijun Pan &Tao Li, Guidelines for health protection of shopping malls during the outbreak of novel coronavirus pneumonia. Journal of Environmental Hygiene (02), pp.117-118+121.

[5] Xiaopeng Li, Zhongwei Li, Zixuan Cui &Rufeng Wang. Mirror and reflection on my country's sports modernization governance in the Irish epidemic prevention and control stage. (eds.) Keeping the righteousness and innovation: Returning to the basic theory of sports" Proceedings of the first international conference on basic sports theory (poster exchange). pp .48-49.

[6] Lin Ma. Research on community governance problems and countermeasures in Liaoyuan City under the background of epidemic prevention and control [D]. Changchun University of Technology, 2022.

[7] Mengjie Liu, Yangyang Chen, Yanan Chen&An Chen. Construction and application of a comprehensive evaluation system for sporadic epidemics in China in the post-epidemic era. Science and Technology Herald (09), pp.67-77.

[8] Liqin Huang, Yin Sun & Siyang Luo. The influence of individualistic cultural values on the effect of epidemic control and its computational psychological mechanism. Acta Psychological Sinical (05), pp.497-533.

[9] Yangkang Ou & Yusen Wang. Research on the precise prevention and control system of the epidemic under the background of the mutation and spread of the new coronavirus pneumonia. Decision and Information (04), pp.5-12.

[10] Enxin Gao. Balanced governance: how can normalized epidemic prevention and control succeed? ——A sample of epidemic control in a megacity in China. Journal of Public Administration (01), pp.1-12+164.