Research on TOD Development and Location Selection among All Urbanized Areas – A case study in China

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Abstract: Currently, China is in the period of rapid urbanization and gradual improvement of the rail transportation network. With the increasing population in towns, the construction of many cities has become blind and disorderly to meet people’s housing needs, resulting in traffic congestion, uneven distribution of resources, and other "big city diseases" more serious. From the urban construction experience of developed countries, the mode that urban rail transportation and urban development complement each other and develop together, that is, the regional-wide TOD construction, is an effective way to promote sustainable urban development. This paper focuses on how to select the stations of the rail transit for priority development of TOD projects (TOD development advance sites) within the whole area of the town. When selecting stations, the investment potential and regional driving ability of each station are taken into consideration to make a comprehensive evaluation of each rail transit station, so that the TOD development advance sites can drive the gradual development of its surrounding areas and finally form an urban renewal pattern of interoperability and integrated development of the whole area. With this method, we can effectively solve the current situation of blind and disorderly construction of TOD and various problems in urban development in China, and help to build efficient, green, and livable cities in various places.

1. Research background

In recent years, the rapid development of technology and economy has accelerated the process of urbanization in China. And the increasing number of urban population has led to problems such as low-density sprawl or disorderly renewal of urban construction[1]. Due to the prolonged period of development and duration of urban construction, unplanned city construction is detrimental to the long-term development of cities.

In order to meet the transportation demand caused by the annual growth of the urban population, urban rail transportation in China is also developing rapidly. Under this circumstance, many cities have gradually introduced the Transit Oriented Development (TOD) model [2], using its public transportation-oriented function of enhancing regional accessibility and its high-density, high-utilization land development model to solve the problems of land saturating and traffic congestion in urban centers. However, there is also a certain blindness and disorder in its TOD planning and constructing.

Previous researchers and governors have studied and applied the TOD model at the early stage of its introduction, making it run through the planning and construction of entire cities, forming a more comprehensive and wider coverage rail transportation TOD system [3][4]. According to the experience of urban construction in developed countries, and in view of the conditions and problems brought by the current rapid development of urbanization in China, this paper proposes that using the leading function of transportation to develop TOD construction among all urbanized areas, so as to promote the interconnection and coordinated development of various regions of the city, is a feasible urban development strategy in the stage of rapid development of urbanization.

Since the selection of TOD development advance sites is the first step of planning for the TOD construction among all urbanized areas, its driving effect on the surrounding areas will last for a long time, and it is the basic force to lead the coordinated development of the region-wide of the city. Therefore, this paper focuses on the location selection method of TOD development advance sites, using the leading function of the regional-wide rail transportation TOD system to promote the interconnection and coordinated development of various regions, and accelerate the construction of regional integration pattern.

2. Research methods

In order to reasonably select TOD development advance sites among all urbanized areas, this paper firstly screens out the sites that match basic requirements for TOD development among all the rail transit sites in the city, and then establishes an evaluation model to assess the investment potential among the initially screened sites,
so as to screen out the sites with high economic and social benefits for the development of TOD projects among all urbanized areas. Considering that the goal of regional-wide planning and construction of TOD projects is to drive multi-region development by multi-point development, and then drive the integrated development of the regional-wide town through multi-region interconnectivity. However, this process takes a long time. Therefore, the first step of the regional-wide TOD construction is crucial to its long-term development, that is, TOD development advance sites should improve the driving effect on regional development as much as possible. In this regard, this paper divides the sites that pass the second screening within the whole town region into several areas and focuses on the driving effect of the sites on their affiliated areas in the third screening, combining the investment potential of each site to determine the final TOD development advance sites. In the following discussion, the sites retained after each screening will be called "TOD sites to be selected" in the next stage.

2.1. Preliminary screening - important site selection

By reviewing abundant literature and combining the road network, rail network, and other basic conditions affecting TOD development in China, finally, the rail transit station is set as the center point of TOD projects, and its service radius is set as 1km [5]. At present, many cities in China have dense stations in rail line networks and some stations do not have the conditions to develop TOD projects in terms of passenger flow, geographical location, and service facilities. Therefore, this paper makes a preliminary screening of TOD sites to be selected.

In the preliminary screening stage, considering that interchange stations which are generally located in commercial areas or population centers, have large ridership and play the role of transportation hubs, this paper firstly classifies all interchange stations as TOD sites to be selected. Secondly, as the road runs through the whole city, the city's trunk roads generally have important status and special value, thus this paper classifies the stations located in the city’s trunk roads as TOD sites to be selected. Besides, there are many important service facilities such as hospitals, schools, and gymnasiums in each area, so the sites around the important service facilities are also classified as TOD sites to be selected. In this way, the sites suitable for the development of TOD projects are screened out, and their investment potential is further evaluated.

2.2. Secondary screening - investment potential evaluation

2.2.1. Establishing evaluation index system

Most of the studies on the synergy between transportation and land development in the service area of transportation stations in China and abroad have adopted the Node–Place Model for evaluation. The "imbalanced node" in the Node–Place Model means that transportation development around the node takes precedence over land development. Nodal areas in this state can increase their place value by developing the surrounding land, i.e., nodal areas in this state are more valuable for development. [6]

The objective of this paper is to select TOD development advance sites from the rail transit stations under the premise of regional-wide urban renewal planning. Considering the consistency of the existing research on Node–Place Model and the theoretical basis of this paper. This paper summarizes the indicators selected by domestic and foreign scholars to evaluate the node and place values of urban rail transit stations and establishes a set of indicator elements in this way (Table 1). Then the evaluation indexes for judging the investment potential of the TOD site to be developed are selected in the index element set by combining the development characteristics of the TOD project.

Table 1. Formatting sections, subsections and subsubsections.

<table>
<thead>
<tr>
<th>Nodal Value</th>
<th>Place Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>reachability of road network; density of bus lines; Number of interchangeable rail lines; station area; distance between station and city center; land price; road operation level; passenger flow; density of bicycle lanes; density of parking lots</td>
<td>land development intensity; land mixing degree; land use mixing degree; comprehensive land development intensity; building density; residential facility density; employment facility density; commercial facility density; number of residents; space use intensity factor; development intensity; population density; average house price; floor area ratio; site function; daytime population density</td>
</tr>
</tbody>
</table>

To evaluate the investment potential of the preliminary selected TOD sites, this paper sorted out the common evaluation indexes of node value and site value. Combined with the construction conditions of TOD projects, a total of seven indicators are selected from three aspects of crowd, traffic, and resources to establish the evaluation index system (Fig. 1).
Figure 1. Evaluation index system

(1) Reachability
Station reachability is a measure of how convenient the station is to other stations in the rail network. In this paper, the average of the minimum time required to travel from the TOD sites to be selected to other sites is used to calculate the site reachability. The smaller the value of reachability calculated, the more accessible the station is in the whole rail network and the higher the interchangeability of the station. To enhance residents’ willingness to choose rail transit mode to travel and make TOD projects better play the role of transit guide, this paper selects the reachability index to evaluate whether rail transit stations have the value of developing TOD projects.

The specific calculation Equation is:

\[ A_i = \frac{\sum_{j=1}^{n} t_i}{n-1} \quad (i \neq j) \] (1)

\( A_i \)——Reachability of the “i” site
\( n \)——Number of TOD sites to be selected
\( t_i \)——Average of the minimum time required to reach other sites from the “i” site

(2) Road network density
Road network density refers to the ratio of the total mileage of the road network to the area of the region. It can measure how convenient the Slow Travel System is within the service area of the site. A reasonable road network density can also improve the economic benefits of TOD projects, so this paper selects the road network density index to evaluate the potential value of site development.

To calculate the road network density within the service area of each TOD site to be selected, this paper obtains vector road network data of an area in OpenStreetMap and a regional vector map in DataV.GeoAtlas. And then in the Arcmap software to crop, project, create the fishing network, enter the site latitude and longitude coordinates, and other processing, you can use Arcmap software to calculate the length of the road network within the service area of each site (Fig. 2).

Figure 2. Road network density map of Qingdao West Coast New Area

(3) Detour factor
The detour factor is the ratio of the actual travel distance between two points to the straight-line distance. In order to measure the slow walking environment of the TOD site, the density of the road network within the service area of the site and the detour coefficient should be considered.

In this paper, the detour factor is calculated by calculating the ratio of the actual shortest walking distance to eight directions within the service area of the TOD site to be developed and the radius of its service area.

(4) Developable intensity of the site
The planning department of each municipal government has clear regulations on the type of urban parcels, floor area ratio, building area, and other indicators. The different volume ratios within the service area of the TOD site to be selected will affect the

Figure 3. Development intensity of a site
economic benefits of the TOD project, so the analysis of the index of developable intensity of the site should be focused on when selecting the TOD site to be developed.

In this paper, by looking up the detailed control plans of each area released by the municipal government, the authors get the relevant regulations on the plot ratio around the TOD site to be selected (Fig. 3). Then, the comprehensive plot ratio of the land within the service area of the TOD site is weighted according to the proportion of the area occupied by each type of land.

(5) Density of service facilities
TOD projects containing more types of service facilities can not only improve the quality of life of residents but also help stimulate regional vitality. Some typical international TOD projects have better integrated commercial service functions. For example, Singapore's Clementi Station is an important project using the TOD model for town center renewal. This complex integrates a rail transit station with a bus hub, shopping mall, library, residential, and other complex functions, effectively stimulating the urban vitality of the Clementi area. [13] Moreover, the goal of urban renewal at this stage is stock optimization, so the existing service facility conditions around the rail transit stations are conducive to the development of TOD projects. [14]

In this paper, a total of seven categories of service facilities that need to be counted are selected according to the characteristics of TOD projects: education, medical, cultural and sports, commercial services, finance, office and transportation. The POI data of the services and facilities around each TOD site to be selected can be obtained through google maps. The ratio of the aggregated POI data to the service area of the TOD site is the density of service facilities. [15]

(6) Population density
The higher the population density in the TOD service area, the greater the demand for TOD services, and the more beneficial to improve the economic and social benefits of TOD projects.

In this paper, the population density of each cell is counted as the smallest object to investigate the population number, and then the population density within the service area of each TOD site to be selected is calculated by the method of weighting the area of each cell.

(7) Population activity intensity
The population activity intensity index can measure the intensity of various activities of residents around the site in a certain period, which can reflect the spatial vitality of the area around the site. The higher the intensity of population activity, the better it is for giving full play to the function of TOD mode and improving the economic benefits of TOD projects.

In this paper, the heat map of the service area of the TOD site to be selected is obtained through Baidu Map, and the thermal value grades are divided by different colors. The number of pixel points of each color is obtained by using Python software, and the actual area corresponding to each thermal value is calculated proportionally. The population activity intensity within the service area of the site to be selected for TOD is obtained by calculating the two according to the following Equation. Taking the three different areas in Figure 4 as an example, their population activity intensities are 4.23, 3.95, and 2.55 respectively after bringing in the calculation of Equation 2.

$$Q_i = \frac{\sum_{r=1}^{7} r S_r}{S}$$  (2)

$Q_i$——The intensity of population activity within the service area of the “$i$” site
$S_r$——The intensity of population activity within the service area of the “$r$” site
$S$——The total area of “$i$” site service area
$r$——Thermal value grade

Figure 3. Detailed Control Plan of Haixi Road Station  
(Source: https://www.xihaian.gov.cn/)

Figure 4. Thermal value grade  
(Source: https://map.baidu.com/)
2.2.2. Establishing evaluation models

The entropy-weighted TOPSIS model is suitable for determining the weights of objective indicators and enables an objective evaluation of each site. The method can make full use of the information from the original data, and its results can reflect the gap between each evaluation object more objectively and accurately. According to the seven evaluation indexes selected in the previous paper and the characteristics of the evaluation object, this paper selects the entropy-weighted TOPSIS model to evaluate the investment potential of the site to be selected for TOD. The calculation process is shown in Fig. 5.

The specific Equations in the calculation process is as follows:

\[
\begin{align*}
    x_i &= \frac{x_i}{\sum_{i=1}^{n} x_i} \quad p_i = \frac{x_i}{\sum_{i=1}^{n} x_i} \\
    e_i &= \frac{1}{\ln n} \sum_{i=1}^{n} p_i \ln p_i \\
    d_i &= 1 - e_i
\end{align*}
\]

Where \( j \) indicates the number of evaluation indexes, and the meanings of other letters are shown in the flow chart. According to the above calculation process, the investment potential score of each evaluation object can be obtained, which is expressed by "value_i".

\[
    \text{value}_i = \frac{D_i^-}{D_i^+ + D_i^-} \quad (3)
\]

"value_i" indicates the proximity of site "i" to the most ideal site indicators, and the larger the value, the closer it is to the most ideal site, and the higher the investment potential of the corresponding site.

Due to the different levels of economic development in each region, the number of TOD sites to be selected through preliminary screening may vary greatly. Therefore, when applying this method to each region, the reasonableness of site selection should be judged based on the score and ranking of each site's investment potential evaluation, combined with the current state of development around the site. Using this method, a certain number of sites can be identified for the next screening step.

2.3. Final screening - Regional driving capacity evaluation

As mentioned earlier, this paper ensures that the construction of TOD covers the whole town by initially selecting sites with basic conditions for TOD development throughout the region. Through the second screening, the sites with high TOD investment potential were obtained, which can ensure the economy of developing TOD projects.

From other scholars’ studies on the conditions and factors for state-level core city development, it can be found that the important locations of these central cities, such as geographical locations, nodes and hubs, determine the support, service, radiation and driving role of the central cities to the surrounding towns. [16] The authors believe that the TOD development advance sites have the similar radiation and driving effect on the development of its surrounding areas, and the first TOD development site can attract and gather resources to accelerate regional development, improve regional functions, and create better conditions for the subsequent TOD development. Therefore, the ability of the TOD development advance sites to drive the surrounding area is crucial to the long-term development of the city, so this paper selects sites that not only meet the economic requirements but also have a strong ability to drive their surrounding areas through the third screening.

From a long-term perspective, the preliminarily screened sites are qualified to develop TOD projects. Therefore, in the third screening, the initially screened sites were divided into zones according to the density of the sites and the range of the residents' regular activities, and the TOD development advance sites were selected in each of the divided zones.

In the last screening, the paper shifts the perspective from a regional-wide scale to within each region, focusing on the geometric location advantages and accessibility of the TOD sites to be selected in their respective regions. This method is used to evaluate the regional driving capacity of each site, and finally arrive at the best choice of TOD development advance sites. [17]
2.3.1. Geometric location advantage

For the inner part of the region, in order to make the TOD development advance sites better play its radiation function, the distance difference between it and other stations in the region should be reduced as much as possible, and make it close to the geometric center of the region, so as to better promote the balanced development of the region with the guidance and radiation function of the rail transit network and slow-moving system. For the outside of the region, the TOD development advance sites will produce a certain siphon effect, if its distance from the regional edge in each direction is small and close to the regional geometric center, it can better absorb outside resources and drive the surrounding economy. Therefore, this paper compares the distance between the TOD site to be selected and its regional center, and derives the geometric location advantage ranking of the TOD site to be selected, which is used as the basis for evaluating its regional driving effect.

2.3.2. Convenience of transportation

(1) Intra-district interconnection
One of the functions of TOD is to enhance regional accessibility by public transportation. In order to make full use of this function to make residents’ travel more convenient, this paper selects the accessibility in the area of the site to be selected as an important evaluation index. In this way, it can lay a good foundation for the gradual expansion of TOD projects in the region, so that these TOD development advance sites can better drive the gradual development of TOD projects in their surrounding areas. This paper uses the average travel time between the selected station and other stations in the area to measure the accessibility of the station in the region.

\[ S_a = \frac{\sum_{i=1}^{m-i} \bar{t}_i}{N-1} \]  

\[ \bar{t}_i \] —— Average time from site to be selected “i” to other rail transit sites in the region to which it belongs

\[ m \] —— Number of TOD sites to be selected within the region

\[ N \] —— Number of rail transit sites within the region

(2) Inter-district Interconnection
Considering the long-term development of the city, urban renewal should focus on rational planning of the city in addition to adopting a high-density and high-utilization land development mode. The construction of TOD should take the form of multi-point development, complementary advantages, interconnection, and comprehensive development. Therefore, interregional transportation convenience is crucial to the construction of urban integration. In this paper, the travel time from the selected station to the nearest metro station in each region is averaged to measure the convenience of transportation between regions.

2.3.3. Comprehensive ranking

Taking into account geometric location advantage, the convenience of transportation, and investment potential, the new west coast area will conduct a final screening of TOD development advance sites in each region. Because TOD development advance sites in each region have different ranking orders in different aspects, this paper assigns weights to geometric location, intra-district interconnection, inter-district interconnection, and investment potential based on the degree of importance.

\[ \text{Geometric position} = 3 \]

\[ \text{Intra-district interconnection} = 2 \]

\[ \text{Inter-district interconnection} = 3 \]

\[ \text{Investment potential} = 2 \]

Each site was then ranked separately in different aspects and assigned a score based on the ranking according to the following Equation.

\[ T = \frac{2(m-R+1)}{m(m+1)} \]

\[ T \] — Site ranking the corresponding score
\[ R \] — Ranking of the site among TOD sites to be selected within the region

Finally, the ranking scores of each site in four aspects are added up according to the weight of 3:2:3:2 to obtain a comprehensive score that reflects the regional driving ability and select the site with the highest score in each region as the TOD development advance sites.

3. Instance verification

Qingdao West Coast New Area is the 9th national new area approved by the State Council, and is a key development area in Shandong Province. Compared with several domestic regions that have adopted the TOD model for construction earlier, the West Coast New Area has less intensive land development and is in a period of rapid rail transit development and gradual transformation of the old city, so it has the conditions for planning regional-wide TOD construction. In this paper, the authors take the West Coast New Area as an example and bring it into the above-mentioned screening method.
of TOD development advance sites to verify the feasibility of the method. According to the information released by the Qingdao municipal government, find all the subway stations in the West Coast New Area that are expected to be completed by 2035. Initial screening of these sites resulted in 50 TOD sites (Fig 6, Fig. 7).

The relevant data were found through the data sources shown in Table 2, and the indicator values were calculated for the 50 sites using the principles of indicator calculation described previously such as Equations 1 and 2. The entropy-weighted TOPSIS model (Equation 3) is then used to evaluate the investment potential of the sites to be selected for TOD, and the final results of ranking the investment potential of each site are shown in Table 3.

Table 2. Data sources for the indicator

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Sources of data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population activity intensity</td>
<td><a href="https://map.baidu.com/">https://map.baidu.com/</a></td>
</tr>
<tr>
<td>Population density</td>
<td><a href="https://www.xihaian.gov.cn/">https://www.xihaian.gov.cn/</a></td>
</tr>
<tr>
<td>Detour factor</td>
<td><a href="https://www.google.com/maps">https://www.google.com/maps</a></td>
</tr>
<tr>
<td>Road network density</td>
<td><a href="https://www.openstreetmap.org/">https://www.openstreetmap.org/</a>, <a href="https://datav.aliyun.com/">https://datav.aliyun.com/</a></td>
</tr>
<tr>
<td>Developable intensity of the site</td>
<td><a href="https://www.xihaian.gov.cn/">https://www.xihaian.gov.cn/</a>, <a href="http://zrzylq.hq.in.gov.cn/">http://zrzylq.hq.in.gov.cn/</a></td>
</tr>
<tr>
<td>Density of service facilities</td>
<td><a href="https://www.google.com/maps">https://www.google.com/maps</a></td>
</tr>
</tbody>
</table>

Table 3. Investment potential score and ranking results of 50 TOD sites to be selected

<table>
<thead>
<tr>
<th>Station</th>
<th>Investment potential score</th>
<th>Sort Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nanbei Tun</td>
<td>0.417</td>
<td>10</td>
</tr>
<tr>
<td>Tangdao wan</td>
<td>0.0287</td>
<td>31</td>
</tr>
<tr>
<td>Wuyishan Road</td>
<td>0.301</td>
<td>26</td>
</tr>
<tr>
<td>Jimiya</td>
<td>0.274</td>
<td>33</td>
</tr>
<tr>
<td>Tianmuishan Road</td>
<td>0.195</td>
<td>49</td>
</tr>
<tr>
<td>Xuejiado</td>
<td>0.233</td>
<td>43</td>
</tr>
<tr>
<td>Jinggangshan Road</td>
<td>0.355</td>
<td>22</td>
</tr>
<tr>
<td>Taihangshan Road</td>
<td>0.375</td>
<td>18</td>
</tr>
<tr>
<td>China University of Petroleum</td>
<td>0.593</td>
<td>3</td>
</tr>
<tr>
<td>Wangjiagang</td>
<td>0.638</td>
<td>2</td>
</tr>
<tr>
<td>University of Technology</td>
<td>0.361</td>
<td>20</td>
</tr>
<tr>
<td>Fuchunjiang Road</td>
<td>0.520</td>
<td>6</td>
</tr>
<tr>
<td>Jialing Road</td>
<td>0.252</td>
<td>39</td>
</tr>
<tr>
<td>Tongjiang Road</td>
<td>0.266</td>
<td>38</td>
</tr>
<tr>
<td>Qing Medical West Hospital</td>
<td>0.546</td>
<td>4</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Station</th>
<th>Investment potential score</th>
<th>Sort Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dazhushan Road</td>
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</tr>
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<td>Shenghai Road</td>
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</tr>
<tr>
<td>Shenghai Road East</td>
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<td>19</td>
</tr>
<tr>
<td>Yueyue Road</td>
<td>0.292</td>
<td>29</td>
</tr>
<tr>
<td>Shuangzhu Road</td>
<td>0.384</td>
<td>15</td>
</tr>
<tr>
<td>Lingshanwan Road</td>
<td>0.330</td>
<td>24</td>
</tr>
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<td>Xintun Road</td>
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<td>17</td>
</tr>
<tr>
<td>Mangroves</td>
<td>0.509</td>
<td>8</td>
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<td>West Coast Center</td>
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<td>Shuangzhu Road</td>
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<td>34</td>
</tr>
<tr>
<td>Shuangzhu Park</td>
<td>0.384</td>
<td>15</td>
</tr>
</tbody>
</table>

Figure 6. West Coast New Area Metro Route Planning (Source: https://www.xihaian.gov.cn/)

Figure 7. Site distribution map after initial screening (Source: https://www.xihaian.gov.cn/)
The town area of West Coast New Area is developing rapidly in economics and has a good basis for TOD development. The authors analyzed the 50 sites after the initial screening through field visits, questionnaire surveys, and comparative studies. In the comparative study, the authors evaluated the investment potential of several existing TOD projects in the West Coast New Area, compared the results with those of the regional-wide TOD sites to be selected, and finally selected the top 20 sites to be selected for the next stage of selection by combining the fieldwork.

In this case, 20 TOD sites to be selected are divided into 10 zones. As shown in Figure 8, there are multiple TOD sites to be selected in regions 1, 2, 3, 5, and 7, and it is necessary to evaluate the regional driving ability of the TOD sites to be selected in these five regions.

The geometric location of each TOD site to be selected in the region is ranked according to its distance from the regional center. Equations 4 and 5 are then used to calculate the average journey time to the corresponding rail transit sites in the intra-district and inter-district, respectively, to determine the ranking of transportation convenience. Finally, combined with the obtained investment potential ranking, the ranking is assigned according to the weight of 3:2:3:2, so as to determine the ranking of regional driving ability evaluation, and the highest ranked site in each region is selected as the final selection point (Table 4).

### Table 4. Evaluation of regional driving ability evaluation

<table>
<thead>
<tr>
<th>Area code</th>
<th>TOD sites to be selected</th>
<th>Geometric position sorting</th>
<th>Traffic Convenience Ranking</th>
<th>Investment potential ranking</th>
<th>Overall Score</th>
<th>Final site selection</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>West Huaizhe Road</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1.67</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Qing Medical West Hospital</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3.33</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Qi Changcheng Road West</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3.33</td>
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<td></td>
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<td>1</td>
<td>5.00</td>
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<tr>
<td>3</td>
<td>University of Technology</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>6.67</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Haixi Road</td>
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<td>China University of Petroleum</td>
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<tr>
<td></td>
<td>Yinzhu</td>
<td>3</td>
<td>2</td>
<td>2</td>
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</table>

Figure 8. Distribution of TOD sites to be selected.
Finally, 10 TOD development advance sites of West Coast New Area were identified, which are: University of Technology, Taihangshan Road, Wangjiagang, Qing Medical West Hospital, Xinan, Lianghe, Fenghekou, Shenghai Road East, Suangzhu Park, Dongyue Road.

In terms of traffic, Shenghai Road East Station and Dongyue Road Station have higher road network density and better slow walking environment. Wangjiagang Station and Xin'an Station have lower detour coefficients and more reasonable road design, the advantages of these stations’ basic conditions have laid a solid foundation for the development of TOD project. Besides, Fenghekou Station is an interchange station with convenient traffic and good accessibility. In terms of resources, Shuangzhu Road Station and Ching Medical West Hospital Station have a higher density of service facilities. Their service area contains schools, hospitals, shopping malls, hotels, and many other types of service facilities. Developing TOD projects in such stations can not only better meet the basic service needs of residents, but also better realize the urban redevelopment planning, which is more in line with the urban renewal objectives at this stage. In addition, the University of Technology Station and Lianghe Station are typical "unbalanced node" stations with large developable intensity, which have a certain demand for surrounding land development; In terms of population, the population density is higher at Two Rivers Station and the population activity intensity is higher at Taihang Shan Road Station. Developing TOD projects at these stations can serve more residents and thus bring higher economic and social benefits; In terms of regional-wide development, the TOD development sites finally identified in this paper not only have high development potential but also have certain geographical advantages and convenient transportation conditions in the areas they belong to, so that they can give full play to the driving effect on the surrounding areas and the whole town.

Through the above cases, it can be seen that the TOD development advance sites screened in the whole town have certain advantages in four aspects: transportation, resources, population and regional driving ability. This will ensure a more robust first step in the urban renewal process for regional-wide TOD construction. This case proves that the screening method of TOD development advance sites in this paper is feasible and effective.

4. Conclusion

This paper presents how to plan the construction of regional-wide TOD projects in urban renewal, making full use of TOD modes’ functions such as high density, high efficiency, and resource pooling, as well as making the rail transit network give full play to the linkage between various regions of the town, so as to solve the problems in urbanization phase and improve economic and social benefits in the development process. By screening the urban rail transit stations three times in the aspects of basic development conditions, investment potential, and regional driving abilities, TOD development advance sites are identified, and the feasibility of this method is verified by substituting cases. Scholars both at home and abroad have less research on the problems of regional-wide planning of TOD construction, and they have insufficient experience in the selection of development sites for regional-wide TOD projects, which is still at the exploratory stage and has not yet formed a perfect decision evaluation system. Therefore, this paper combines the TOD model with the regional-wide urban renewal strategy to study the selection of TOD development sites, which provides a new direction for the study of TOD model and urban renewal strategy. At the same time, this paper establishes a screening system based on the concept of regional development, inter-district interoperability, region-wide participation, and coordinated development to select TOD development advance sites within the city and town, so as to promote the integrated development of the whole city, which is a feasible method to solve the “big city disease” in the stage of rapid urbanization. Therefore, the research in this paper also provides a planning direction for urbanization development for countries and regions around the world in the rapid urbanization stage.

References


