Tram development and urban transport integration in Chinese cities: a case study of Suzhou

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Abstract

This paper explores a new phenomenon of tram development in Chinese cities where tram is used as an alternative transport system to drive urban development. The Suzhou National High-tech District tram was investigated as a case study. Two key findings are highlighted. Firstly, the new tramway was routed along the "path of least resistance" – avoiding dense urban areas, to reduce conflict with cars. Secondly, regarding urban transport integration, four perspectives were evaluated, namely planning, design, service operation, and transport governance. Findings related to issues of integration and accessibility include tram and bus routes and services, fares on multi-modal journeys, tram station distribution, service intervals, and luggage auxiliary support. The paper argues there is a need for a critical review of the role of tram and for context-based innovative policy reform and governance that could possibly facilitate a successful introduction and integration of tram into a city.

Highlights

1. In an era of rapid urban rail development, with strict policies limiting metro and light rail systems, trams have been adopted by a number of Chinese cities as an alternative transport system for driving urban development.

2. The SND tram system was designed along a "path of least resistance" to reduce conflict with cars, but this has led to long journey times by public transport, and accessibility issues.

3. Integration and accessibility issues in planning, design, service operation, and transport governance are reflected in aspects such as tram and bus routes, multi-modal fares, tram station distribution, service intervals, and luggage auxiliary support.

4. The recommendations include a need for a critical review of the role of tram in Chinese cities, context-based innovative policy reform, and better integration governance.

Classification codes

H7, J6, P2, R3, R4, O2

Keywords

Tram, urban development, urban transport integration, Suzhou, China

1 Introduction

The past decade has seen rapid development of urban rail systems in the People's Republic of China (hereafter referred to as China). By 2015, more than 3,600 kilometers (km) of urban rail tracks had been constructed in 26 Chinese cities. By comparison, tram development is in its infancy, with only 161 km of tramways in ten Chinese cities (CAMET, 2016). However, more than 2,000 km of new tram networks are currently being planned across the country, as a result of supportive national policies and gradual cost reduction through consolidation of the tram-building industry.

Since the economic reform of 1978, urban transport network in China has been rapidly developed to cater for economic and industrial development, which often did not coordinate well with wider urban development strategies, whereas transport had significant impacts on urbanization patterns. After an era of massive construction of highways in the 1980s, the automotive industry was designated as one of the key pillar industries for the national economy in the mid-1990s. Around this time, because of increasing problems with traffic congestion, several large cities began developing metro systems. However, public urban rail development was not officially regulated on the national scale by the Central Government until 2003, and was not advocated until the early 2010s. Smaller Chinese cities could not justify the construction and operation cost of urban rail, and so instead began planning tram networks. There has been relatively little research into whether these tramways provide an effective alternative to private car use. This article therefore explores the role of new tramways in Chinese cities, how well they integrate with other urban transport systems, and any particular issues and challenges. To do this, I focus particularly on a case study of the Suzhou National High-tech District (SND) tram.

This article is structured into four main parts. Section 2 reviews key policies and mechanisms underlying urban rail development and decision-making in the Chinese context. Section 3 provides a background introduction to the wider context of rapid urbanization and rail development. Section 4 focuses on the SND tram, to gain insights into the uniqueness of Chinese approaches, including the motivation for choosing a tram over other options, and the current approaches to urban transport integration and its impacts. Section 5 summarizes the issues identified and discusses implications.

2 Policies and mechanisms of developing urban rail

2.1 Classification of urban rail systems in China

According to the "Standard for Classification of Urban Public Transport", urban public passenger transport has four top-level ("Level 1") categories, including street, rail, water and other transport modes. Each category can be further sub-divided into more detailed definitions (Levels 2 and 3) (Ministry of Construction, 2007).

Rail urban public transport is classified into seven systems depending on coach types and carrying capacities (Table 1). Metro in China is defined as having large carrying capacities while light rail, monorail, maglev, and automated people mover (APM) have medium carrying capacities. In addition to carrying capacities, a major distinction between metro and light rail lies in the types of railcar.

Tram (GJ24) is defined to provide low passenger capacities and is the main focus of this paper. There is no standard worldwide definition of a 'tram system'. In Europe, a tram is a light rail system that runs (at least part of its way) on existing roads, and shares these roads with cars. While in China tram and light rail are regarded as different systems. A key purpose of this paper is to understand how and whether transport planners can successfully introduce trams as part of an existing transport system in a city.

Table 1. Categories of rail urban public passenger transport in China

Level 1	Level 2	Notes
GJ2 Rail urban public passenger transport	GJ21 Metro	• For high and large passenger capacity • Suitable for underground, ground, or elevated tracks • Type of Metro railcar: A, B, L_B
	GJ22 Light Rail	• Medium passenger capacity • Suitable for underground, ground, or elevated tracks • Type of Light Rail railcar: C, L_C
	GJ23 Monorail	• Medium passenger capacity • Suitable for elevated tracks
	GJ24 Tram	• Low passenger capacity • Suitable for ground tracks (Independent right of way), mixed use, or elevated tracks
	GJ25 Maglev	• Medium passenger capacity • Suitable for elevated tracks
	GJ26 Automatic People Mover (APM)	• Medium passenger capacity • Suitable for underground or elevated tracks
	GJ27 City-regional Express Rail	• Serving city-regional territory • Medium-to-long distance passenger transport

Source: Ministry of Construction (2007, the document code: CJJ/T 114)

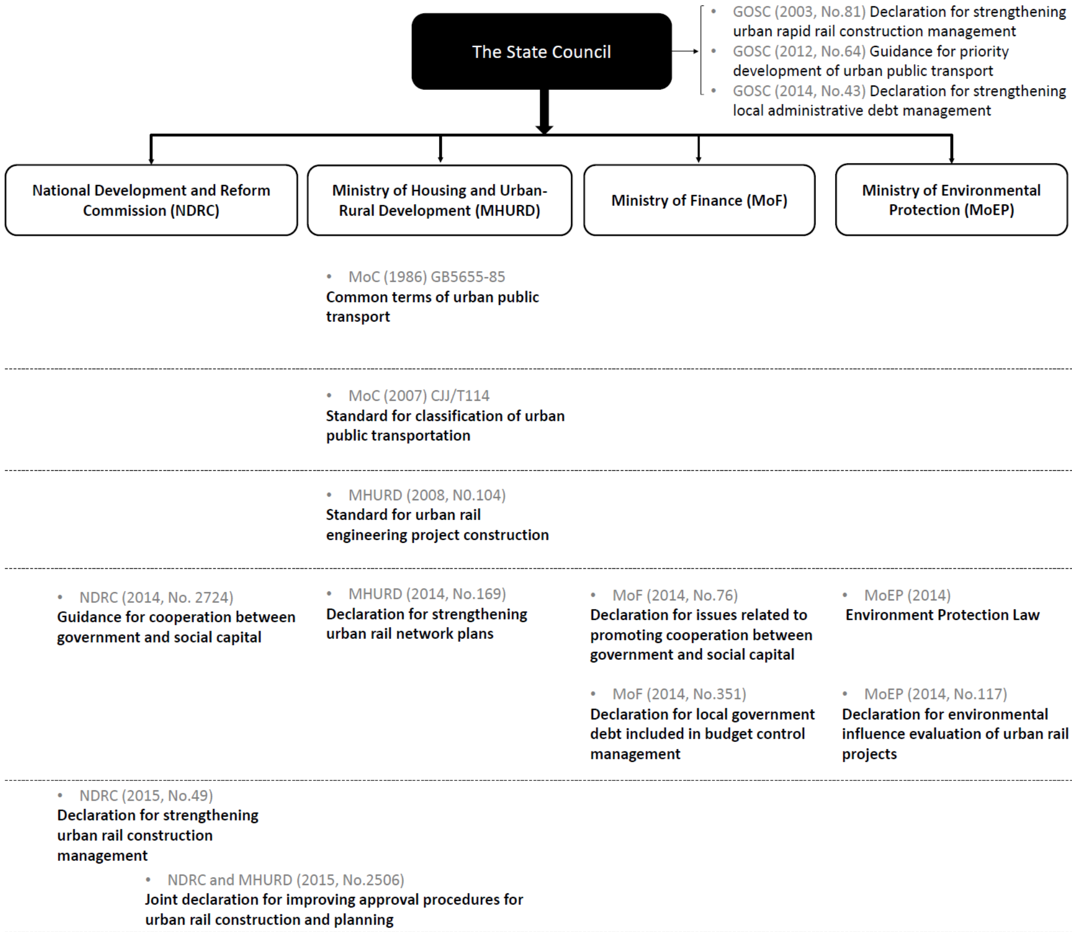
2.2 National policy for urban rail development

Although the first metro system appeared in Beijing in 1969, it was arguably not rail, but road building that facilitated rapid urbanization in China from the 1980s onwards. Prior to 2000, China's urban rail systems covered a total of just 135.8 km in four cities (Beijing, Tianjin, Shanghai and Guangzhou). It was not until the early 2000s that the national government started to formalize urban rail development in China.

2.2.1 Policy framework

Since 2003, the national policy framework related to the development of urban rail has expanded to involve four major ministries: the National Development Reform Commission (NDRC), Ministry of Housing and Urban-Rural Development (MHURD), Ministry of Finance (MoF), and Ministry of Environmental Protection (MoEP). The framework has four main objectives: 'integration and linking up', 'economic efficiency and suitability', 'convenience and efficiency', and ‘safety and reliability’. The framework also sets out the procedure for evaluating and approving specific projects, as well as the guidance for planning and design, environmental protection, and financial capacity (Figure 1).

Figure 1. National policy framework and guidance for urban rail development in China.



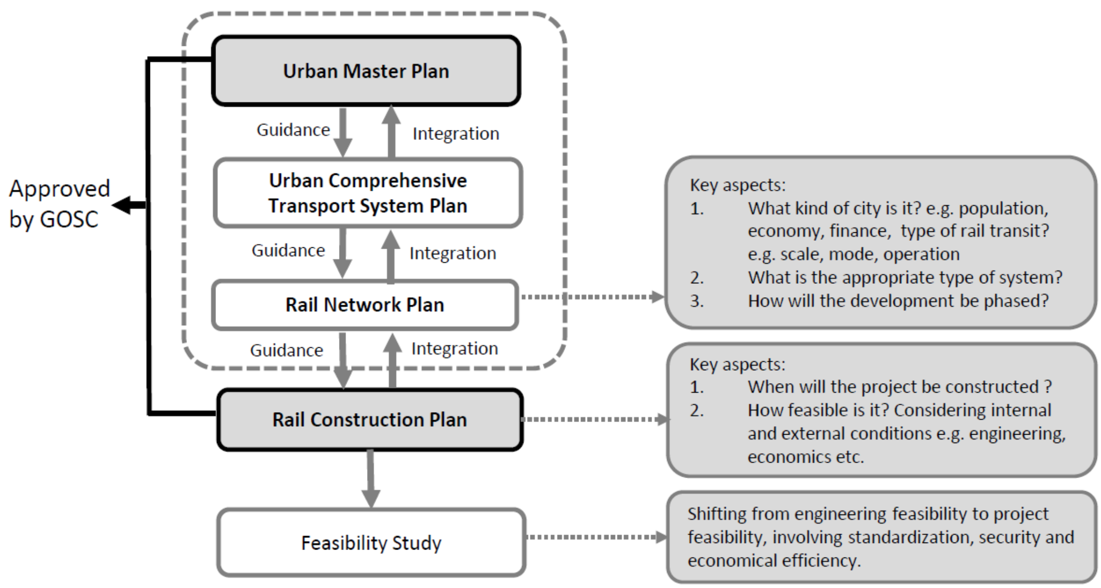
Note 1. Some relevant policies fall under the Ministry of Transport (MoT), such as the urban rail transit trial operation standard (MoT, 2013-GB/T 30013). *Note 2.* The Ministry of Construction (MoC) was reshuffled in 2008 to create the Ministry of Housing and Urban-Rural Development (MHURD).
Source: Author

Planning integration

Urban rail network planning is required to integrate with wider urban development and transport system plans. According to Chinese national regulation No.81 (General Office of the State Council [GOSC], 2003), a ‘Rail Network Plan’ sits under an ‘Urban Comprehensive Transport System Plan’, which in-turn sits under a long-term ‘Urban Master Plan’. Once the Urban Rail Network Plan is determined, rail construction plans need to be proposed in-line with urban development needs and financial capacities, including corresponding short-term (5–6 year) and long-term financial schemes.

In practice, rail development often deviates from this strict approach according to local demands. A local municipality might propose a rail construction plan after higher-level planning documents have been drafted, but not fully complete the approval process. Although the higher-level planning documents have a top-down guidance role, they are required to reflect and integrate the latest rail construction plan. There is therefore an interactive relationship between the higher-level plans and lower-level construction plans in China, with both top-down guidance and bottom-up integration (see Figure 2). In most cases, Urban Master Plans will be approved before Rail Construction Plans, meaning that Rail Construction Plans will not be approved if they are non-compliant. However, if the local municipalities insist on specific Rail Construction Plans, Urban Master Plans may need to be revised and approved before Rail Construction Plans are approved.

Figure 2. Planning integration and rail construction plan procedures in China.



Source: Adapted by author from original by GOSC (2003, No.81)

Environmental protection

An Environmental Impact Assessment (EIA) is required for each rail proposal before construction can be permitted. The EIA aims to facilitate a balance between construction and environmental protection. There are three key principles guiding the EIA:

1. EIAs are approved by the Ministry of Environmental Protection.

2. Schemes with favorable EIA results should be prioritized. Sites for urban rail schemes should be consistent with Urban Master Plans.

3. Facilities for reducing pollution should be designed, constructed and operated as an inseparable part of the main construction project.

Financial capacity

Urban rail schemes are the remit of local governments. To prevent over-borrowing by local governments, national guidance instructs that public capital out of local capacity should constitute no less than 20% of the project's total capital cost, and this government contribution is generally not allowed to be higher than 5% of its municipal annual financial budget. Moreover, a rail construction project is not allowed to exceed 30% of the local government's urban construction budget. The percentage of borrowing allowance is also subject to adjustments announced by central government. The guiding principles of the financial assessment are:

1. Every city has to establish a transparent mechanism to manage long-term public capital investment, balance financial expenses and incomes, and ensure sufficient income to cover operational costs.

2. Innovative financial approaches are encouraged by the national policy framework. Private investment is possible through a wide range of public-private partnerships, such as franchise concessions for rail construction and operation, and private-led transit-oriented developments.

3. Rail operators are entitled to have discounted electricity bills and receive support from the government with issuing bonds.

2.2.2 Criteria qualifying settlements for urban rail development

The Chinese central government has strict numerical criteria which must be met before a city is officially permitted to undertake urban rail development. These fall into three main categories, namely: population size, transport requirement and economic development level. Each criterion has a numerical threshold (see Table 2), and meeting these criteria is necessary (but not sufficient) for a city to be considered eligible for development of a metro or light rail system.

Table 2. Numerical thresholds for various criteria which must be met to qualify a city for urban rail construction.

	Metro	**Light rail**
Population size	≥ 3,000,000	≥ 1,500,000
Gross Domestic Product (GDP)	≥ CNY 100 billion	≥ CNY 60 billion
Local government financial income	≥ CNY 10 billion	≥ CNY 6 billion
Passenger flow scale	Peak time, one-way ≥ 30,000 persons/hour	Peak time one-way ≥ 10,000 persons/hour
Initial passenger flow	≥ 7,000 persons/day.km	≥ 4,000 persons/day.km

Source: GOSC (2003, No.81) and NDRC (2015, No.49).

2.2.3 The approval procedure for urban rail construction plans

Urban rail construction plans must comply with a rigorous approval process. Both the Urban Master Plan associated with a long-term vision and the Rail Construction Plan (Figure 2) are required to get approval from the GOSC at the national level. Feasibility studies of urban rail systems also need to conform to a Construction Plan approved by GOSC.

2.3 Approval process for tram construction projects

By comparison, tram systems do not need to be approved at the national level. Construction plans of tram systems can be approved by either the provincial or municipal Development Reform Commissions. Also, trams are not required to meet numerical criteria specified in Table 2. In this context, trams are easier to get permission and expected to be constructed rapidly and widely across China. This paper is especially interested in tram development as lessons derived from early cases could provide valuable implications for future practice.

3 Wider contexts: rapid urbanization and rail development

Since the Chinese economic reforms of 1978, and particularly since the 1990s onwards, China has experienced unprecedented rates of rapid urbanization, which has manifested as rapid urban population growth and urban expansion onto previously rural land (see Table 3). From 1990 to 2015, the urban population share increased from 29% to 56.1%. Built-up areas have more than tripled in overall land coverage, and enlarged communities have led to longer distances for commuting, business, shopping, and other activities. With economic growth and higher income levels, more people can afford to own a car, and private vehicles have therefore increased 56.4-fold over the 25 years to 2015. This has resulted in serious traffic congestion and wider concerns about social justice issues relating to transport provision (Zhang, 2011; Wang, 2012).

Table 3. Data illustrating the phenomenon of rapid urbanization in China

Indicator	Unit	1990	2015	1990–2015 change
Urban population share	%	29.0	56.1	+ 27.1 percentage points
Urban population	million	302	771	2.6 times
Built-up area	km^2	12,855	52,102	4.1 times
Private vehicles	10^4 cars	250	14,099	56.4 times

Source: China Statistical Yearbooks (1991 & 2016)

The role of transport infrastructure in this rapid urbanization process can be broadly divided into three stages between 1978 and 2015:

1. From 1978 to 1995, a 'USA-style' approach was adopted, with a number of large-scale road building programs. In the 1980s, several large Chinese cities expressed a desire to learn lessons from the motorization experiences in Western countries, and considered a strategy of prioritizing public transport instead. Ultimately, however, policies prioritizing personal mobility prevailed, and public transport was largely neglected (Chen, 2005).

2. From the 1990s onwards, urban congestion became an increasing problem, and investment in public transport began to increase (Table 4). However, at the same time, car manufacturing was promoted as a key industry, which brought about an unprecedented increase in car ownership without effective regulations. This was also clearly reflected in the remarkable increase in the number of taxis (Table 4). Around this time, the financial issues caused by an overambitious rail scheme in Shengyang led the Chinese Government to suspend any approval of urban metro and light rail systems (GOSC, 1995, No.60).

3. From the early 2000s, the explosive growth of private cars dramatically increased the seriousness of urban transport issues such as congestion, chaotic parking and worsening air quality. There was renewed enthusiasm for public transport, and a new wave of large-scale investment in urban rail systems.

Table 4. Number of public transport vehicles in China

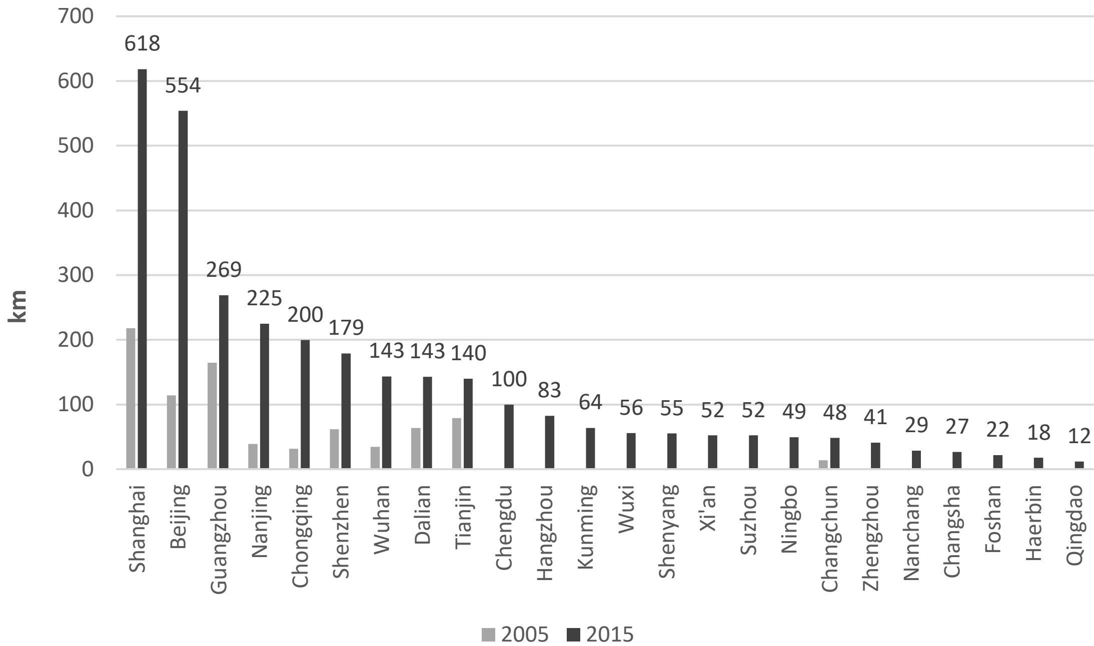
Indicator	1985	1989	1996	2000	2005	2010	2015
Number of Public Transport Vehicles	45,155	59,671	147,591	225,993	313,296	383,161	502,916
Number of Public Vehicles/per 10^4 people	1.8	2.1	3.6	4.9	5.5	5.6	6.2
Number of Taxis	27,078	98,508	585,369	825,746	936,973	986,190	1,092,083

Source: China Statistical Yearbooks (1991–2016)

3.1 Urban rail development in China

There has been a phenomenal rate of development of urban rail in China in the last 10–15 years, not only in terms of the total lengths of railway network in major cities, but also in terms of development of new networks in smaller cities (Figure 3). According to statistical figures by the end of 2015, Shanghai had the largest urban rail network, 618 km, followed by Beijing, with 554 km. Underground lines had the largest share of urban rail networks, 57.8% with a total length of 2093 km (CAMET, 2016). More than twenty cities had more than two urban rail lines. It is worth noting that, although tram is by definition an urban rail system, these figures exclude trams as new tram development had not come into being in Chinese cities until 2007 in Tianjin (see Table 5). The exception is Dalian, whose first tram system was inaugurated in 1909 during the colonial period, and has operated ever since.

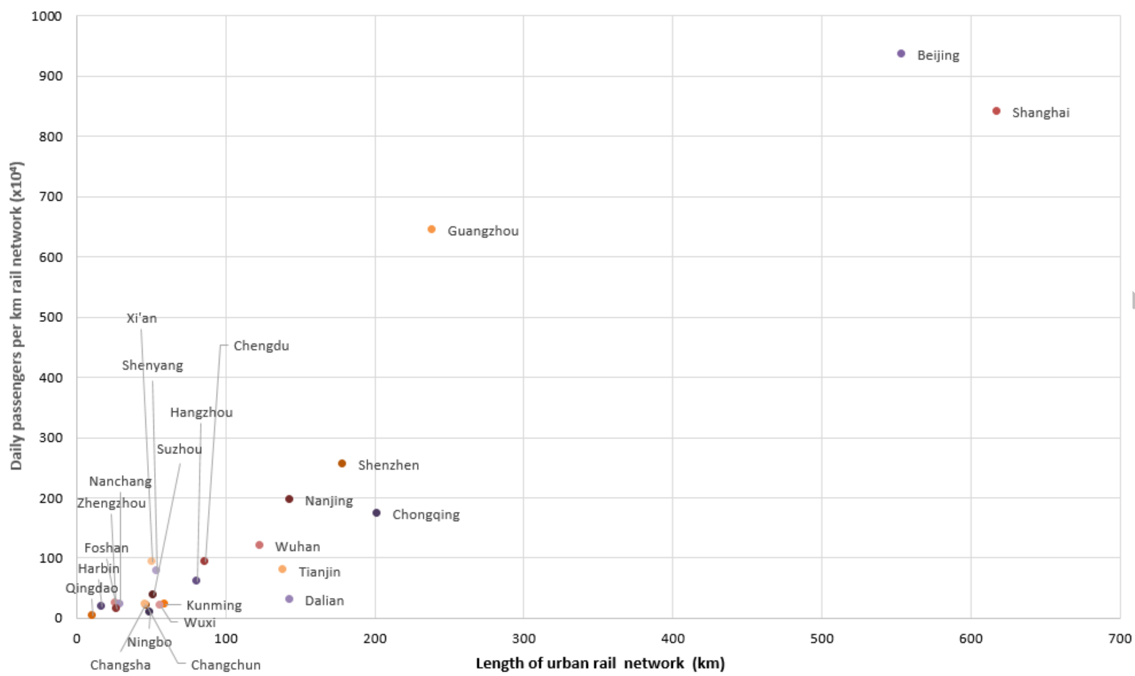
Figure 3. Total length of urban rail public transport networks in operation in Chinese cities, 2005 and 2015.



Note: Figures exclude tram and city-regional express rail.
Source: CAMET (2016) and the websites of various urban rail operators.

Likewise, numbers of urban rail passengers have also been increasing rapidly. Passenger traffic on the urban rail networks in China amounted to 13.8 billion journeys in 2015, 1.2 billion more than the previous year (CAMET, 2016; excludes five city-regional rail lines and six tramlines). However, passenger traffic is not necessarily proportional to the overall length of urban rail network (Figure 4). Some cities with smaller rail networks have higher load intensities with more passengers per km than cities of larger rail networks. For instance, Guangzhou had less than half of Shanghai's network length in 2015, but it served a total volume equal to three fourths of urban rail passengers in Shanghai per day. Similarly, Xian had a high intensity rate of daily passenger per km although it has a relatively small urban rail network (Figure 4).

Figure 4. Urban rail passenger traffic (2015) normalized to length of urban rail network.



Note: Figures exclude tram and city-regional express rail.
Source: CAMET (2016)

3.2 Tram development and typology in China

Tram development in China is not new. The first tram system in China was constructed in Beijing in 1899 by the German company, Siemens. The tram initially connected suburban areas with the central gate of Beijing city and was subsequently extended within the city walls in 1924. Port cities such as Hong Kong (1904), Tianjin (1906) and Shanghai (1908) followed suit. Later on, Japan and Russia built tramlines in main cities in the North East of China e.g. Dalian (1909), Shenyang (1925), Harbin (1927) and Changchun (1941). These cities were mainly capital, port, or colonial cities, subject to foreign influences. From the 1950s onwards, trams were removed in the majority of these cities, in the name of modernization: private cars being regarded as a symbol of the future, and trams as obsolete, noisy, slow, bulky, and expensive to operate and maintain. Consequently, urban space (including roads) was rearranged for urban development and industrialization. By 2006, only three north-eastern cities—Harbin (until 2008), Changchun and Dalian—still operated tram systems. A new generation of tram systems arrived in 2007 in Tianjin, which adopted a French rubber-wheel guided-rail trolley system.

By 2016, ten Chinese cities had operated tram systems (Table 5). Among them, Shengyang has the most extensive tram network. Most tram systems are constructed in large cities (Tier 1 and Tier 2 under the grading of administrative divisions) which already have their own metro/light rail systems (the exception being Huaian). Passenger volumes are very small on all systems; most have fewer than 10,000 passengers per day, except Dalian, Shenyang, and Huaian which have more than 25,000 daily passengers (although this is still lower than the designed tram capacities).

Table 5. Tram systems in Chinese cities (statistics by the end of 2016).

City	Year of opening	Length by 2016 (km)	Daily passenger numbers	Tier of city	Existing metro/LRT systems	Population 2015 (million)
Dalian	1909 & 2015	24	16000 (L201) 55000 (L202)	Tier 2^B	Yes	7
Tianjin	2007	8	4000	Tier 1	Yes	15.5
Shanghai	2009	9	6000	Tier 1	Yes	24.2
Shenyang	2013	71	30000	Tier 2^A	Yes	8.3
Guangzhou	2014	7.7	9000	Tier 2^A	Yes	13.5
Nanjing	2014	8	2000	Tier 2^A	Yes	8.2
Changchun	2014	13	4000	Tier 2^A	Yes	7.8
Suzhou	2014	18.2	6000	Tier 2^C	Yes	10.6
Huaian	2015	20	25000	Tier 2^C	No	5.6
Qingdao	2016	9	2200	Tier 2^B	Yes	9.2
Zhuhai	Trial	8.9	-	Tier 2^C	No	1.6

Note: In China, there are three city tiers in the administrative divisions: Tier 1 (province-level city), Tier 2 (prefecture-level city) and Tier 3 (county-level city). Within Tier 2, there are three variations: Tier 2^A (sub-provincial city), Tier 2^B (prefecture-level city with independent planning status and Tier 2^C (ordinary prefecture-level city). *LRT,* light rail transit.
Source: Ministry of Transport (2016) and CAMET (2017)

Tram development in China can be grouped into three types (A, B and C), according to the city's size and the tram's role and service route (Table 6). Type A refers to those systems in north-eastern cities that are inherited from the early 20th century. In these cities, trams run through the traditional city center, and other urban rail systems (such as metro) have developed more recently. Type B represents the majority of new tram systems; trams which have been constructed in the newly-developed urban districts of large cities which already have extensive metro lines. The motivation behind planning such trams is typically development-oriented rather than for addressing traffic congestion. In this model, trams are typically associated with positive, modern images of city life, such as the concept of sustainability and a high standard-of-living. Type C describes trams constructed in small cities which haven't met the threshold to qualify for construction of a metro or light rail system, and therefore develop their public transport backbone around a tram system. By the end of 2016, the only case of type C is Huaian (and a trial system in Zhuhai then). Cities in the southern and south-west Chinese provinces, like Gueyang and Yunnan, with populations around one million, could be considered suitable for this model, but do not currently have any trams in operation.

Table 6. Three types of tram development in Chinese cities.

Type	Features	Examples (by the end of 2016)
A. Tram runs in traditional city centers	• An existing/inherited tram system; • Common in north-eastern cities in China, with colonial backgrounds; • Trams integrated with metro systems which have been developed later on.	Dalian, Changchun
B. Tram serves newly-developed urban areas	• Trams do not run through traditional city centers, but instead serve new urban districts; • Usually in larger cities that have developed metro and light rail systems; • Trams aim to: (1) extend the catchment area of a metro line, (2) provide a service before a metro line is constructed, or (3) connect two metro lines at the outskirts.	Shanghai, Tianjin, Nanjing, Guangzhou, Suzhou, Qingdao, Shenyang*
C. Tram is the main urban transport skeleton	• Implemented in small and medium sized cities that do not (yet) qualify for metro systems • Tram is developed as the main urban transit system • Motivations for the tram routes vary among cities	Huaian, Zhuhai

Note: Shenyang* could be a Type A city but it becomes a Type B city because of the disappearance of its tram systems in the old city center and the arrival of new trams in the newly-developed urban areas.
Source: Based on data from Qin et al. (2013), Shi (2014), Xue et al. (2008), Zhou (2013) and Zi et al. (2009).

The decision as to whether a tram system is a good alternative to an express bus, or other transit systems, has been controversial in China (as elsewhere). It has been argued that there might be a case in the future to remove tram systems from cities, just as already happened 50 years ago, albeit for different reasons (Qin et al., 2013).

4 Case study of Suzhou

This section provides a case study of the Suzhou National High-Tech District (SND) tram, to gain deeper insight into the pattern of tram development and use in China. Suzhou is representative city of 'Type B' tram development, where trams do not run through traditional city centers but serve new urban districts, through an interchange station between metro and tram.

Data collection for this case study involved five major research methods: (1) desk-based research and literature review of local planning documents and academic papers; (2) site visits; (3) analysis of data from descriptive statistical yearbooks at both national and local levels; (4) a user satisfaction survey regarding attitudes about the tram system and urban transport integration in Suzhou; and (5) interviews with local officers and experts.

4.1 City profile

Suzhou is located in the Yangtze River Delta Area (YRDA), 30 minutes by high-speed rail to the west of Shanghai. Suzhou is a prefecture-level city with an administrative area of 8,488 km^2 (akin to the concept of a 'city region'), which contains six urban districts as well as four county-level cities (Taicang, Kunshan, Changshu, Zhangjiagang) (see Table 7 and Figure 5). In 2015, the total population of Suzhou prefecture-level city was 10.6 million, of which approximately 5.5 million lived in Suzhou's urban districts. With regards to gross domestic product (GDP) and public financial budget revenue, Suzhou has been performing more strongly than two other provincial capitals (Nanjing and Hangzhou) and second-only to Shanghai within the YRDA.

Table 7. Profile of Suzhou urban districts.

	Population ('000s)	GDP (CNY billion)	Land area (km^2)	Public financial budget revenue (CNY billion)
Suzhou prefecture-level city	10,616	1,450.0	8,488	156.1
Urban Area	5,492	749.4	2,895	83.0
- **Gusu district**	952	60.0	85	5.9
- **Wuzhong district**	1,121	95.0	742	12.1
- **Xiangcheng district**	729	60.5	439	7.0
- **New & High-tech Zone, Huqiu district (SND)**	591	100.6	258	11.0
- **Suzhou Industrial park (SIP)**	803	206.0	278	25.7
- **Wujiang district**	1,297	154.0	1,093	27.0

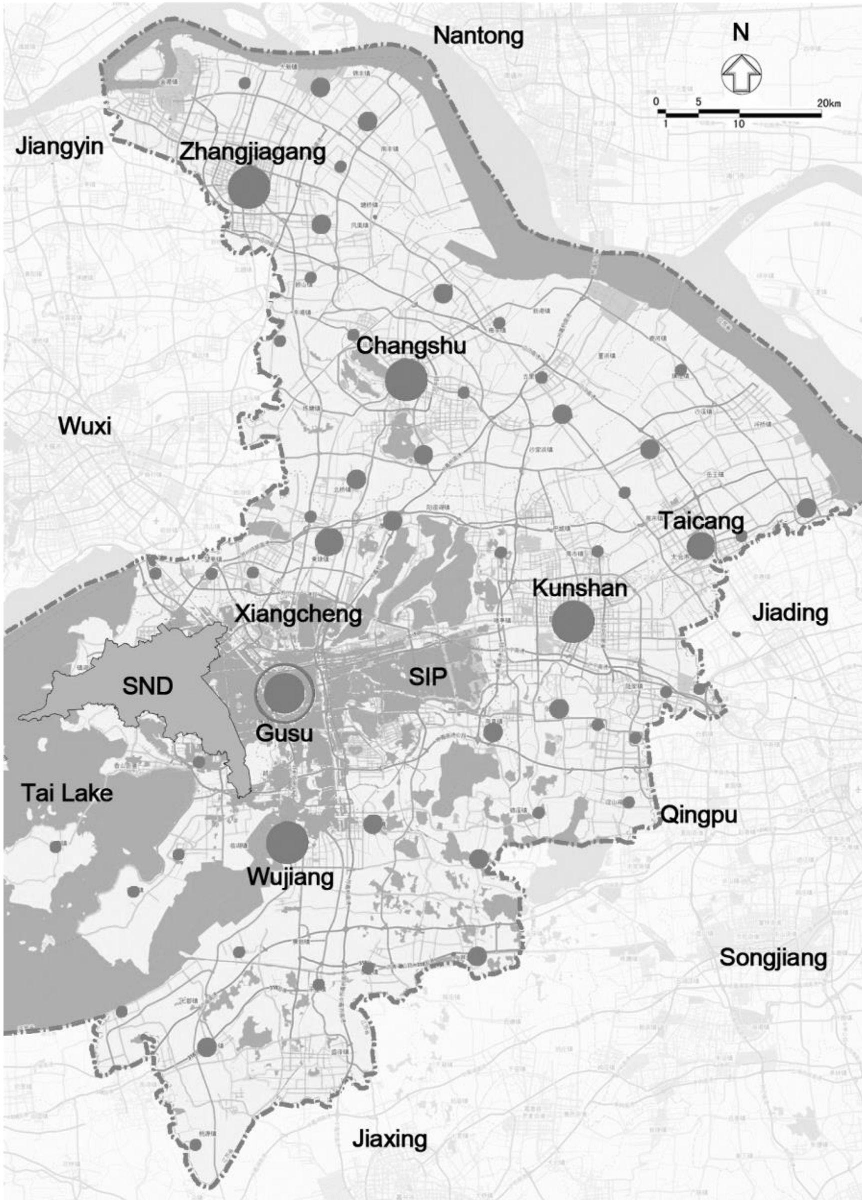
Note: Suzhou city region also includes cities at the county level, namely Changshu, Zhangjiagang, Kunshan and Taicang. Here, figures for county-level cities are not further specified. In 2002, Suzhou National Hi-Tech District (SND) was created by merging the Suzhou New & High-tech zones and Huqiu district.
Source: Suzhou Statistical Yearbook 2016; National Economic and Social Statistical Bulletin (Gusu, Wuzhong, Xiangcheng, SND, SIP, Wujiang).

From the early 1990s, Suzhou started to expand its urban area in four directions. Two major industrial development zones were created: National High-Tech District (in 1992, in the west) and Suzhou-Singapore Industrial Park (in 1994, in the east). In 2001, Xiangcheng district was created in northern Suzhou, and in 2011, Wujiang in the south was annexed to become an urban district of Suzhou, instead of a neighboring county-level city. Consequently, over the past two decades, Suzhou has vastly expanded its urban area from 312 km^2 in 1990 to 2,895 km^2 in 2015.

Suzhou National Hi-Tech District (SND), an urban district in the west of Suzhou, has natural resources such as mountains and close proximity to Tai Lake. This overall offers a favorable position for leisure and tourism development, in addition to science and technology industries and housing development. The development of this area has followed four key themes: technology, ecology, efficiency, and culture and humanity (SUCDRI, 2012).

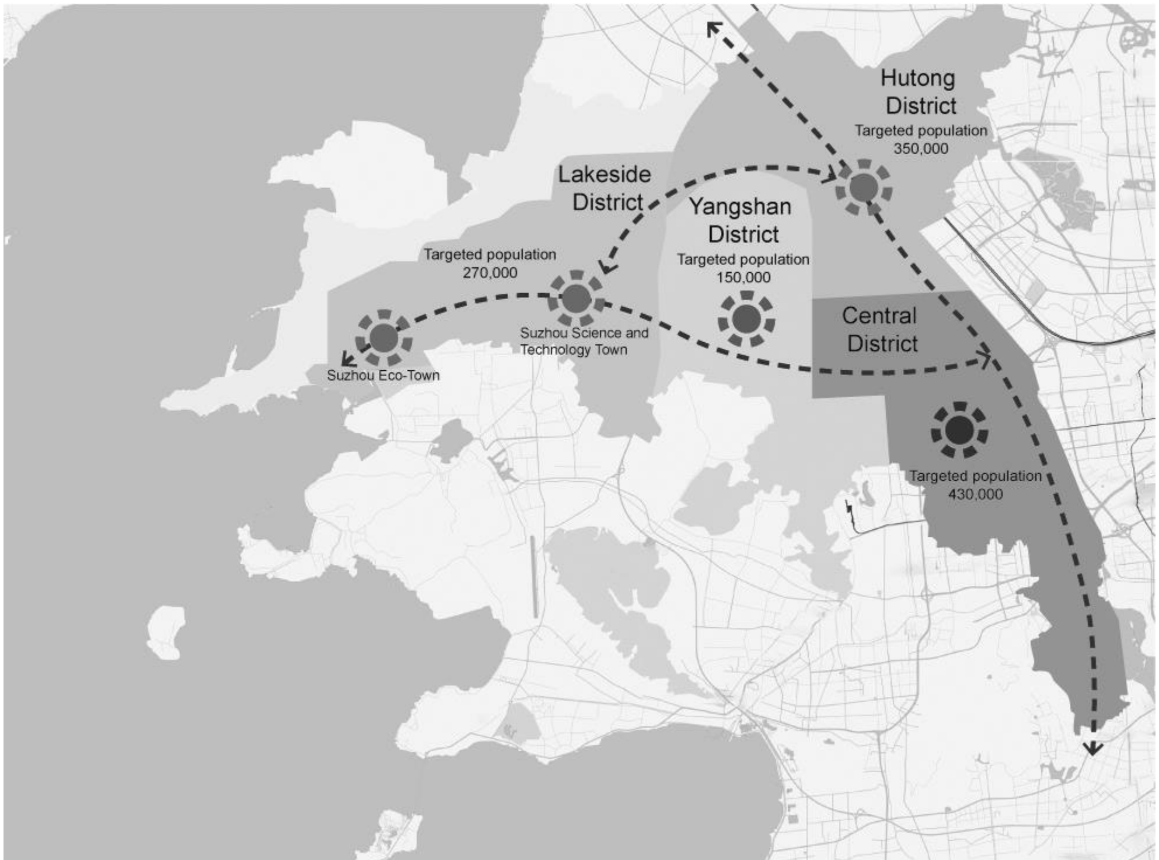
The SND Urban Master Plan defines four spatial districts: Central, Hutong, Yangshan and Lakeside (Figure 6), which together are planned to accommodate an estimated 1.2 million residents by 2030 (compared to the current population of 0.6 million) on newly-converted land (with an increase in area from 107 km^2 to 143 km^2). The western part of the area was nearly rural until the last decade, but now there are two major designated development zones: Suzhou Science and Technology Town and West Eco Town.

Figure 5. The location of SND within Suzhou



Source: Modified from OpenStreetMap data.

Figure 6. Key development zones in SND

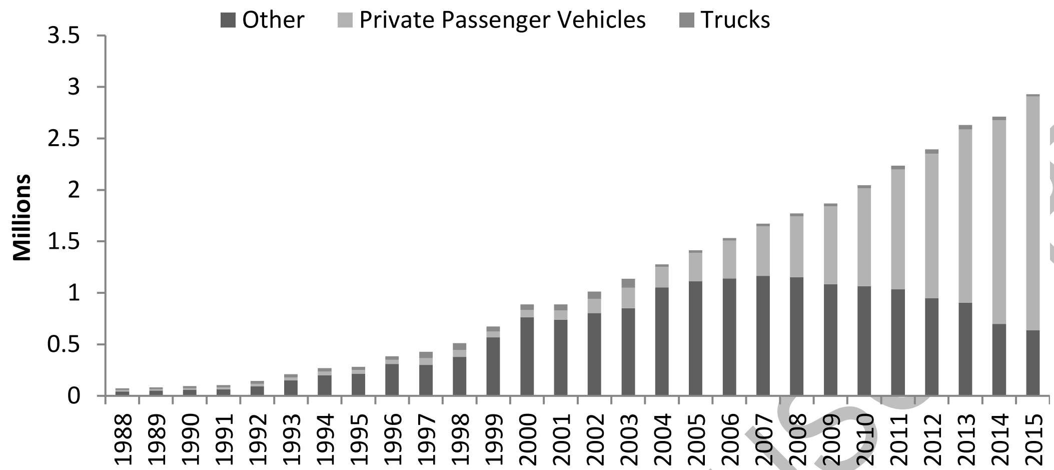


Source: OpenStreetMap and SUCDRI (2012)

4.2 Urban rail development in Suzhou and SND

Suzhou has not been spared from the rapid motorization and worsening traffic congestion that most Chinese cities have experienced as a result of recent urbanization. By 2015, the total number of motor vehicles in Suzhou had reached 2.9 million, placing it 9th in the ranking of Chinese cities by car ownership (China Statistical Yearbook, 2016). Of these motor vehicles, the proportion of personal passenger vehicles has increased particularly quickly (Figure 7). 2007 was a pivotal year, when the number of private passenger vehicles began to grow rapidly, whereas the numbers of other types of vehicles began to fall (Figure 7).

Figure 7. Composition of motor vehicles in Suzhou, 1988–2015



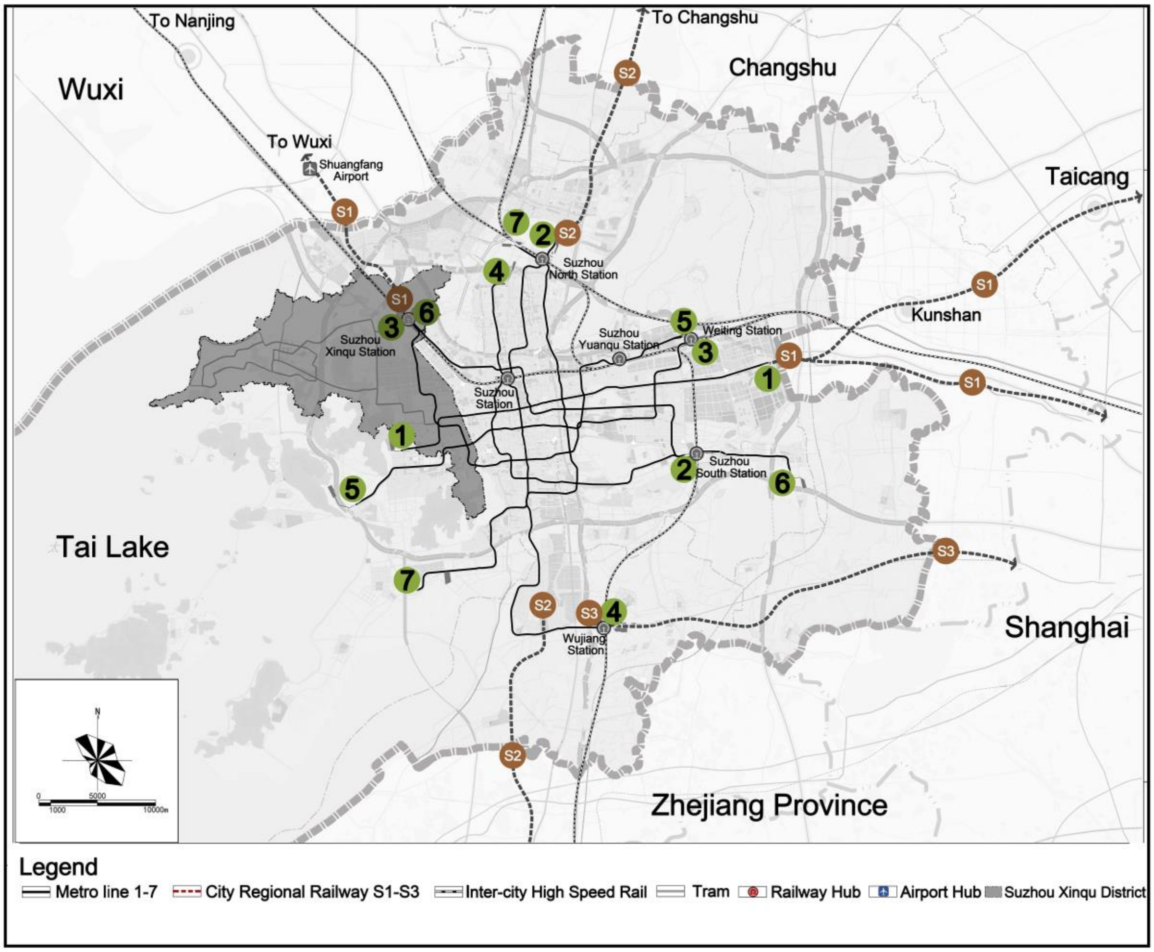
Note: Category "other" refers to anything outside the category of "private passenger vehicles" and "trucks", including motorcycles, tractors, agriculture transport vehicles, and other specialized vehicles.
Source: Suzhou Statistical Yearbooks (1989-2016)

Suzhou rail network planning began in 2002. In 2007, Suzhou became the 15th city nationwide (and the first prefecture-level [Tier 2C] city) to be granted permission to construct metro lines. According to Suzhou's 'Comprehensive Transport Plan' (covering the period 2007–2020), the aim was to develop three levels of system: inter-city rail, city-regional express rail (lines S1–S3)[1], and urban metro (Suzhou Urban Planning Bureau, 2008).

Figure 8 displays the revised long-term rail network plan (Suzhou Urban Planning Bureau, 2012), which is required to be consistent with Suzhou's Urban Master Plan 2007–2020. In this 2012 revision, the tram network for SND is also included.

[1] A local transport expert, Director of the Transport Unit at the Suzhou Planning and Design Research Institute Co. LTD has argued that the role of city-regional rail (S1–S3) is not clearly defined yet and the plan could be altered later on. There was no space reserved for this kind of rail integration in city centre in this plan. More discussion is needed regarding the role of city-regional rail lines and how they should be integrated with urban rail systems to serve the Suzhou city-region.

Figure 8. Suzhou long-term rail network plan (2007–2020).

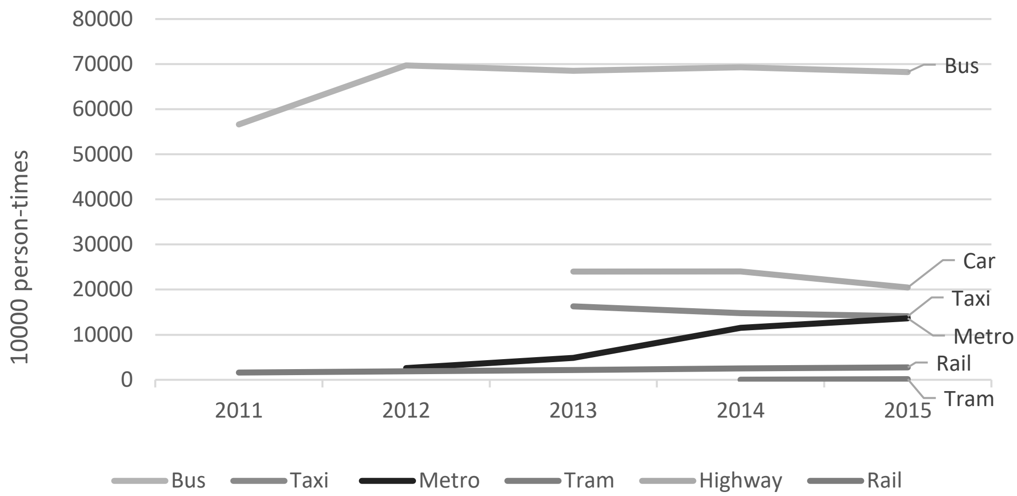


Source: Redrawn based on an original by the Suzhou Urban Planning Bureau (2012).

Suzhou's Metro Line 1 was inaugurated on 28 April 2012, followed by Line 2 on 28 December 2013. The current total length of metro lines in Suzhou is 52 km (March 2017). Lines 3, 4, and 5 (an additional 139 km) are under construction. Another three lines have been planned but construction dates have not yet been confirmed.

The Metro system has attracted an increasing number of passengers (2011–2015 data), and use of other modes of transport has shown a concomitant decline (Figure 9). The average daily metro passenger flow in Suzhou reached 373,500 in 2015 (equivalent to 7,182 people per day per km of line).

Figure 9. Passenger traffic by mode of transport Suzhou urban districts (2011–15).

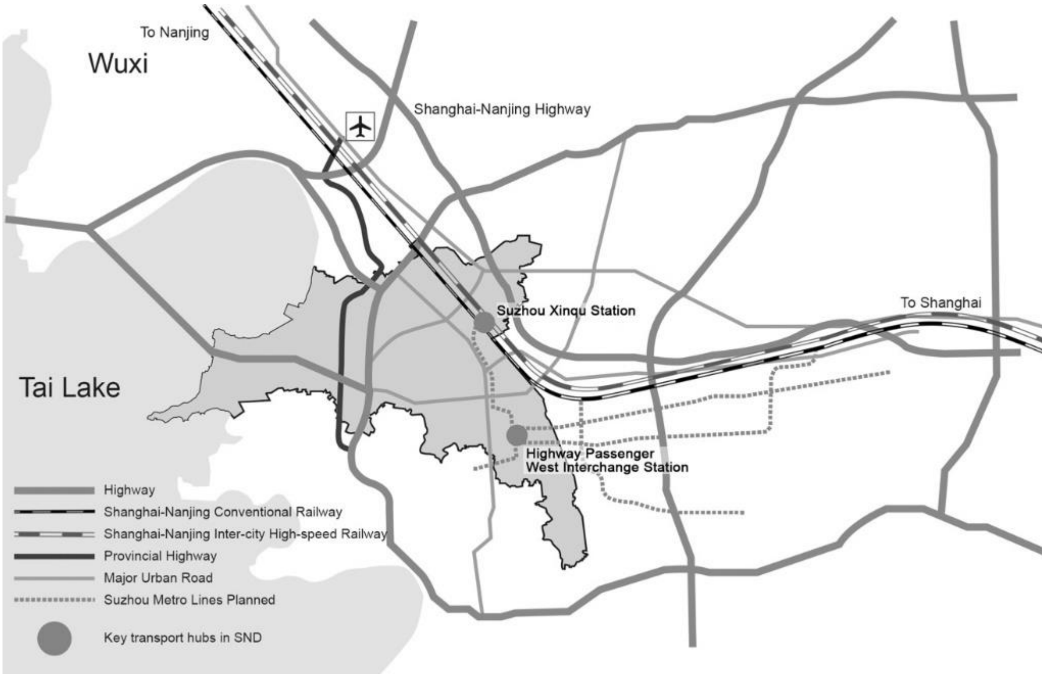


Source: Suzhou Statistical Yearbook 2016.

The urban rail network in SND

Figure 10 shows how the transport network of Suzhou relates to SND. Transport systems including the inter-district transport between SND and other Suzhou urban districts and the intra-SND district transport are closely shaped by the natural contours of the land, the distribution of populations, and various development strategies. In general, SND is well served by various regional and national/international transport systems, including highways, and the nearby Shanghai-Nanjing airport. Shanghai-Nanjing inter-city railway also runs along the eastern fringe of SND (north-west to south-east). There are major transport interchanges in SND, both located towards the east of the district: at the main SND (Suzhou Xinqu) railway station (north-east corner of SND) and at the West Bus interchange (south-east corner of SND).

Figure 10. Transport links of SND to the wider region.



Source: Modified from SUCDRI (2012)

However, the planned urban rail network in SND is limited and partial. Metro lines mainly route through the east edge of SND and via Suzhou Xinqu railway station. In addition, this station has very low train frequencies compared with other railway stations in Suzhou: only four trains a day in total (Table 8).

Table 8. Daily train frequencies at four railway stations in Suzhou.

Station	From Shanghai	To Shanghai
Suzhou station	117	118
Suzhou North station	54	58
Suzhou Yuanqu station	16	18
Suzhou Xinqu station	2	2

Source: www.12306.com (accessed 23 March 2017)

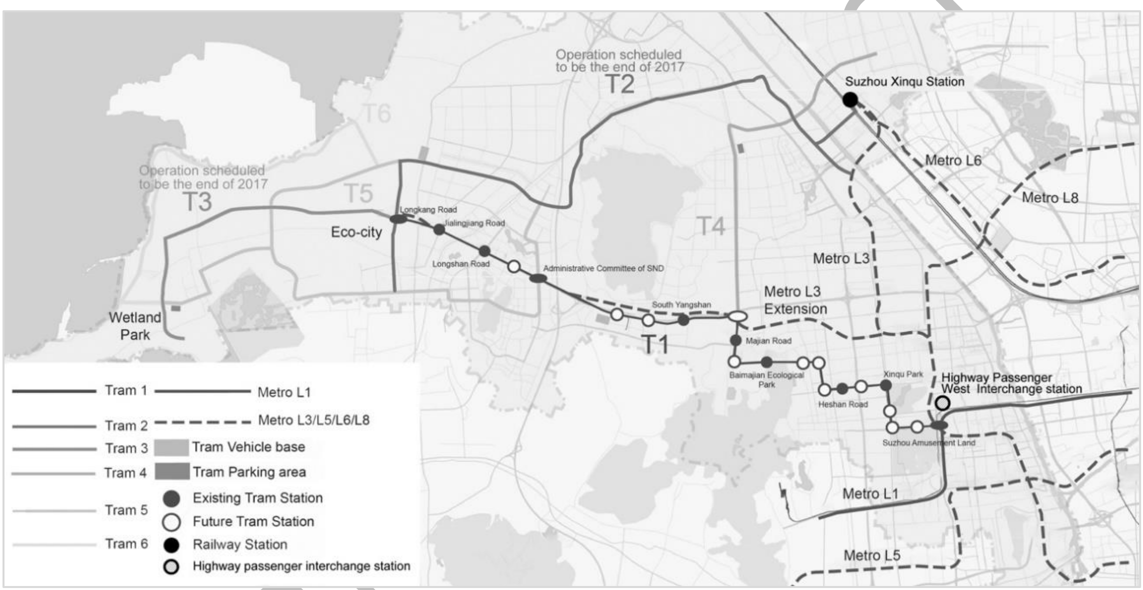
4.3 *Motivations for a SND tram network*

Prior to the tram's introduction, the local government argued that an efficient and comfortable public transport backbone system did not exist to serve the urban development need in SND (SUCDRI, 2012), and therefore a tram system was proposed for the district. The SND tram network plan was developed by the SND tram company and approved by Suzhou Municipality in December 2010 (Figure 11).

In total, six tram lines are planned, with a total network length of 80 km (The SND tram company, 2012). At the north-eastern transport interchange (Suzhou Xingqu inter-city station), passengers can change between Tram Line 2 and Metro Lines 3 and 6. At the south-eastern transport interchange (Highway Passenger West Interchange station/Suzhou Amusement Land), passengers can change between Tram Line 1 and Metro Lines 1 and 8, as well as for long-haul regional coaches, airport shuttle buses, car parking, and a commercial complex.

The first tram line (Tram Line 1, ‘T1’; 18.2 km) came into service in October 2014. In total, 22 stops were planned for Tram Line 1, but only ten stops are currently in operation. The remaining stops will be installed gradually based on the future land development. Both Tram Line 1 extension (shown in Figure 11 as ‘T3’) and Tram Line 2 (‘T2’) are expected to start operation sometime in the second half of 2017.

Figure 11. The SND Tram network plan 2030.



Source: Modified from OpenStreetMap data and SUCDRI (2012)

A primary aim of the SND tram is to foster urban development in the west of SND. Rather than simply being used to relieve traffic congestion in dense central areas, the SND tram is designed to make the most of surrounding scenery and landscape. SND Tram Line 1 is also designed to serve as an extension of the metro system, in order to ensure good connections with other urban districts in Suzhou in the short-to-medium term. In the future, once the planned Metro Line 3 is eventually completed, Tram Line 1 will be converted to be a supplementary line.

There was a hope that the SND tram would increase the modal share of public transport in the district. Before it began operation (2010 data), the two highest shares of transport mode in SND were e-bike (29.5%) and private car (21.9%). Bus travel accounted for only 9.6% (SUCDRI, 2012). The SND tramway planning document shows that the designed capacity was based on an assumption that the modal share by public transport in SND would reach 30% by 2020, at which point the tram would be expected to take 175,000 passengers per day, or approximately 4,100 people per km-day (SUCDRI, 2012).

According to planning documents (SUCDRI, 2012) and an interview conducted with the Deputy Manager of the SND Tram company, there were five main factors which led to the choice of a tram system for SND, rather than another mode of public transport (Shi, 2014):

1. **Planning approval procedure**: In line with national policy, constructing metro lines requires approval from the national government, but this is generally ruled in low-density and under-developed areas, even if city-size thresholds are met. By contrast, tram construction plans do not require national approval and can be approved by either the municipal or provincial level of the Development and Reform Commission (DRC), which is easier and quicker, and more likely to be supportive of local developments.

2. **Population density:** Because the population is dispersed in SND and the western part of the district is still under development, high-capacity rail schemes were likely not considered viable. The tram network as a backbone transit system was proposed soon after the Suzhou Metro L3 extension into SND was not approved. The Deputy Manager of the SND tram company revealed that, although the initially proposed Metro L3 extension did not get approval straight away, the possibility of extending Suzhou metro lines has not been eliminated.

3. **Cost and time:** The construction cost of a tram network is generally around one-sixth to one-quarter that of metro (around CNY 100 million per km). Trams also have a much shorter construction period: around two years, compared to around 5–6 years for a metro system, in a typical Chinese city (NDRC, 2015, No.49; Zi et al., 2009; Xue et al., 2008).

4. **Capacity:** Trams can serve 6,000–15,000 passengers per hour, which is higher than the equivalent Bus Rapid Transit (BRT) system (Qin et al., 2013). In fact, a BRT system was initially proposed in the Suzhou Comprehensive Transport Plan (2007–2020), but this was ultimately replaced by a tram system (Suzhou Urban Planning Bureau, 2008).

5. **Comfort and image:** According to the tram network planning document (SUCDRI, 2012), a tram system met aspirations for environmental friendliness, low energy consumption, and better accessibility with low-floor design. Furthermore, trams were felt to have a safe, smart, comfortable and modern image, which fitted well with the future vision of SND.

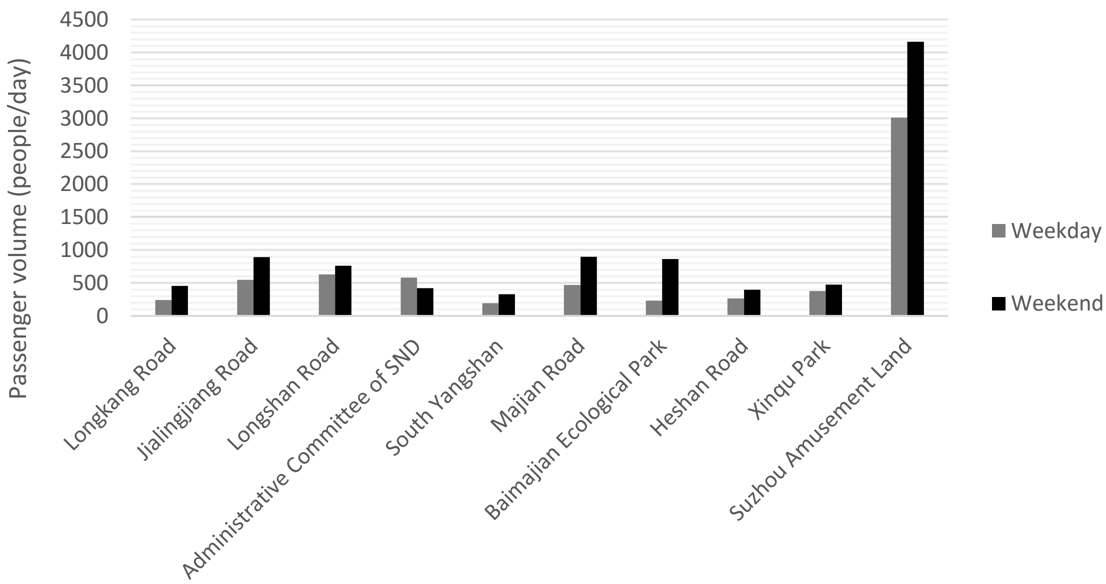
4.4 Use of the SND tram

To better understand the use of the SND tram, a survey of passengers was carried out on three half days in February 2017: the 22nd (Wednesday afternoon), 26th (Sunday afternoon), and 27th (Monday morning). Valid responses were collected and analyzed from a total of 126 passengers, reflecting both peak/off-peak and weekday/weekend passengers. More findings from the survey are discussed in Section 4.5.4.

Data obtained from the SND Tram Company showed that the SND tram attracted around 7,000 passengers a day in February 2017. Two and half years after its inauguration, this patronage is considerably lower than the 28,200 passengers per day that the system was designed for and expected to carry at this point, and dramatically lower than the 92,300 passengers per day that the system is expected to carry by 2020 (Wang, 2013, p.41). The survey data showed that most tram passengers were not frequent users: 30% used the tram "seldom" and 25% were "once-a-week" users. Only 23% declared that they used the tram "multiple times a day".

The findings showed that the tram attracted more passengers during the weekend than on weekdays (Figure 12), suggesting that leisure travel was the dominant use. The exception to this rule was the 'Administrative Committee of SND' stop. This is likely to be because of the number of places-of-work near this stop, although the stop was generally lightly used, with only around 500 people in total boarding and alighting during a weekday.

Figure 12 Tram daily passenger volumes by stop (February 2017).



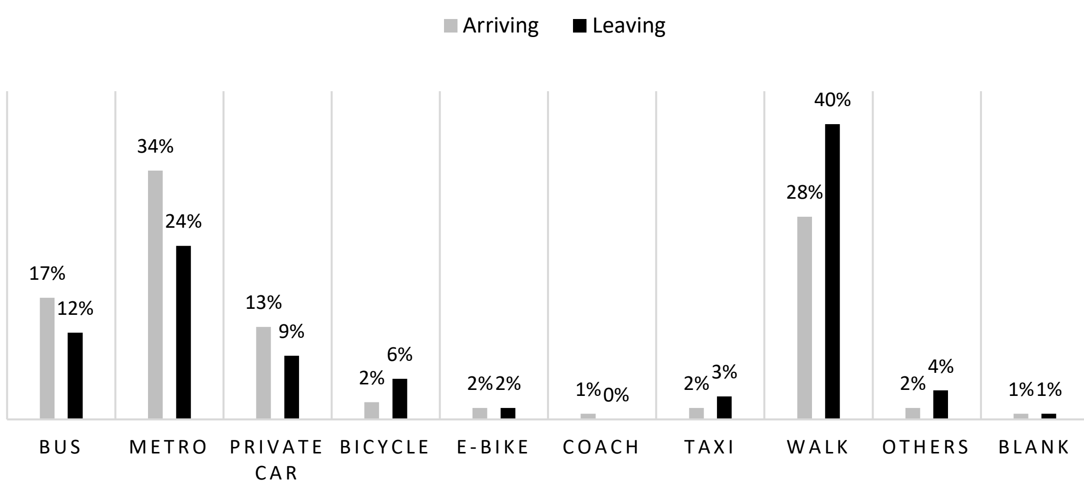
Source: The SND tram company (data for 26 and 27 Feb 2017)

The development-driven model requires time for the number of tram passengers to grow. There are some indications of improvement in tram patronage since 2015. Average daily passengers were only around 4,000 in 2015. On a recent sunny weekend in early 2017, passenger numbers were 9,661, and although the figure dropped to 6,563 on a subsequent weekday, this still represents a considerable growth in numbers since the service opened. However, for many people, the tram is still not seen as a viable alternative to the private car.

The passenger survey suggested that the majority of tram users were from two broad groups of people: (1) those who live in the newly developed residential compounds near the SND tramway and walk to and from tram; and (2) those who took the tram in order to change to/from Metro Line 1. Bus transfer users were the third most common group of passengers – perhaps reflecting groups that do not own a car.

In spite of bike parking provision, the survey revealed that only 2% and 6% of tram passengers took bikes when entering and leaving tram stations, respectively. On the other hand, the findings showed that 13% and 9% of tram passengers drove to and from tram stations, respectively, even though there are no formal car parks at most stops (Figure 13). This suggests that many tram users may have been dropped off (and picked up) by family members or friends.

Figure 13. Mode of transport for passengers arriving and leaving the tram station.



Source: Survey by author (data collected on 22, 26, and 27 Feb 2017)

4.5 Evaluating current approaches to integration

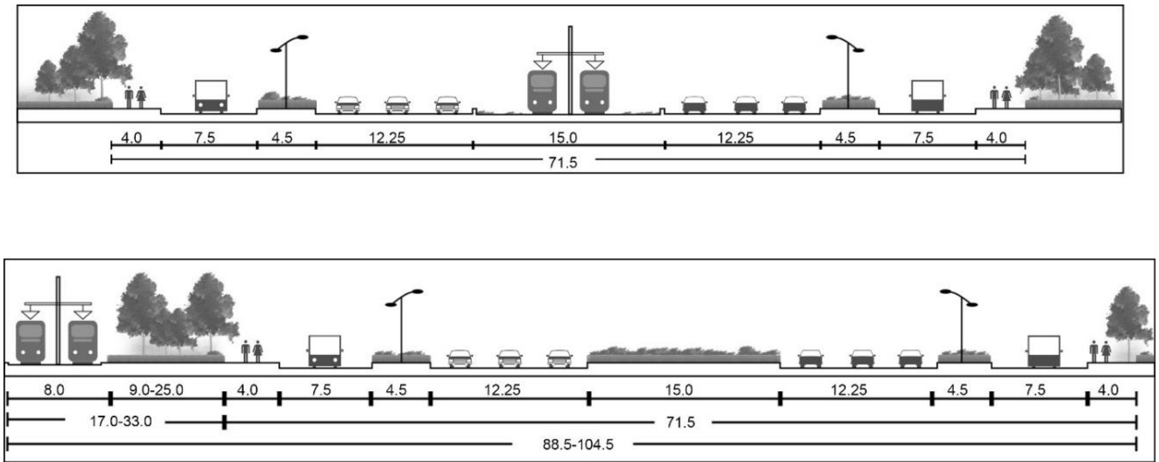
The previous section illustrates the patterns of tram usage in SND, and how tram usage integrates with the wider urban transport network. In order to better understand these use patterns, further examination on urban transport integration in SND was made, from four perspectives: planning and design; service operation; tram operation/management and urban transport governance; and user experience.

4.5.1 Planning and design

As discussed in Section 3, it was not until the early 2000s, that urban planning in China shifted away from a car-centric model, towards active promotion of rail. Therefore, many urban rail systems have been laid on land developed in a car-based era.

Suzhou Science and Technology Town, in the west of SND was created in 2006. Taihu Avenue was designed to be the gateway to this new area, allowing a high-speed car journey from Suzhou city center to Tai Lake within 15 minutes. Construction of this six-lane freeway started in 2008, and was completed in 2010, before the tram network was initiated. As a result, the tramway was subsequently added, either in the center, or to the side of this main arterial road. Cars therefore retained priority, and it is very unlikely in this situation that a journey by tram will ever be as fast as a journey by car.

Figure 14 Two representative road/tramway sections of Taihu Avenue

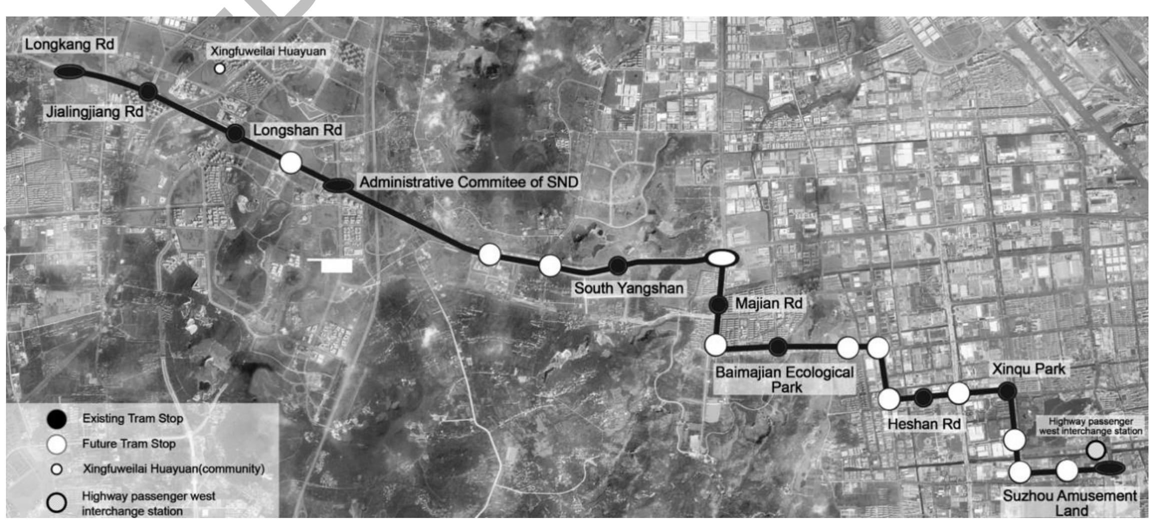


Source: Redrawn based on the road sections in SUCDRI (2012)

Generally speaking, the SND tram is routed along a "path of least resistance"—along wide roads, avoiding existing dense urban areas—in order to reduce conflict with cars and traffic accidents. The current SND tram has a half-independent right of way, giving trams priority at road junctions.

Satellite imagery clearly shows how SND Tram Line 1 runs through thinly-populated areas of SND, such as Majian Road, Baimajian Ecological Park, South Yanshan and Longkang Road (Figure 15). Places around Heshan Road and Xinqu Park are mostly industrial. Further to the west, the newly-created Administrative Committee of SND is a local government showcase for Science and Technology Town with newly-developed culture facilities (library, museum, office tower blocks and governmental buildings). Both Jialingjian Road and Longshan Road stations are not too far from newly developed large-scale housing blocks and employment sites in the Science and Technology Town.

Figure 15. Satellite imagery of the SND Tram Line 1 and its surrounding area.



Source: Modified from Baidu Map

As the tram is designed as a main artery for connecting the west and east of SND, and it is anticipated that passengers will walk or take buses to access trams. However, a critical question arises: in reality, to what extent will they be willing to use the tram to replace a car journey? To answer this question, examining journey times required by transport mode choices could be instrumental. For instance, if one wants to travel 17 km to Suzhou Amusement Park from a new housing development in Xinfuweilai Huayuan (see the location in Figure 15), it requires a 1.5km walk (approximately 19 minutes) to the nearest SND tram station (Longshan Road stop), and a total journey time (including interchange) of around 1 hour 22 minutes. This compares to a car journey of just 22 minutes. For bus passengers, it would take at least one-and-a-half hours, including one bus interchange. Therefore, neither bus, nor bus/tram combined, has a journey time that is competitive versus a car journey, meaning that people who cannot afford a car will be disadvantaged in terms of travel time when journeying within SND.

Table 9. Alternative routes and modes from Xinfuweilai Huayuan to Suzhou Amusement Park.

Mode choice	Travel time	Interchanges	Walking distance (m) (ingress +interchange+ egress)
Car	22 mins	0	
Tram	1 hour 22 mins	0	1400+110
Bus (Route 353)	1 hour 37 mins	0	250+300
Bus (Route 353) + Tram	1 hour 22 mins	1	250+280+110
Bus (Route 44 +337 or 357)	1 hour 44 mins	1	1500+310

Source: Baidu map

Access to the tram is inconvenient, as stops are not generally located near densely populated areas. Access might involve either an overpass bridge (e.g. Figure 16, *left*) or an underpass tunnel (e.g. Figure 16, *right*) in order to cross a wide road. Thus, walking distance is increased and there are more obstacles for people with mobility impairments, particularly as some stops are not fitted with lifts.

Figure 16 Access to the SND tram: examples of an overpass bridge (*left*) and underpass tunnel (*right*).

Source: Author (*left*) and Huahui Ai (*right*)

The facilities designed into each tram station reveal how it was envisaged that the SND tram would serve the population. Public bike stations are provided near every tram station exit, but there are no park-and-ride or "kiss-and-ride" facilities for car users within the SND tram network, except some interchange facilities at the Highway Passenger West Interchange Station complex. This suggests that inadequate consideration was taken of passengers who might live in a much wider catchment area and need to drive to a tram station, park and then take a tram to access the city center. The reason for this might be absent of serious congestion occurring in SND yet and thus driving to take public transit does not appear competitive when being compared with convenient door-to-door driving. It has reduced the appeal of P+R which could be potentially exploited to assist wider territorial development.

4.5.2 Service operation

There are four key aspects to integration of service operation between different modes of public transport, namely: connecting timetables, bus re-routing, travel cards, and fare integration.

Firstly, public transport in Suzhou operates according to service intervals, rather than pre-arranged timetables, with trams every 8–10 minutes, buses every 10–20 minutes and metro services every 5–7 minutes. Given the frequency of these services, and the time spent on interchange, it does not seem necessary to integrate timetabling between them. However, what is critical, is integration between the final tram service of the day, and the availability of connecting bus services to wider territories. For instance, bus services should be available 30 minutes after the last tram arrives. The deputy manager of the SND tram company explained that this was attempted initially, but was later abolished because of low demand from the relatively undeveloped surrounding residential areas.

Secondly, bus routes were modified after the arrival of tram, in order to avoid competition along the same routes, and provide better interchanges between tram and bus. In practice, however, depending on the road condition, bus services tend to have the least regular service than tram, the integration service between bus and tram could be problematic. This could be addressed by updating real-time multi-modal travel information.

Thirdly, passengers do have the option of using their Suzhou citizen cards for fare payments on the tram, although the SND tram also has its own travel cards. Suzhou citizen cards have multiple functions including transport (metro, tram, bus, public-bike), social functions, tourism, civic cultural facilities (e.g. library, gardens), dining and shopping. There are a variety of discount rates available through the card, thus encouraging people to use public transport. Furthermore, for wider territorial integration, there is a degree of cross-compatibility of citizen cards between different cities in the region. For example, Shanghai citizen cards can be used to pay for transport in Suzhou and vice-versa (although there are occasionally technological issues due to different versions of cards). Other payment methods include traditional cash payments, or increasingly popular e-wallet platforms such as WeChat Pay and Ali Pay.

Unfortunately, what has not yet widely implemented is fare integration between different modes of public transport. For instance, if one takes a metro and then interchanges to a tram, then the fares are not always integrated, and the user can end up paying full-cost for both sections of their journey. Fare integration can be complex, as it requires negotiation between different transport operators, but it can greatly encourage use of public transport if passengers aren't penalized for completing a trip with multiple modes.

4.5.3 Tram operation/management and urban transport governance

There are three main types of tram operation and management model in China, based on whether the tram service is managed by a specific tram company, a bus group, or by the metro company (Table 10). The SND Tram Company was created specifically to operate and manage the tram service (with some guidance from Suzhou Metro Company), so is an example of the first model – a stand-alone tram company. However, because tramways share road space with buses, and sympathetic coordination of routes is so critical for service integration, there is an argument that the second model (a bus group running the tram service) would be more practical.

Table 10. Tram operation and management models in China

	Tram company	**Bus group**	**Metro company**
Character	Tram operated by a tram company	Tram managed and operated by bus group	Tram managed by a branch company of a metro company
Examples	Shanghai, Shenyang, Nanjing, Suzhou, Huai'an	Changchun, Dalian, Qingdao, Tianjin	Guangzhou

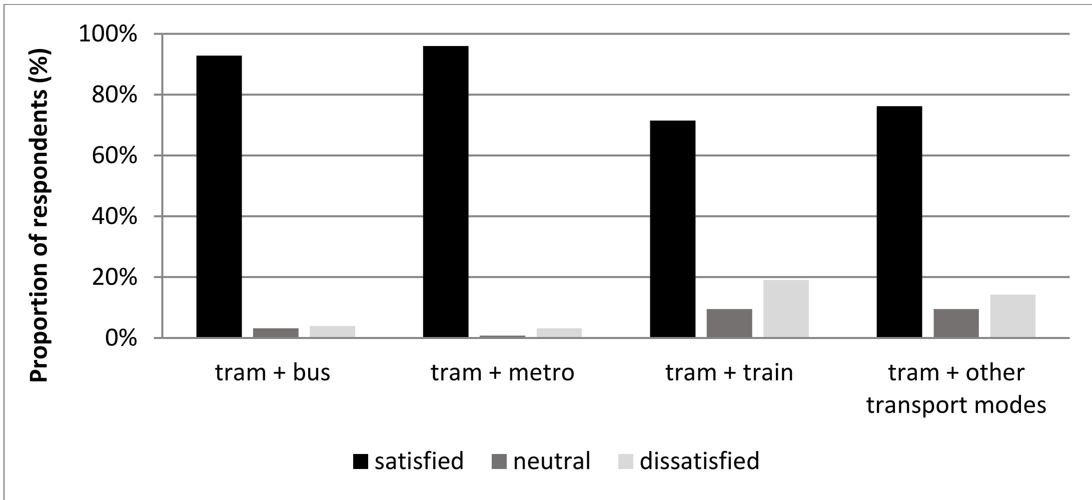
Note: Shanghai tram is operated by Shanghai Pudong Modern Tram Transport in partnership with a Bus group; Shenyang is co-financed and managed by a French Metro company (51%) and Chinese tram company (49%).
Source: Modified from Dong et al. (2013), with data from the Suzhou Municipal Government (2014)

In addition to the tram operation and management, urban transport governance in Suzhou involves a wide range of institutions and remits, covering urban planning, construction, operation, and management (Chen, 2017). Generally speaking, given that various stakeholders are involved, integration of urban transport services is difficult, and in many cases, simply doesn't not exist. This does not exclude the determination of public intervention under extraordinary conditions (Hu, 2013). For instance, Beijing used to be known for its severe air pollution whereas these pollutions could be deliberately controlled and eliminated for a limited period of time. Typical examples are the blue sky and fresh air during the 2008 Beijing Olympic Games and the 2014 APEC meeting.

4.5.4 User experience

A passenger survey was conducted to establish user satisfaction with the SND tram and its integration with other public transport services. The findings showed that user satisfaction with tram integration was generally high (Figure 17). Tram integration with train services had the lowest satisfaction, which may be because there is currently no direct link between the tram system and Suzhou Xinqu train station (until Tram line 2 is completed towards the end of 2017). Even then, the satisfaction level with tram and train integration may not be improved much if the train services at Xinqu station remain infrequent (see Table 8), as the majority of people may still prefer to travel to Suzhou station, where trains are much more frequent. The next lowest satisfaction was related to integration between tram and other transport modes, such as car and walking. Several survey participants commented on long walking distances to the tramway, and the lack of car parking provision.

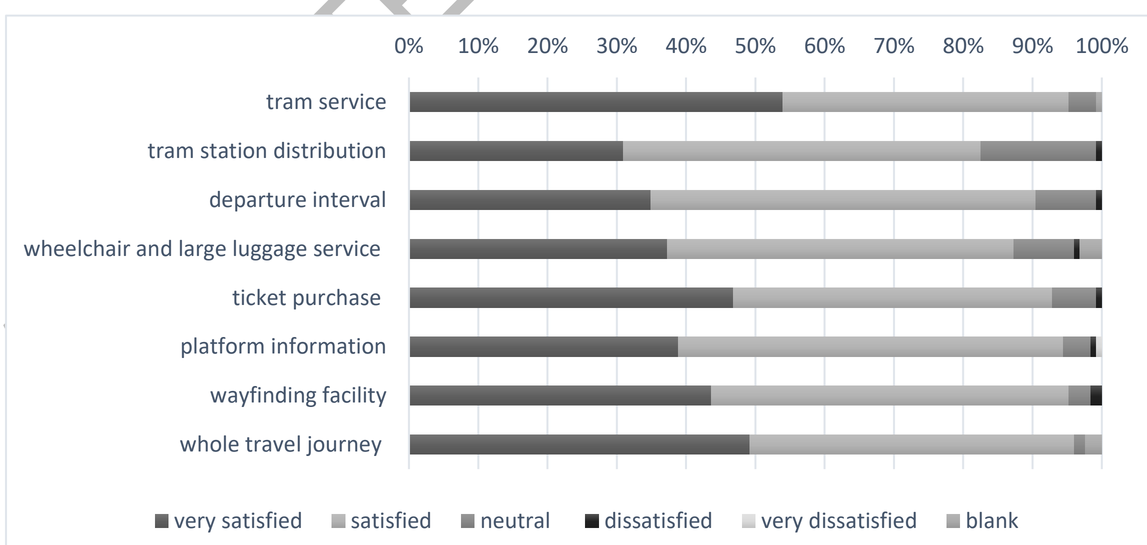
Figure 17. User satisfaction with tram integration.



Note: "Other transport modes" include car, walking, cycling, and other transport types not listed.
Source: SND Tram Survey (conducted on 22, 26, and 27 February 2017)

The findings showed that the overall satisfaction with SND tram services was very high (Figure 18). The majority of tram users commented that the tram is clean, modern, high-quality, and comfortable. The three factors with the lowest levels of "very satisfied" responses were "tram station distribution", "wheelchair and large luggage service" and "departure interval". These factors are closely associated with issues of the tram route avoiding dense areas and the relatively slow journey time compared with a private car.

Figure 18 User satisfaction with SND tram services.



Source: Survey by authors (conducted on 22, 26, and 27 February 2017)

Notable limitations of these data are the relatively small sample size ($n = 126$) compared to the population size (many thousands), and the high potential for self-selection bias, in that users who continue to use the tram service are those who are more likely to rate it highly. Furthermore, the perception of a service tends to reflect individual experiences and local contexts, and without an experience elsewhere for comparison, it is difficult for one to make objective judgments.

5 Conclusions and implications for the future

Over the past decade, Chinese cities have invested massively in urban rail systems, the development of which has been closely facilitated and shaped by national policies. Although presently there are relatively few tram systems in operation in China, a further 2,000 km of tram network is expected to come into service in the near future. This paper draws on a case study of the SND tram, an example of the Type B tram development model that underlies the majority of new tram cases. This case has been explored to understand the role of tram development in Chinese cities, the pattern of tram use, and the degree of urban transport integration.

Regarding the role of tram, the findings show that the tram in Suzhou has been used as a city-marketing tool to drive urban development. Tram systems are widely regarded as a good alternative if a case for constructing metro or light rail systems does not appear justifiable. Unfortunately, after two and half years in operation, despite of a noticeable increase in users in recent months, the number of SND tram passengers is less than one-quarter of what was initially projected. The tram is relatively popular at the weekend, particularly for leisure purposes e.g. travelling to and from the Tai Lake.

The exploration of the integration of the tram service into the urban transport network has produced a number of key issues that should be addressed. Firstly, during planning and design of the tram line, a 'path of least resistance' was chosen along a wide artery road inherited from the car-based era, and avoiding dense urban areas. Unfortunately, locating the tramway in the middle of a wide road and away from the most populated areas means that journey times by public transport are still long compared to by private car. Also, there are barriers to tram accessibility (e.g. long walking distances, poor access for wheelchair users). Furthermore, there is deficiency of park-and-ride and "kiss-and-ride" facilities at tram stops, to cater for journeys that combine car and tram. Secondly, regarding service operation, there is insufficient integration of tram and bus routes and services, and of fares on multi-modal journeys. Thirdly, a wide range of institutions involved in transport governance explains the difficulties of integration of planning, design and operation processes in current practice. Issues reflected in the questionnaire survey include aspects such as tram station distribution, service intervals, and support with luggage. As a result, although an increase in public mode share is recognized as one of the key objectives, all lead to an uncompetitive provision of public transport and inadequate consideration of user experience.

These findings have a number of implications for practice. Firstly, understanding the planning context is fundamental. Wholesale transfer of transport infrastructure policies from other countries should be treated with caution. The role of trams and how trams could be better introduced into Chinese cities should be thoroughly evaluated. It is worth noting, as trams have experienced a renaissance in recent years in European cities (notably in French small and medium-sized cities), that there has been considerable debate and disagreement about how and why road space should be taken back for public transport, rather than kept for car use. Thus, tramway development in France implies a consensus reached through various battles and negotiations among a wide range of public and private stakeholders beyond single modes and with supporting measures that integrate transport and territorial development strategies (Richer and Hasiak, 2014).

Unlike Europe, China has a unique political economy model, very different trajectories of development, scale of cities, population sizes, culture and social norms across provinces. In an era of rapid industrialization and urban development, the rising car ownership has resulted in public awareness that the environmental management is at stake and urban rail systems are regarded as a solution to combating with private car. However, it appears paradoxical when a political will intends to combat car use, whereas the transport policy lends full support to developing automobile industry. For a better outcome of tram development, it is critical to identify what is the ultimate aim and involve necessary actions (trade-off, integration, consistency, negotiation, coordination) in the planning, design, and operation process.

Context-based innovative policy reform could be also beneficial to address financial sustainability and environmental protection of tram networks and elicit new approaches for integrated development. Last but not least, better integration governance should be promoted, to ensure that transport and urban planners can successfully introduce tram lines where necessary, as part of an urban transport system.

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7 References

CAMET (2016) *Urban rail transit statistics and analytical report of 2015*. Beijing: China Association of Metros.

CAMET (2017) *Urban rail transit statistics and analytical report of 2016*. Beijing: China Association of Metros.

Chen, Y. (2005). Brief Introduction about Construction and Development of Urban Express Public Transit System. *Urban Roads Bridges and Flood Control,* Vol.5, 22-24.

Chen, C.-L. (2017) Modern tram and public transport integration in Chinese cities: A case study of Suzhou. Discussion Paper (No.21), International Transport Forum. https://www.itf-oecd.org/public-transport-integration-chinese-cities

Dong, X., Xie, Y., & Qiu, H. (2013). Discussion for rail transit running and management. *Railway Technical Innovation*, Vol.6, 105-106.

GOSC. (1995) *Declaration for suspending urban rapid urban underground rail construction projects*, No.60. Beijing: General Office of the State Council.

GOSC. (2003). *Declaration for strengthening rapid urban rail construction management,* No.81. Beijing: General Office of the State Council.

GOSC. (2012). *Guidance for priority development of urban public transport,* No.64. Beijing: General Office of the State Council.

Hu, X. (2013). Brief Discussion for Urban Public Transit Development. *Young & World*, Vol.34, 256.

MoC. (1986). *Common terms of urban public transport,* GB5655-85. Beijing: Ministry of Construction.

MoC. (2007). *Standard for classification of urban public transportation*- CJJ/T114. Beijing: Ministry of Construction.

MoEP. (2014). *Declaration for environmental influence evaluation of urban rail projects,* No.117. Beijing: Ministry of Environment Protection.

MoF. (2014). *Declaration for issues related to promoting cooperation between government and social capital*, No.76. Beijing: Ministry of Finance.

MoF. (2014). *Declaration for local government debt included in budget control management*, No.351. Beijing: Ministry of Finance.

NBS. (1991-2016). *China Statistical Yearbook, 1991-2016*. Beijing: National Bureau of Statistics.

NDRC. (2015). *Declaration for strengthening urban rail construction management*, No.49. Beijing: National Development and Reform Commission.

NDRC. & MHURD. (2015). *Declaration for improving approval procedures for urban rail construction and planning*, No.2506. Beijing: National Development and Reform Commission and

Qin, G., Miao, Y., & Zhang, S. (2013). A Review on Streetcar Development. *Urban Transport of China*, Vol.4, 6-12.

Richer, C., & Hasiak, S. (2014). Territorial opportunities of tram-based systems: a comparative analysis between Nottingham (UK) and Valenciennes (FRA). *Town Planning Review*, 85(2), 217-236.

SCBS. (1989-2016). *Suzhou Statistical Yearbooks, 1989-2016*. Suzhou: Suzhou City Bureau of Statistics.

Shi, D. (2014). Modern tram for urban development. *Construction*, Vol. 35 (4) (the page number is not shown).

Suzhou Urban Planning Bureau (2008) *Suzhou Comprehensive Transport Plan*. Suzhou: Suzhou Urban Planning Bureau.

Suzhou Urban Planning Bureau (2012) *Suzhou Urban Rail Network Plan* (Revision). Suzhou: Suzhou Urban Planning Bureau.

SUCDRI. (2012). *SND Tram Network Planning Expert Review.* Suzhou: Suzhou Municipal Government.

The SND Tram Company (2012). *Tram planning for SND*. Retrieved from SND Tram: http://www.sndtram.com/Single.aspx?channelid=3

Wang, X. (2012). Urban transit management policy research. *Urban Transport of China*, Vol.8, 45-50.

Wang, L. (2013). *Suzhou SND Tramway Line 1 Engineering Construction and Operation Scheme Design*. Master Dissertation. Nanjing University of Science and Technology.

Wu, F. (2015). *Planning for Growth: Urban and Regional Planning in China*. London: Routledge.

Xue, M., Yang, L., & Cheng, J. (2008). Modern Trams: Characteristics & Development both at Home and Abroad. Urban Transport of China, Vol.6 (6), 88-96.

Zhang, S. (2011). *Research on Urban Public Transport System based on Transit Equity.* Lanzhou: Lanzhou Transport University.

Zhou, Y. (2013). Social Progress Needs Rapid Development of Modern Tram. *Urban Mass Transit*, Vol.16, 1-4.

Zi, H., Guo, X., & Yang, J. (2009). On the application and adaptability of modern tramcar. *Urban Mass Transit*, Vol.12, 46-49.