

# Intelligent Signage Impacts of TOD Mall Based on The Way-finding Behavior

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**Abstract**—With the rapid development of urbanization in China, the urban complex with a public transportation-oriented development (TOD) meets people's needs in living space, however, its characteristics of large building volumes and complex space make it difficult for people to find their destination in the urban complex. The signage system is regarded as the main medium of communication between people and the spatial environment and also has a significant impact on pedestrian way-finding. In order to investigate the influence of the signage types and signage carriers location on people's way-finding, we designed a series of way-finding experiments in the study, Among them the forecast variables are organized into two types in the questionnaire design: signage types and location of the signage carriers. The results indicated that pedestrians pay more attention to directional and illustrative signs in the TOD commercial centre, they hope the signage carriers could be placed in crowded areas, such as escalators and central courtyard. In addition, signs and side signs identification are easier to be ignored. This study has great significance for the design of the signage system in the TOD, it could improve people's way-finding effectiveness in complex space.

**Keywords**—TOD; Signage design; Intelligent signage; Way-finding behavior; Quantitative;

## 1 INTRODUCTION

In contemporary society, dense urban complexes play an important role in urban space, the transportation-oriented development (TOD) of urban complexes contain Transportation interchange, commercial shopping, entertainment leisure and other functional areas. TOD has become an indispensable model in the process of urban development in China. The emergence of TOD commercial centre is caused by population growth. The characteristics of large building volume and complex space make it difficult for people to find their destination in the

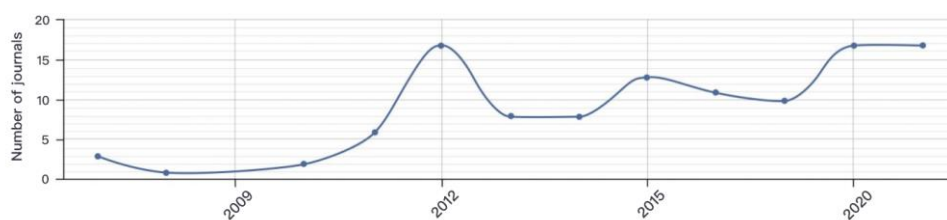
urban complex. Signage system is an important medium for pedestrians to understand information of surrounding space. Under the circumstances without the awareness of spatial environment, how to make pedestrians find their destination by reasonably arranged signage system as quickly as possible is an urgent problem to be solved.

In addition, with the increasing innovation and breakthrough development of science and technology. The channels and forms of information dissemination are no longer limited to the traditional static mode, and the application of signage is also prone to a dynamic development. This kind of activity includes not only the dynamic mode, but also the interaction between scientific technology and humans. Therefore, for the TOD commercial centre, the traditional and static signage can no longer meet the needs of all consumers.

At present, the explanatory researches about the traditional static signage system have obtained abundant results. Related scholars discussed some aspects of signage system such as design and construction in their books [1]. A more detailed, comprehensive, and multi-faceted explanation of urban spatial signage systems was provided by Limin Chen, Lili Zhang [2][3]. Japanese scholars focused on the relationships between signage system and surrounding environment, human psychology and behavior [4]. According to the above analysis, it can be inferred that the research of signage systems has been gradually developing towards classification and independence.

In fact, there were few research results related with the signage system in TOD commercial centre, most of them are mentioned in the researches of urban space signage or urban traffic signage. Although Xu Leiqing et had investigated on the signage system in TOD commercial centre, their research scope was only on the metro environment [5]. Duan Wu and others had analysed deeply on the signage system of urban space [6]. It was indicated that specialized researches are still lacked at the current stage.

In this paper, we utilized way-finding as a keyword to search literature in the CNKI. The results indicated that researches on way-finding behavior have shown a rising trend and received high attention in recent years (Fig.1). Researches of way-finding behavior have been conducted broadly in the perspectives of spatial cognition, way-finding strategies, signage design and gender experiences.



**Fig.1.** Quantity of studies on “wayfinding behavior”

The concept of way-finding was first proposed by Kevin Lynch (1960) in Urban Imagery [7], it mainly studied public's cognition of the urban space. He summarized the imagery of urban space to five elements: Paths, Edges, Zones, Nodes and Markers. Soon afterwards, some scholars continued to analyze the interaction between way-finding theory and signage system. Levine et investigated the impacts of azimuth signage on people's way-finding process, they

found people who used azimuth signage can arrive their destinations easily [8]. Findlay et al studied the different information which pedestrians need at stages of way-finding process. Meanwhile they summarized four factors causing difficulties to wayfinding and indicated that signage systems played an important role in providing way-finding information [9]. Vilar et al examined different impacts of vertical and horizontal signage on people's way-finding in unfamiliar environment [10]. According to the above, it showed that it was reasonable and correct to optimize design of signage system in the TOD commercial centre by exploring the influence of the signage system on pedestrian way-finding.

## 2 METHODS AND MATERIALS

### 2.1 Study area

The study area was selected as Longemont shopping mall in Shanghai, China, which is a large comprehensive business district integrating large-scale commerce, exhibition and commercial buildings. It is located next to Zhongshan Park Station of Rail Transit Lines 2, 3 and 4 and is one of the larger commercial projects in western Shanghai and part of the "Zhongshan Park Comprehensive Transportation Hub Plot". (Fig.2). Longemont shopping mall, adjacent to Metro Line 2, Line 3 and Line 4, bus terminals such as Bus 88, 67, 922 (original No. 13) and 946, as well as taxi stations, will be assembled into a large public transport transfer hub, which is supported by large shopping centers, entertainment, hotels and other commercial facilities. It is a large comprehensive business district in western Shanghai.



**Fig.2.** Longemont mall traffic relations map

## **2.2 The current situation of the signage system**

Although Longemont mall's signage system covers all types of sign, including the five major categories of signage, such as Directional sign, Identification sign, azimuth sign, illustrative sign and manageability sign. However, its design does not break out of the original design style of highlighting and repeatedly emphasizing commercial-type signage, thus making the traffic interchange guide design in the complex much weaker. Although it satisfies the shopping mall's need of attracting customer flow, it makes the convenient features of Longemont mall as a transportation hub much weaker, and weakens the resulting flow. In terms of the location design of the signage carriers, there are basically signs at key points such as central courtyard and road intersections. However, in vertical traffic (escalators) and other places, there is still a lack of signage carriers, and many of them lack on-site research and have problems of obscuring and improper maintenance.

## **2.3 Way-finding experiment design**

### **2.3.1 Determine the path finding target point**

According to relevant studies, people rely on the signage system to find their destination. According to the core functions of Shanghai Longemont mall: "zero interchange" and "one-stop shopping", this study focuses on these two core functions to study the influence of the design of the signage system on people's way-finding effect, this study focuses on these two core functions and selects two way-finding routes with "transportation" and "commercial consumption" as the target points.

### **2.3.2 Tested personnel and experimental equipment**

The way-finding experiment has 30 subjects, including undergraduate and master's students (15 male, 15 female), who were recruited through an online posting. At the same time, incorporating the shortcomings of related way-finding experiments, camera equipment was included in this study to ensure the recording of the signage information observed by the subjects during the way-finding process.

### **2.3.3 Experimental procedure**

In order to ensure the subjects to acquire the same amount of initial spatial information. All subjects were brought into Longemont mall by the researchers, and were told to complete the way-finding experiment destination 1 -Sinbad Castle of Joy and destination 2 - the entrance of subway line 1. The staff helped the subject to bring the camera equipment and asked the subject to make sure that the range of images taken by the camera was the same as the subject's visual range. During the subjects' way-finding, the staff followed and recorded the subjects' routes of action on the distribution map marked with a guide, and if the subjects had doubts, wandered or watched, they went up to ask and marked the corresponding positions in the map. At the end of the wayfinding experiment, the subjects were taken out of the field to fill in the questionnaire.

## 2.4 Statistical analysis

Using SPSS25.0 and EXCEL software to sort and analyze the experimental data, this study first assigns values to the experimental data (such as gender assignment: male=1, female=2), and then enters SPSS25.0 to analyze the correlation of all variables, and finds the correlated variables that correspond to each other, then analyzes each pair of correlated variables one by one to get the experimental results.

## 3 RESULTS AND DISCUSSION

### 3.1 The impact of signage types on way-finding

According to the functions of the signage system, the guides are divided into five categories: identification guides, oriented guides, orientation guides, explanatory guides and management signage. Since this experiment does not involve escape-related content, the managed signage is not included in the scope of the experiment. The questionnaire is designed as follows: at the beginning of receiving the way-finding task, what type of signage do you most want to see. The results are as follows (Table 1):

**Table 1.** The influence of different types of signs on wayfinding

Types of guides	Selected	No selected	Cumulative percent
Identification sign	4	26	15.3%
Directional sign	16	14	53.3%
Azimuth sign	10	20	35.6%
Explanatory sign	12	18	40%
Management sign	/	/	/

The results of the experimental questionnaire are assigned to SPSS25.0 for correlation analysis. Most of the assignment directions are: the deeper the degree, the higher the assignment, the single-choice type is assigned according to the order of the options, and the multiple-choice questions will individually propose each option as a variable, and the choice is assigned as 1. If it is selected, it is assigned a value of 0. The calculation results of the correlation meter are as follows (Table 2):

**Table 2.** Correlation analysis of different types of signage

Variable 1	Variable 2	Pearson Correlation	Sig.(2-tailed)	N
Identification signage	Gender	.392*	.031	30
Directional signage	Azimuth sign	-.358*	.039	30
Azimuth signage	Not get lost	.462**	.008	30
illustrative signage	Escalator	.432*	.013	30

\* Correlation is significant at the 0.05 level (2-tailed).

\*\* Correlation is significant at the 0.01 level (2-tailed).

1) The identification signage is the mark of the surrounding environment information, which is mostly reflected in the shop signs and public facilities nameplates in the Longemont mall Shopping Mall. The SPSS statistical software was used to analyze the correlation between "choice and identification signage" and other variables. Correlation analysis result: "Choose the identification signage" and "gender" have a moderately positive correlation, because the gender variable assignment is: male=1, female=2, which indicates that women are more likely to be women than men in the decision-making stage of way-finding and more inclined to choose identification signage.

2) Directional signage is a type of signage that can guide users to a specific destination or route. The correlation calculation results are as follows: Correlation analysis results: "Selection-directional signage" and "Selection-Azimuth signage" have low levels. The negative correlation indicates that the subjects who choose the directional signage in the path-finding decision-making stage may not choose the azimuth signage.

3) Correlation calculation results show (Note: "No loss in shopping malls in the past" variable assignment: often lost=1, sometimes lost=2, generally not lost=3, never lost=4) Correlation analysis results: There is a high degree of positive correlation between "type signage" of "choose directional" and "previously no getting lost in shopping malls", (sig=0.008, Pearson Correlation 0.462), indicating that in the past, subjects who were not prone to getting lost in shopping malls were more likely to choose directions. The type guide serves as a way-finding signage.

4) The correlation calculation results show that: the correlation analysis result: there is a moderately positive correlation between "selection signage" and "signage on the up and down of escalators during the way-finding process". Because there is basically an explanatory guide at the escalator at the Longemont mall Shopping mall, the statistical results show that there is a positive correlation between the two variables in the prediction. However, this correlation is not high. Perhaps Longemont mall's signage system was not perfect in the planning and design, and many key locations lacked signage facilities.

5) The complexity of the building space has an influence on the choice of the type of signage, the questionnaire designs "feel the complexity of the mall space" variable assigned to the value of -simple=1, average=2, very complex=3, the correlation results are calculated as follows (Table 3):

**Table 3.** The correlation analysis between the complexity of building space and the types of signage

The correlations between the complexity of building space and the use of signage types	Type of signage			
	Identificati on	Directional	Azimuth	Lllustrative
Pearson Correlation	-.431*	-.197	.372*	.464**
Sig. (2-tailed)	0.18	0.297	.043	.010
N	30	30	30	30

\* Correlation is significant at the 0.05 level (2-tailed).

\*\* Correlation is significant at the 0.01 level (2-tailed).

The results of the correlation analysis: "perceived complexity of the mall" has a moderate negative correlation with "choice of identification signage", indicating that people who perceive the mall space to be simpler are likely to choose identification signage in the way-finding decision stage. Secondly, there is a positive correlation with "choice of directional signage", which indicates that people who perceive the more complex mall space are likely to choose directional signage. Finally, there is a high positive correlation with "choice of directional signage", indicating that people who perceive more complex mall spaces are more likely to choose directional signage at the way-finding stage.

### 3.2 The influence of the type of the signage carrier on the way-finding

The relevant question in the questionnaire is designed as Question 10: When looking for a destination in the shopping malls, two types of signage carriers appear at the same time, and you prefer to choose which type of signage carrier. The selection results are shown in Table 4. The statistical results are as follows:

**Table 4.** The influence of the type of the signage carrier on wayfinding

Type of signage carrier	choice	Not selected	Select Percent
Traditional signage carrier	11	19	36.6%
Intelligent signage carrier	19	11	63.3%

The statistical results show that, compared with the traditional static signage carrier, people prefer to use the intelligent signage carrier in the path finding process. Its simple operation, beautiful interface and highly humanized characteristics have greatly deepened people's dependence on it.

### 3.3 The influence of the position of the signage carrier on the way-finding

In the questionnaire design, the research topics for the influence of the signage system carrier position on the way-finding are Question 11: When you are looking for a destination in the mall, which location signs have you paid attention to (can be multiple choices) and Question 12: According to your attention times, please sort from high to low to rank the options selected in the previous question. The selection ratio is shown in Table 1. The statistical results are as follows (Table 5):

**Table 5.** The influence of the position of the signage carrier on wayfinding

The location of the signage	Question 11 select a percentage	Question 12 select a percentage
Central courtyard	23(30)76.6%	4(30)13.3%
Aisle	22(30)73.3%	9(30)30.0%
Escalator	26(30)86.6%	13(30)43.3%
Ground	11(30)36.6%	3(30)10.0%
Safe exit	2(30)6.6%	/
Store entrance	10(30)33.3%	4(30)13.3%

The correlation calculation results are as follows:

**Table 6.** Correlation analysis of signage in different locations

Variable 1	Variable 2	Pearson Correlation	Sig. (2-tailed)	N
Focus on the Central courtyard	Find by yourself	.485**	.008	30
Focus on the Aisle	Focus on the Store entrance	-.386*	.035	30
Focus on the Escalator	Crowded place	-.447*	.013	30
Focus on the Store entrance	Crowded place	.430*	.015	30
Near the escalator position	Focus on the Store entrance	.432*	.016	30

\* Correlation is significant at the 0.05 level (2-tailed).

\*\* Correlation is significant at the 0.01 level (2-tailed).

### 3.3.1 Central courtyard

results of correlation analysis: There is a high degree of positive correlation between "relying on one's own way in the path-finding decision-making stage" and "attention to the guidance of the Central courtyard in the path-finding process", which means that it usually relies on one's own power to find the way instead of the fact that Participants who come to find their way are more likely to pay attention to the guidance of the location of the central courtyard.

### 3.3.2 Aisle

People spend most time in each aisle during the journey. In the way-finding experiment, 21 (30) 70% of the subjects have paid attention to the signs of the aisle position, of which 9 (30) 30.0% of the participants identified the most frequently followed signage as the aisles, which was the second place. Correlation analysis results: There is a moderate negative correlation between "Guidelines that pay attention to aisles during way-finding" and "Guidelines that focus on store entrances during way-finding". The signage system at the entrance of the store may be ignored.

### 3.3.3 Escalators

In the way-finding experiment, 26 (30) 86.6% of the subjects have paid attention to the signage of the escalator position, and this proportion ranks first among all signage carriers position options. Through interview analysis, in daily life, most shopping malls basically hang horizontal or vertical illustrative signage at the escalator position. Consumers have also formed a habit of observing the signage here to get information about the next floor of space. Correlation analysis results: "Focus on the signage at the escalator during the way-finding process" and "way-finding decision-making nodes go to places with large traffic" have a moderately negative correlation, which means that the way-finding decision tends to be more crowded. Subjects walking in the direction are more likely to ignore the signage on the up and down positions of the escalator.



### 3.3.4 The entrance of the store

The correlation analysis results "Pay attention to the signage at the entrance of the store during the way-finding process" and "Go to a crowded place at the beginning of the way-finding" has a moderately positive correlation, indicating that the subjects have a herd mentality in the way-finding decision-making stage, they are more likely to pay attention to the signage in densely populated areas such as the entrance of the store. Secondly, there is a moderate positive correlation with "the subway sign should be near the escalator position", which means that people who pay attention to the signage at the entrance of the store during the way-finding process think that the subway sign should be set at the escalator. The above results indicate that there are a large number of people at the entrance of the Longemont mall store, and people pay more attention to the signage here. Secondly, the Longemont mall store is located on the first and second floors of the basement, close to Line 1 and Line 10 of the Metro. It is even more necessary to add subway signs to the escalators near the stores.

### 3.3.5 Ground

From Table 5 it can be seen that the subjects paid very little attention to the ground signs. The on-site way-finding experiment found that at the beginning of the planning and design of the Longemont mall Shopping Mall, the three central courtyards on each floor passed three-color paving, distinguished by red, yellow and blue, but in the interviews after the way-finding experiment, few people noticed this. These two points can show that the ground signage is a very weak signage position.

## 4 CONCLUSION

According to the questionnaire survey, it could be concluded that the rank of influence degree of signage types on way-finding is as follows:

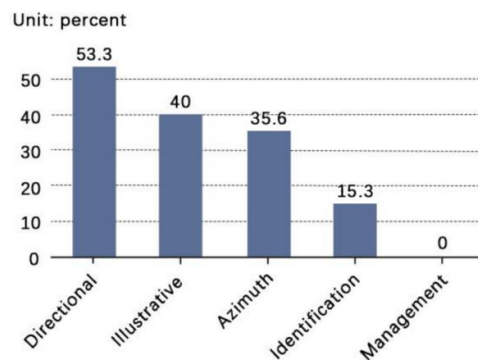


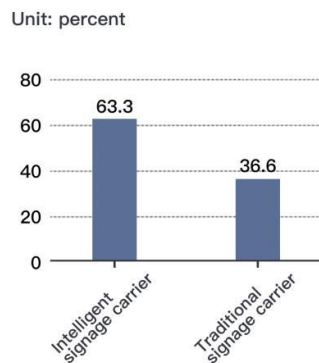
Fig.3. The rank of influence degree of signage types on way-finding

Directional signage has the largest percentage of overall signage board quantities in the TOD commercial centre, followed by illustrative signage, azimuth signage and finally identification

signage. The identification signage plays certain guiding role in a simple architectural space. In commercial environment, the identification signage should be located in the same position as the public walk and full of lighting to contrast with the surrounding environment in order to make it convenient for the pedestrians to watch. It is difficult to understand the overall information for people in the TOD commercial centre, therefore they are more inclined to choose way-finding strategies based on finding ways. The intuitive characteristics of directional signage make people convenient to judge quickly. Azimuth signage can provide overall information of building to people. It should be placed in main entrance and central courtyard of the buildings, in most cases, it can appear with illustrative signage at the same time. Firstly, azimuth signage must have a north indicator, which is convenient to distinguish the direction inside the buildings for people. Secondly, using azimuth signage requires the public to have a sense of direction, in other way-finding experiments, it was found that utilizing azimuth signage was very difficult for the elderly. Therefore, managers should reduce azimuth signage and increase directional signage in buildings where there were a large number of elderly users.

People prefer choosing identification signage in complex spatial areas and choosing directional signage or illustrative signage in simpler spatial areas. Because identification signs indicate the names of objects, so people find these signs as if they find their destinations. Pedestrians can possibly find destinations directly by identification signage in the simple spatial areas. Although the illustrative signage can not help pedestrians to find destination directly, it can provide more effective information about the spatial environment for the public.

According to the influence of the type and location of signage carrier on people's way-finding:

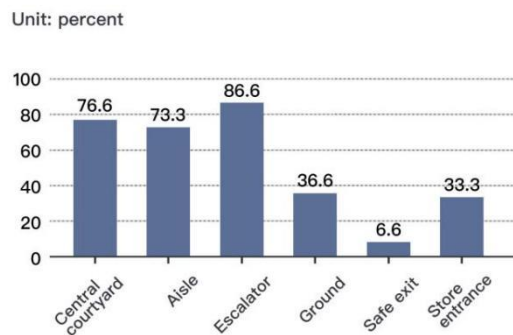


**Figure 4.** Ranking of the influence of the type of signage carrier on people's wayfinding

In the TOD commercial centre, young people account for the largest proportion of mall customers. The correlation analysis shows that young experimenters prefer to use intelligent signage in their way-finding process (Figure 4). In the age of big data, the operation and adjustment of commercial space cannot be separated from the support of computer information technology. The intelligent signage can carry all kinds of spatial information (such as pictures, audio, etc.), and can combine these information flexibly and ingeniously to present them to the pedestrian in the most intuitive way. Due to its own limitations, traditional

signage carrier often consumes a lot of time, manpower and cost when it needs to update the content. The update of the intelligent signage is faster and simpler than that, and can realize the simultaneous update of multiple mobile terminals, greatly reducing the labor and time costs. In addition, the intelligent signage is intuitive and easy to use, and users can usually operate it by clicking or touching the operation interface of the intelligent signage. In the field survey of Longemont TOD Mall in Shanghai, it can be found that the application of intelligent signage is not popular, and mall managers can reasonably set intelligent signage carriers according to the needs of different users to bring more detailed way-finding experience to pedestrians.

According to the questionnaire survey (Figure 5), signage boards should be located in key points of crowded areas in TOD commercial centre, they are escalators, central courtyards and aisles. The building spaces of TOD commercial centre have a three-dimensional form due to characteristics of high-density development, therefore escalators, as the most important vertical transportation services, the signage boards around them are used the most frequently. People have formed a habit to use signage system at the escalators for a long time, so managers should add signage boards quantity around the escalators according to people's habits. In addition, Longemont mall is a commercial centre based on transportation-oriented development, its main function is transportation interchange, it is necessary to increase quantity of signage boards of public transportation. Pedestrians don't have enough time to make judgments at elevators due to huge pedestrian flow, the content design of the signage system should avoid lots of words, the size of words should be more prominent. The central courtyard, as the intersection of aisle, can not only provide the open view, but also sufficient time to decide for pedestrians. In addition, escalator facilities are located in both sides of the central courtyard in most cases.



**Figure 5.** Ranking of the Influence of the position of signage carrier on people's wayfinding

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