A Study on the Spatial Coupling Relationship Between Urban Complex and Public Transportation Based on Vitality Orientation——The Comparison of the International Finance Center Between Shanghai and Hongkong

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Abstract
Based on the perspective of urban vitality, this paper analyzes the necessity of coupling the urban complex with the public transportation and the composition of the coupling relationship, and discusses the basic characteristics of the spatial coupling between them. And through the comparative analysis of the case of the international financial center (IFC) in Shanghai and Hongkong, the qualitative and quantitative studies on the spatial coupling are carried out to explore the design factors which influence the spatial coupling relationship and to draw conclusions.

Keywords: High Density; Urban Complex; Public Transportation; Spatial Coupling; Comparative Analysis

1. Introduction

As a production of the idea of the "mixed use" and "the integration of city and architecture", the urban complex has its own unique characteristics of the city. Urban complex is becoming a hub for organizing the flow of people, gathering popularity, accommodating activities and maintaining the city's vitality. The spatial coupling is instrumental in shaping the core of urban public vitality, and promoting the economic effect, environmental effect and social effect in the area of urban complex. Through the comparative study of the behaviors of the users in the urban complex between Shanghai and Hongkong, we have sorted out the spatial coupling relationship between urban complex and public transport, evaluated the benefits, and summarized the design strategy. By using the method of environmental behavior science, such as path tracing and gate counting, we collected the data of user's behaviors. Through the method of comparative analysis, the data were presented as several figures for quantitative comparison. Finally, this study will be used as a basis to evaluate the degree of spatial coupling of urban complex and public transportation space.

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2. The Necessity of Spatial Coupling

Improve travel environment. In Hongkong, Shanghai and other high-density living environment, the integration of architectural space and urban public space phenomenon is more and more common, the body of the city to accommodate more urban traffic space, the body of the city accommodates more urban traffic space. Space coupling makes a variety of spatial elements woven into a three-dimensional network for people in which shuttle and stay, the formation of a multi-level system as a whole to improve the travel environment and the continuity of walking traffic.

Enhance the vitality of the city. Traffic station’s traffic intensity, density and turnover frequency are higher. Organize the urban rail transit, office, shopping, hotel, leisure and other functional organizations into a complex, is the main trends that current urban creates the mainstream of business in the development and construction, which can enhance the vitality of the city, form the core node. On the other hand, the coupling within a limited land, attracts a large number of targeted flows and passing flows, and increases the public vitality of urban space.

Create a win-win effect. A large number of people in the complex can make full use of the transport capacity of public transport and improve the transport efficiency. It is more important that public transport enhances the availability factor of the inner space of the complex and reduces the travel difficulty and travel costs of user access. This virtually enhances the efficiency of the interior space of the complex and the influence of the complex in the city.

3. The Three Levels of Spatial Coupling Relationship

The spatial coupling relationship between urban complex and public transportation mainly includes three levels (Fig. 1).

Fig.1. Three Levels of Spatial Coupling.

1) Convergence and conversion of traffic. After the public traffic enters the complex, the following kinds of traffic flow will converge and transform in the internal space, and form a transportation network. In this network, the traffic flow relies on the public space of the complex to form a “channel” for convergence. A large number of integrated traffic flow in the complex form a "node" for conversion. The interaction between "Node" and "line", achieves the convergence and conversion of comprehensive variety of traffic flow, and has become a complex of public places of public activity.

2) Functional penetration and continuation. Mainly refers to the function of the complex itself and the public transport space in the function of the infiltration and continuation, which is based on the circulation and flow of flow of people in the city, inevitably carried out various activities produced by different people. A variety of
public activities in the process of compatibility, can make connections between different functions, such as dining, watching, transportation, shopping and so on.

3) Integration and integration of facilities. Urban complexes often use the internal atrium to connect with the entrances and exits of the rail transit station to form a traffic hub, which allows the pedestrian traffic facilities to remain continuous and complete in three dimensions, underground, ground and air. (Figure 2) This allows the complex's own commercial facilities, public service facilities and public transport facilities in series with each other, both to save land and reduce government investment in construction, and through the integration within the space system to make the complex into the core of urban space system, bring a steady stream of people for all kinds of facilities.

![Fig.2. Physical Connection (Left) and Spatial Coupling (Right) of Complex and Public Transport](image)

4. Case Research - A Comparative Study on the Spatial Coupling Relationship of IFC in Shanghai and Hongkong

4.1 Case selection: The study selected two cases of Hongkong IFC and Shanghai IFC as control group. The similarity of the two cases provides the basis for avoiding the influence of the interference factors in the study, and the difference between the cases is the focus of the study on the influence of the spatial coupling relationship. (Figures 3 and 4)

![Fig.3. The Relationship Between Shanghai IFC and Public Transport.](image)  ![Fig.4. The Relationship Between Hongkong IFC and Public Transport.](image)

4.2 Research meaning: This study evaluated the spatial coupling benefits of urban complex and public transportation based on the spatial and temporal distribution and behavior of users, and qualitatively evaluated the strength of the relationship in spatial coupling. By making a quantitative analysis and comparison based on the traffic flow of the section and the direct flow ratio, this study explored the design factors that affect the spatial coupling relationship between the urban complex and public transportation, and summarized the conclusions. These indicators can be collected or further processed in the research and design of urban complex.

4.3 Research method and process: Set up the flow data collection point at the designated space section. The data collection points include several types such as the import and export (including escalators as entrances and exits), the internal space section of the two IFC, the underground space section, the central
overpass section and the subway gates and the entrances and exits. The research of direct flow adopted Route Tracking method: Route Tracking refers to the fact that the investigator tracks a selected researcher starting from somewhere at the entrance, and records the path of the selected researcher’s movement in the complex, and the store he enters until he finally leaves the complex from an entrances or exits. All data were collected in four time periods: weekday morning, weekday evening, holiday noon and holiday evening.

4.4 Analysis of survey results

1) Sectional flow analysis

The flow analysis of exits and entrances section: The time that the entrance of Shanghai IFC has the largest sectional flow is the evening of holiday; and the time entrance of Hongkong IFC has the largest sectional flow is the evening of working day, the flow of people in the morning of working day is also higher than the two of the holiday (Figure 5, Figure 6). This shows that the two cases in the spatial coupling relationship has obvious strength of the points, and lead to the relative superiority or inferiority of the coupling efficiency. Shanghai IFC is more of a destination for shopping, leisure and dining. The Hongkong IFC and public transport are more comprehensive and can be used as urban nodes for urban inhabitants on and off duty. And from the point of view of the intensity of human flow, the spatial coupling relationship of Hongkong IFC is still strong.

The flow analysis of inner space section: In the inner space section of the flow of people, the average flow of people in the L1 floor of the Hongkong IFC is slightly less than the sum of the average of three-layer flow of LG1, LG2 and L1. However, the top layers, L2 and L3 floors, of the Hongkong IFC are much smaller, and the L3 layer’s flows is closed to the upper L3 and L4 layers of the Shanghai IFC(Figure 7, Figure 8).

The spatial coupling relationship of Shanghai IFC is weak, and basically each layer is mainly for objective flow of people based on the purpose of shopping and leisure. It is not directly related to urban public transport, and the entrances are distributed in four levels; the Hongkong IFC is the hub of the city link, L1 layer as a manifestation of this situation, the flow of which is much higher than the Shanghai any layer of IFC, and the upper L2, L3, especially L3 basically gives first place to the objective flow of people, so the flow of people and
the Shanghai IFC with the same location traffic is relatively close (Figure 9). It also proves that through spatial coupling, it can bring huge traffic to the L1 floor of the Hongkong IFC.

![Relationship of the Average Pedestrian Flow and Time Period Between HK IFC and SHH IFC](image)

**Fig. 9.** The Relationship of the Average Pedestrian Flow and Time Period Between HK IFC and SHH IFC.

2) Direct flow analysis: Direct flow including from subway to overpass, from the overpass to the subway and from the overpass to the other side Bridge and several other types. According to the chart (Table 1, Table 2), the proportion of direct flow of people in the Hongkong IFC was 61.4%, of which direct traffic between the overpass and the subway accounted for 43.2%, while the proportion of the direct flow of people in Shanghai IFC is 37.8%. The comparison of these two sets of data proves that the space coupling relationship between the Hongkong IFC and the overpass and the subway system is more compact.

**Table 1. Route Tracking Summary of Hongkong IFC.**

<table>
<thead>
<tr>
<th>Type</th>
<th>From the Overpass to the Subway</th>
<th>From the Subway to the Overpass</th>
<th>From the Overpass to the Subway</th>
<th>Go Shopping, Eating, Working</th>
<th>Go to the Toilet</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passengers</td>
<td>10</td>
<td>9</td>
<td>6</td>
<td>17</td>
<td>2</td>
<td>45</td>
</tr>
<tr>
<td>Percentage</td>
<td>22.70%</td>
<td>20.50%</td>
<td>13.60%</td>
<td>38.60%</td>
<td>4.50%</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Table 2. Route Tracking Summary of Shanghai IFC.**

<table>
<thead>
<tr>
<th>Type</th>
<th>From the Overpass to the Subway</th>
<th>From the Overpass to the Subway</th>
<th>From the Overpass to the Subway</th>
<th>From the Overpass to the Subway</th>
<th>Go Shopping, Eating, Working</th>
<th>Go to the Toilet</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passengers</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td>Percentage</td>
<td>6.70%</td>
<td>4.40%</td>
<td>13.30%</td>
<td>8.90%</td>
<td>0%</td>
<td>4.40%</td>
<td>51.10%</td>
</tr>
</tbody>
</table>

5. Conclusion

Through the comparison of the case of IFC in Shanghai and Hong Kong, the difference of design factors influencing the spatial coupling relationship between the two cases is summarized:

1) The number of spatial coupling interfaces: the greater the number, the more closely linked to public transportation. In the city complex and the subway connection, the complexes in Hongkong are more than the interface between Shanghai case and the subway, and more closely linked with the subway. Most of the complex in Hongkong has multiple interfaces with the subway, and Shanghai’s complex generally has only
one entrance, and even some complexes are not yet connected to the subway (Fig. 10). This is closely related to the development of the public transportation system in Hongkong. The 90% of Hongkong residents choose to take public transportation, while subway and metro travels reach 40% of public transportation trips.

![Image of public transport connection]

**Fig. 10. Public Transport Connection with Hongkong IFC (Left), Shanghai IFC (Right).**

2) Spatial coupling in the complex to accommodate more urban traffic space: To enhance the directive flow of people. In addition to the subway, the city complex in Hongkong also accommodates more urban traffic space. Many complexes combine the urban overpass system, bus or taxi station, and other traffic conversion nodes with the public space of the complex, to combine them into three-dimensional traffic transfer system, and to guide people flow through or even stay. Therefore, in the selected case, the number that the Hongkong complex used as a different mode of transportation hubs is more than Shanghai, it is difficult to find such a project in Shanghai. The transfer of different modes of transportation in the complex will result in a direct flow of people, for example, it has observed a clear direct flow in the Hongkong IFC and Festival Walk of Kowloon Tong.

3) Spatial distribution of spatial coupling interface: Multi-base configuration, to promote the circle of flow of people and uniformity distribution. In terms of the distribution of the interface between the urban complex and the public transportation, the Hongkong case is basically the same as that of Shanghai. This is influenced by the case selection. In general, Hongkong will still be more. From the view of the spatial distribution of the interface, the Hongkong mountain terrain and the higher density of the city form makes the complex mostly have the entrances in a number of bases with the city, especially interfaces above the ground level, it makes the circulation of different levels of people in complex interior, and dredges different levels of big flow which linked to the city traffic (subway, pedestrian overpass, ground entrance) to the entire complex space, so that the floors have a relatively uniformity flow of people, the benefits of spatial coupling develop to the best. And the complex in Shanghai is mostly in the ground and subway connected with the underground interface, which easily leads to the problem that there are a large flow of people in the bottom and a low popularity in the upper part.

Hongkong's high-density urban form, three-dimensional urban development and other characteristics have promoted the Hongkong IFC and public transport effectively organized together. On the whole, both of them have to meet the characteristics of integration, systematization and recognition to achieve a tight coupling condition.

**References**


