

# Discussion on Applicability and Train of Thought of Urban Small Capacity Rail Transit Development

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**Abstract:** In recent years, small and medium-sized cities have built rail transit to meet the growing travel needs of residents that gain popularity. Among them, small capacity rail transit has been widely used in many cities across the country due to its short construction period, low cost and strong adaptability. This article introduces the classification and characteristics of urban small capacity rail transit. Moreover, it discusses the applicability of small capacity rail transit development based on the current development of urban rail. This article claims that the direction of its development ideas in the future is more strengths, more smart, more standardized and coordination development with multiple types.

**Keywords:** Small and Medium Cities; Small Traffic Capacity; Rail Transit; Applicability

## 1. Introduction

With the development of China's economy and society, urban rail transit construction has become a trend. As the skeleton of urban public transportation, rail transit has the advantages of high arrival rate, high punctuality rate, clean and comfortable riding environment, and therefore driving urban economic development. However, the construction of large-capacity rail transit has high cost and long construction period. In some small and medium-sized cities, due to population aggregation, travel capacity, and economic constraints, the construction of large capacity rail transit has obviously caused the city's economic burden and resource waste. Therefore, for small and medium-sized cities, the proper construction of small capacity rail transit has become a reasonable choice.

## 2. Rail transit system

### 2.1 Rail transit system classification

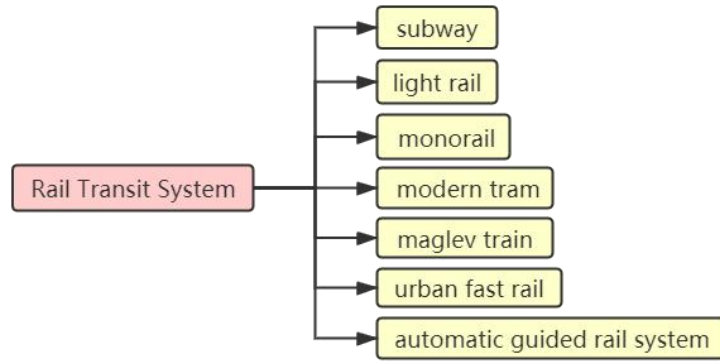
Due to the rapid development of urban rail transit, rail transit in various cities has different characteristics to adapt to various local conditions. There are many types, and the technical indicators are quite different. At present, there is no clear division standard. Urban rail transit can be classified according to one aspect, for example, according to capacity, line erection method, guidance method, line isolation degree, etc. Presently, urban rail transit can be divided into 7 types according to national standards, including subway, light rail, monorail, modern tram, maglev train, urban fast rail, and automatic guided rail system, each with its own adaptability and characteristics.

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**Figure 1.** Urban rail transit system.

Classification Index	Type of Division
Capacity (per hour)	large capacity, medium capacity, small capacity
Guidance Method	wheel rail guide, guide rail guide
Line Erection Method	underground, elevated, ground
Line Isolation Degree	fully isolated, semi-isolated, not isolated
Towing Method	rotating DC, AC motor traction, linear motor traction
Operational Organization	traditional urban rail transit, regional rapid rail transit, city (suburban) railway
Right of Way	exclusive right of way, mixed right of way
Control Method	signal control, visible distance operation

**Table 1.** Other types of rail transit system

## 2.2 Small capacity rail transit classification

According to the classification of one-way traffic capacity per hour during peak hours, urban rail transit is divided into large capacity, medium capacity and small capacity. The transport capacity standards and common types are shown in the **Table 2**.

Classification	Capacity (per hour)	Common Types
Large Capacity	more than 30,000 people	heavy metro, light metro
Medium Capacity	15,000 ~ 30,000 people	miniature subway, high-tech light rail, monorail
Small Capacity	5000 ~ 15,000 people	low-tech standard light rail, automatic guided new transportation system, modern tram

**Table 2.** The rail transit system is divided by capacity

The urban small-capacity rail transit system includes many types. Common light rails with low technical standards, automatic guided new transit systems, and modern trams are briefly introduced in following contents.

### 2.2.1 Light rail

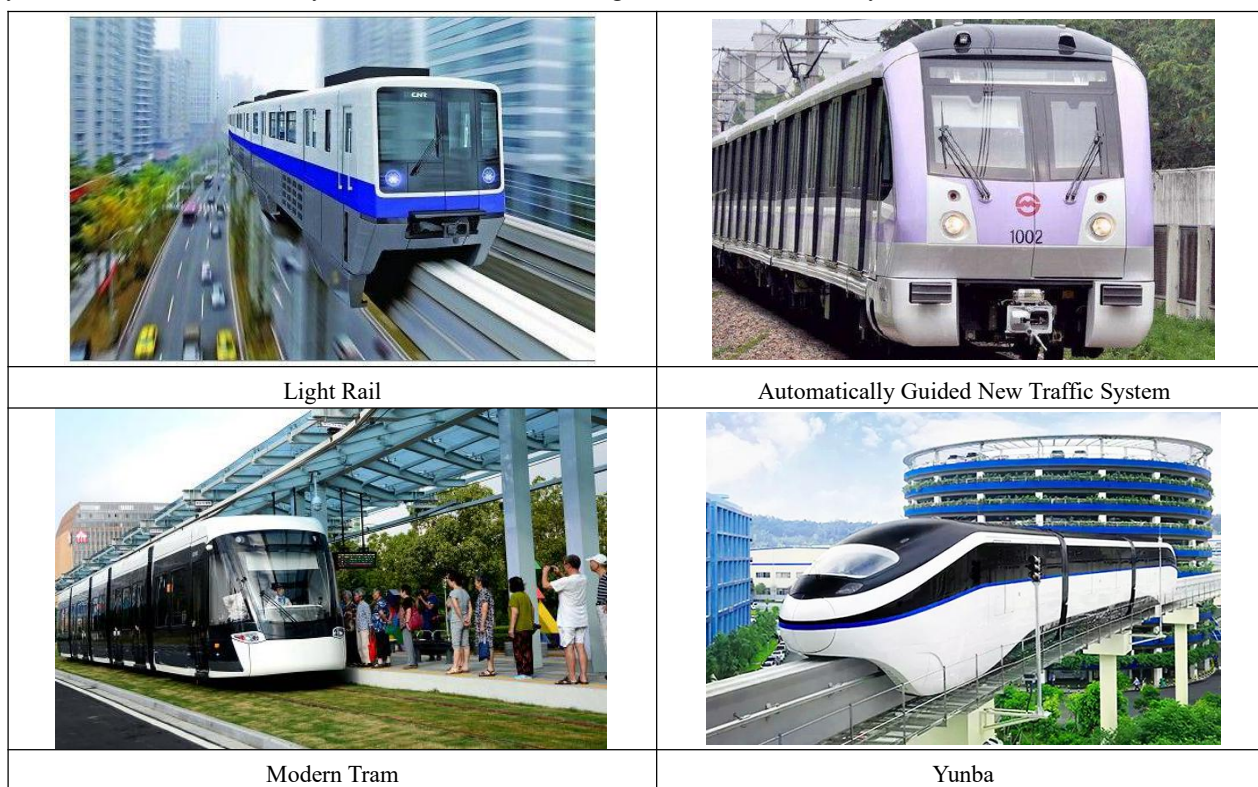
Light rail mainly belongs to the type of small and medium-sized rail transit, also known as light rail rapid transit and light rail railway, referred to as light rail. The difference between it and the subway lies in the traffic capacity, the width of the cars and the number of cars. The traffic capacity, the width and the number of carriages in the light rail are all smaller than that of the subway. The maximum train grouping of light rail is 4 carriages.

### 2.2.2 Automatically guided new traffic system

The automatic guided new traffic system contains a dual-track railway and a single-track railway that are introduced into a computer and a fully automatic control system. Its transportation capacity is between buses and suburban railways.

### 2.2.3 Modern tram

Modern tram is a kind of rail transportation that uses electric power as the starting force on the ground-laying tracks. The number of carriages of a tram is usually one, and the maximum is generally not more than three, so the transportation capacity is small. Among them, Skyshuttle (named Yunba in Chinese), a small capacity rubber wheel system, uses a rubber wheel system, which is similar to a ground bus and can carry concentrated traffic in a small area.



**Figure 3.** Schematic diagram of small capacity rail transit (Source: 360 pictures).

## 3. Characteristics and applicability of small capacity rail transit

### 3.1 Characteristics of small capacity rail transit

The small capacity rail transit system has the characteristics of high punctuality rate, high arrival rate, high service quality, fast driving speed, safe and stable operation of large capacity rail transit. It can also become the link and "capillary" of the city like ordinary public transportation systems, connecting all walks of life, reaching into remote areas of cities, and helping to build a complete and reasonable public transportation system network. The characteristics of small capacity rail transit are mainly reflected in the following four aspects.

### **3.1.1 Low construction and operation costs and short construction period**

Due to different geographical and geological environments, the cost of subways is usually 500-1000 million yuan per kilometer. The cost of light rail is 100-200 million yuan per kilometer, and modern trams are about 100 million yuan per kilometer. However, a city's rail transportation forms a network, which requires the construction of hundreds of kilometers. Moreover, the operation costs are much greater than the construction costs. Compared with large and medium capacity rail transit, the operation and construction cost of small capacity rail transit is lower, which is conducive to reasonable fiscal expenditures of small and medium-sized cities and reduces the urban economic burden. In addition, the short construction time can not only reduce the impact on the ground traffic and the surrounding environment, but also win valuable time costs in the fast-paced development era.

### **3.1.2 The line is adaptable and flexible**

The turning radius required for small capacity rail transit is small, and the climbing ability is strong. It can be adapted to a variety of terrains and has a wide range of applications. Most of the routes use networked operation and organization methods, which can reduce rail transit transfers and improve travel efficiency.

### **3.1.3 Environmentally friendly**

Small capacity rail transit occupies less land resources, and uses more ground or above-ground framing methods to rationally use the ground or above-ground space, reducing damage to the underground environment. In addition, small capacity rail transit is an urban public transport, which can effectively guide residents to use public transport to reduce carbon emissions, and is a green way of travel.

### **3.1.4 Low external negative effects**

The construction of small-capacity rail transit has the functions of improving the urban transportation system, alleviating traffic congestion, and guiding green travel modes. The positive effect on economic and social development is greater than the negative effect, and the negative impact on the outside is small.

## **3.2 Applicability of small capacity rail transit**

Based on the characteristics and advantages of the small capacity rail transit mentioned above, the small capacity rail transit can be applied to the following four aspects:

### **3.2.1 Suitable for large or medium-sized urban rail transit branch or encryption line**

Large or medium-sized cities often choose large capacity rail transit as the backbone of rail transit, and areas with less traffic than mainline stations can choose small-transit rail transit as a supplement to form a reasonable rail transit network, which can meet both the demand for traffic and reduced the waste of funds and resources for the construction of large capacity rail transit.

### **3.2.2 Suitable for the backbone of small and medium-sized cities**

The economic strength of small and medium-sized cities is limited, the number of people and the volume of transportation are relatively small, and the construction of large capacity rail transit is unreasonable. At this time, the strategy of "adapt to local conditions" is adopted. When the amount of travel is within the appropriate range, small capacity rail transit can be used as the main line to form a skeleton of urban public transport, ease the pressure of urban traffic, and improve the structure of urban resident's travel.

### **3.2.3 Suitable for connecting lines in the periphery of cities or integrated rail transit hubs**

With the city's population gathering and industrial development, the city continues to expand, and satellite cities or groups will also be built. Under suitable conditions, the connection between the outer areas of the city and the satellite city and the main urban area can be achieved by the construction of small capacity rail transit. In addition, an expansive city often builds a comprehensive rail hub to achieve the organic combination of multiple modes of transportation, while radiating the surrounding areas, and small capacity rail transit can expand its radiation range and serve more people.

### **3.2.4 Suitable for tourism and sightseeing lines or internal loops in large areas**

In some wider tourist attractions, large-scale places, such as university campuses, buildings, and so on, the

construction of small capacity rail transit can facilitate local residents to commute, and can also realize the function of tourists taking a cable car or coach and effective use of tourism resources.

## **4. Ideas for the future development of small capacity rail transit**

With the development of modern science and technology and the need to "adapt to local conditions" in the planning and construction of urban rail transit, small capacity rail transit will become the focus of development in the future. It may have the following four trends.

### **4.1 Diverse advantages**

Under the various advantages of the small capacity rail transit, it is necessary to find more advantages and increase the advantages. For example, in compliance with construction standards and operation requirements, continue to reduce construction costs, reduce manpower input, and shorten the construction period. Besides, based on the existing advantages, more other advantages can be explored and created.

### **4.2 Intelligent operation management**

Autonomous and intelligent small capacity rail transit is an important aspect of the development of smart cities, further promoting the application of new technologies such as the Internet, cloud computing and IBM, improving operational efficiency, providing people with travel convenience, and greatly saving operations manpower in management.

### **4.3 Standardized construction and operation**

With the arrival of a new wave of small capacity rail transit construction, more standardized construction and operation indicators and specifications are needed to further improve the rail transit construction and operation system.

### **4.4 Coordinated development of multiple rail transit**

At present, there are many types of small capacity rail transit in China, which have different characteristics and are irreplaceable. The construction of small capacity rail transit should be "adapted to local conditions" and "selected according to needs", and the same city can also be developed in a coordinated manner.

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