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Streetcar Development in China: The Motivations Behind

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Abstract: In recent years, there has been a remarkable rebirth of the streetcar in China, with dozens of projects under consideration, in planning and construction, or already completed in cities throughout the country. The development of such a relatively mega-project often raises the question of "why Chinese cities develop their streetcar projects". Building on insights into streetcar projects materials and in-depth interviews with elite figures, and together with relevant socioeconomic data comparisons, the paper sets out to reveal how the resurgence of the streetcar was facilitated and motivated, and why such urban mega-projects are so attractive to cities, and to further derive lessons to better inform policymakers, planners, and researchers in proposing, planning and implementing streetcars in China. Our findings revealed five major themes to motivate streetcars development in China, which unpacked the answer to the question into five aspects: rapid urbanization, supportive policy environment, less-restrictive approval mechanisms, goal-seeking for streetcar development, and potential inter-city competition. A discussion of these themes in the Chinese context leads us to the conclusion that the process of proposing, promoting, and approving streetcar projects is not only dependent on its expected achievements bring to the region but very much on the economic–political reasons and inter-city competition.

Keywords: streetcar project; urban rail transit; motivations; infrastructure; China

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1. Introduction

Transportation is, in many ways, an essential segment of the infrastructure in society [1]. Diverse interactions between transportation development and the city have been widely analyzed from the perspectives of urban development, land use, social economy, and policymaking [2–7]. Button et al. [8] illustrated that urban density and sprawl are influenced by the volume and density of traffic as well as by the capacity and spatial structure of transport infrastructure in the U.S. Furthermore, Coppola et al. [9] put forward transportation drives to promote subjective well-being of modern society by providing for personal mobility, accessibility to services and facilitating economic activity and social interaction in European cities. Salzberg et al. [10] have described that, under the wave of rapid urbanization in China, the growth of a large number of major cities and a restructuring of land use is leading to more complex transport patterns that present a formidable challenge for urban transport policymakers.

Urban rail transit, as compared with other urban transportation modes, is widely considered a preferred public transportation option for major metropolitans worldwide. Faced with the emerging social and environmental problems of urban sprawl, overpopulation, traffic congestion, air pollution, and climate change, an increasing number of cities worldwide have taken steps to develop or expand urban rail transit. Over the past decades, ongoing urbanization and economic growth have contributed to the reason for more and more cities to pursue planning for urban rail transit systems. It is in this context that the streetcar has been revived and developed as a form of urban rail system [11].

In the past decade, the streetcar has made a remarkable resurgence in China. In 2007, Tianjin Binhai New Area opened the first modern streetcar system in mainland China, which was introduced by Lohr Industrie in France. Soon the same type of streetcar system was opened in Shanghai Pudong New Area in 2009. Furthermore, streetcar lines in Shanghai with a total length of about 800 m are in its planning for the years to come. Meanwhile, many cities such as Beijing, Guangzhou, Shenyang, Wuhan, Suzhou, and Foshan are planning and building their own modern streetcar systems. As of December 2021, 21 mainland cities had already operated their own streetcar systems, with a total of 38 projects totaling 505 km. With the rapid streetcar development in China, there is an increasing concern with why Chinese cities develop their streetcar projects.

To better understand the appeal of streetcars to many communities in China, it is important to understand what is actually happening and how firm these new commitments to streetcars actually are within the Chinese context. This paper sets out to investigate the official rationale of such mega-projects and the underlying motivations driving this nationwide development trend in China, and to reveal how the resurgence of the streetcar was facilitated and motivated, and why such urban mega-projects are so attractive to cities.

This article is structured as follows: Section 2 opens with a review of the literature relevant to this research aims. Section 3 provides a more detailed definition of streetcars, together with a number of facts and figures in China. Section 4 describes our research method. Section 5 presents and discusses the findings. Conclusions are reached in the final section.

2. Literature Review

Streetcar, which is generally defined as one type of rail transit system operating entire routes typically on streets in mixed-traffic with lighter vehicles, shorter station distances, and providing medium/low passenger capacity [12,13], is undergoing a resurgence both in China and overseas. Many reasons have driven the streetcar's return to the urban transportation scene, including rapidity, passenger comfort, relatively low construction cost, and environmentally friendly vehicles [14]. Further, other themes have been highlighted as factors contributing to its development trend: its potential to encourage walkable neighborhoods, providing an effective alternative to private car use, and construction and operational cost advantages when compared to other urban mass transit modes [15]. From international perspectives, on the one hand, streetcar projects created new possibilities for urban planning and spatial imagination, in terms of providing novel modes of mobility both in concept and practice and acting as the critical role as a powerful catalyst propelling the outward growth and decongestion of urban centers [16,17]. On the other hand, the proponents of streetcar projects often assert transformative changes brought by the streetcar system [18]. Especially in developed countries, streetcar projects have been found to bring various beneficial changes, in terms of increasing land and property prices [18–22], producing local employment and wider economic growth [18,23–26], achieving local transit-oriented development (TOD) [27–29], etc. Creative city development is then regarded as an underlying but key factor that drives streetcar project developments [30–32]. Within and through neoliberal urbanization, the local governments have been paying more attention and spending more resources on particular civic projects to attract inward investments. The rebirth of the streetcar may prove especially informative concerning the question of making of the creative city for the following reasons: streetcars are exclusively urban [20,22–26]; they are highly visible flagship projects driven first and foremost by city governance stakeholders along with representatives of local urban capital [20–27]; they constitute spatially highly concentrated investments in the tens to 100 s of millions of dollars [20–26,29,30]; and are generally planned in concert with local property (re)investment [30–33].

Other research findings suggested that streetcar projects have been struggling to realize their ambitious goals, especially with the stimulation of some successful project cases [34]. Other cities that operate streetcar services and communities contemplating investment in streetcars might take successful projects as the achievements of best practice adoption, in the hope of the development potential of the new projects to meet the expected

economic benefits [35–37]. Many streetcar projects do not even market themselves as mobility or congestion relieving instruments and instead focus on their role as economic development-generating tools [31–34,38]. From the government to every application for construction funds for these projects to numerous consulting reports on the potential impacts of streetcars, a constant refrain is that streetcars stimulate economic development. A more recent multiple-case study by Concas [39] concludes that streetcars have a catalytic economic development effect related to establishment growth, but this seems to be greater at project announcement and during construction, with decreasing but lingering effects at the opening and during operation.

The projected development impact is often substantial, if not transformative, for these streetcar projects [30]. Although the potential motivation considered for modern streetcar implementation always relates to economic development goals, it is troublesome as there is little evidence on the economic development effects associated with streetcar investment. Crampton [40] compared streetcars in Germany and France with those in Britain and the U.S., including San Diego, Miami, St. Louis, and Sacramento, and concluded that these economic effects are with some respect to a contemporary streetcar system, but almost no analysis of the value premiums is associated specifically with streetcars. Much of the literature that shows real estate or development impacts from proximity to streetcar stations also cautions that other factors contribute to spurring economic development in those areas. Cervero [41] argues that other factors such as local economic conditions, investment policy, and business cycles also contribute to development in corridors near transit. Crampton [40] also caveats that any of his findings on the economic impact of streetcars relied on the presence of other factors such as a strong local economy and a strategic development plan. Even for Portland, Oregon, which is considered a model of the potentially transformative development effects of the streetcar, some caveats were proposed that the associations between streetcars and development activity are likely very context and place-specific [42]. The successful experience of streetcar development is hard to replicate between cities. Cities that are contemplating making a streetcar investment would be best served by keeping these issues in mind when making their own decisions [42–45].

Like metros and LRTs, most streetcar projects in Chinese cities are funded by governments or public–private partnerships (known as PPPs) of local governments and state-owned companies. Since 2008, urban rail transit systems have been emphasized as encouraging development projects by the National Development and Reform Commission (NDRC). A four trillion (CNY) stimulus package instituted by the Chinese central government included 1.5 trillion (CNY) for infrastructure investment, a significant portion of which has been used for urban rail investments, including streetcars. The past decade has therefore witnessed the growing popularity of proposing and constructing urban rail systems in Chinese cities, with billions of dollars of investment coming in every year (see Table 1), reflecting an increasing focus on urban rail projects from the public, central state, and local authorities. In order to initiate an urban rail transit project, Chinese mainland cities were required to meet several requirements proposed by the NDRC in 2003 (in Document (2003) No. 81) [46]. Yet, there has been a difference between the authority of approval of different rail transit projects, as metro and light rail projects require the approval of the State Council, while the authority of approval of streetcar projects is delegated to the provincial investment authorities, rather than the central government [46,47]. By the end of 2021, 21 mainland cities had already operated their own streetcar systems, with a total of 38 projects totaling 505 km (see Table 2).

Table 1. Investment in construction assets and transportation infrastructure in China during 2008–2020.

Year	Construction Assets Investment (Billion CNY)	Transportation Infrastructure Investment (Billion CNY)	Urban Rail Transit Investment (Billion CNY)
2020	51,002.27	7030.61	4528.93
2019	49,087.84	6852.44	4643.03
2018	46,528.76	6470.67	4268.85
2017	44,911.93	6144.99	3875.60
2016	42,310.72	5389.04	3499.54
2015	38,816.35	4920.00	2633.70
2014	34,978.90	4321.57	2065.80
2013	29,842.42	3679.01	1604.64
2012	24,361.75	3144.49	1236.40
2011	20,019.57	2829.17	N/A
2010	15,558.05	3007.45	N/A
2009	13,875.83	2497.47	N/A
2008	10,495.89	1702.44	N/A

Note: the data were collected from China Statistical Yearbooks of each year published by the National Bureau of Statistics of China and Statistical Yearbooks of Urban Rail Transit published by the China Association of Metros.

Table 2. Mainland Chinese cities with streetcar in operation and relevant socioeconomic data at the time of operation.

	City	Lines in Operation/Length (km)	Year Began Operation	GDP (Billion CNY)	Local Government Finance (Billion CNY)	Local Population in Main Urban Area (Million)
1	Dalian	2/23.4	Heritage	N/A	N/A	N/A
2	Changchun	2/12.2	Heritage	N/A	N/A	N/A
3	Tianjin	1/7.9	2007	505.04	54.08	7.86
4	Shanghai	3/49.0	2010	1716.61	287.26	23.03
5	Shenyang	7/107.8	2013	715.90	80.13	8.26
6	Nanjing	2/16.7	2014	882.12	117.20	8.21
7	Guangzhou	2/22.0	2014	1670.71	231.82	8.42
8	Suzhou	2/44.2	2014	1376.12	144.39	5.48
9	Huaian	1/20.1	2015	274.61	51.02	4.91
10	Qingdao	1/8.8	2016	1001.10	110.01	4.97
11	Zhuhai	1/8.8	2017	256.52	31.41	1.77
12	Wuhan	3/49.1	2017	1341.06	140.25	10.89
13	Shenzhen	1/11.7	2017	2249.02	333.21	12.53
14	Beijing	2/20.8	2017	2801.49	543.08	21.71
15	Chengdu	2/39.3	2018	1534.28	142.42	8.51
16	Foshan	1/16.1	2019	1075.10	73.16	8.15
17	Tianshui	1/12.9	2020	66.69	5.39	3.38
18	Sanya	1/8.4	2020	69.54	2.21	1.03
19	Jiaxing	1/10.6	2021	550.95 *	59.88 *	5.41 *
20	Wenshan	1/13.4	2021	32.45 *	2.32 *	0.62 *
21	Kunming	1/1.89	2021	637.38 *	65.05 *	5.83 *

Note: data on the GDP, local government finance, and local population were collected from the statistical bulletin of each city from the operational year (* data in 2020), published by local authorities.

As judged over time, the passion for streetcar development does not appear to be abating, as an increasing number of cities are currently pursuing such projects of their own. A number of cities have been actively planning, proposing, and carrying out their own streetcar projects, even though the ability of streetcars to promote economic development and transportation efficiency has been questioned by the public. More specifically, issues such as relatively lower ridership [48,49], weak/unclear economic stimulus function [19,33], and relatively high cost of built and operation [50,51] all cast doubt on the possible delivery

of a public good, which can bring a potentially heavy fiscal burden on the local state. The risks of being unprofitable and even unsustainable therefore indicate the necessity of further investigation into the true motivations behind proposing and pursuing these relatively costly streetcar projects.

The present literature on streetcar development in China mainly focuses on the aspects of engineering technology, signal optimization, intersection control strategies, and operating parameter design [52–56]. Yet researches on the integrated motives and substantial dynamics that push streetcar projects forward are relatively limited. The only published work found to date was a master's thesis of a graduate student [57] and a one-city case study of streetcar development in China [58]. The thesis explored the streetcar as both an engineering and social technology to elaborate a deeper understanding of the notion of mobility and rhythm in everyday life, looking at the streetcar system of Dalian in northern China from the 1890s to 1940s as a subject. In the one-city case study of the Chinese city, Suzhou, three types of streetcar-developing modes were identified based on the city's size and service route. Thus, except for brief conclusions for classifying previous case studies, much remains unknown about how the resurgence of streetcars was facilitated and motivated.

With this background, we take a closer look at this cautious decision-making with regard to streetcars. We investigate what motivates cities to embark on these relatively mega-projects in the face of strong potential for failure and why such mega-project developments in Chinese cities are so attractive to both central and local states.

3. Streetcars in China

Streetcar systems are not new in Chinese cities. The first streetcar line in Mainland China started operations in Tianjin in 1906. Shanghai opened its first streetcar line in 1908, and Dalian started operating in 1909 [59]. In the early 20th century, streetcar networks provided an urban transit mode in China and epitomized urbanity by providing a symbol of what it meant to be a city. However, streetcars nearly disappeared throughout the country in the period between the 1960s and 1970s. This demise of the streetcar was caused by the emergence of individualized mobility via motorized vehicles, consistent with global trends [60]. Due to supportive national policies and gradually improving technology, the modern streetcar, an urban transportation mode once thought to have passed its golden age, has recently experienced a noteworthy resurgence in Mainland China. As early as 2010, only one streetcar project was put into construction. Yet by the end of 2021, 38 projects have been in service. In addition, another 17 projects are identified by the government as promising and received support for building in the coming years.

There is no worldwide standardized definition of a streetcar system [58]. Vuchic [12] offers a useful description of streetcar: "an electrically powered rail transit operating with one to three-car trains on surface streets with other vehicles". In Europe, streetcars are typically included under the light-rail transit system. Generally, in the U.S., the LRT system is regarded as having a dedicated Right-of-Way (RoW); and the streetcar is viewed as running in mixed traffic [61]. The U.S. Federal Transit Administration [62] defines streetcar as rail transit systems operating entire routes, typically on streets in mixed-traffic and offering service with single-car trains powered by overhead catenaries. However, exceptions to the mixed-traffic operating characteristic exist in a few cases in the U.S., such as New Orleans' St. Charles and Canal Street lines that operate along semi-exclusive RoWs, or Philadelphia's 10, 11, 13, 34, 36 streetcar lines that partially operate in subway within the central city district.

In China, streetcars and light rails are regarded as being different systems. According to the "Standard for Classification of Urban Public Transport" [63], the streetcar system is defined and classified as one transit mode within an urban rail system, providing "moderate/low passenger capacity and [is] suitable for ground tracks", and light rail systems are viewed as rail transit systems running on street or aerial structures typically with dedicated RoW and providing moderate passenger capacity [64] (see Table 3).

Table 3. Typical Differences in Definition between LRT and Streetcar in China.

	LRT	**Streetcar**
Function	High capacity and demand	Moderate/low capacity and demand
Route Design	Multiple lines/same corridor	Discreet routes—less demand
Capacity	12,000–15,000 pass/h	6000–10,000 pass/h
Right of Way	Dedicated RoW	Dedicated RoW; Semi-Dedicated RoW; Operation in mixed traffic
Structure	Mostly with aerial structure and underground structure; On surface streets	On surface streets
Power Supply System	Catenary power supply	Catenary power supply; Ground power supply; Super capacitor
Length	18.9~30.4 m	12.5–28 m
Width	2.6 m	Less than 2.6 m
Maximum grades	6%	6%
Minimum curves	50 m	30 m
Average Schedule Speed	25–35 km/h	15–25 km/h

Note: data were collected from reference [63].

By working from this definition, it can be concluded that the essence of the streetcar is that it is a hybrid form of public transport. It involves passenger rail transport in which the vehicle, as regards size and weight, stands below LRTs. Vehicles are smaller than light rail and have a lighter design than light rail, allowing for lighter engines and more efficient operation. Thanks to the lighter vehicles, the infrastructure can also have a lighter format than required for metros and light rail. Due to its hybrid character, streetcar services can adopt elements of metro, light rail, and even bus operation models. These include operating speeds and stop distances that can be adopted from metros and light rail; schedules can be fixed times or intervals; boarding regimes can have in-vehicle ticket sales and validation or off-vehicle sales with in-vehicle or platform inspection. There are overlapping conditions between streetcars and LRTs in China, as it happens in other regions as well (see Table 3). For instance, China streetcars generally have a dedicated RoW (excluding intersections with vehicular traffic), but they are not identified as light rails since the streetcar category in China is mostly based on vehicle and operational characteristics (see Figure 1).



Figure 1. Semi-dedicated RoW of streetcar in China (Note: photos were provided by the authors).

4. Research Methods

The research method consisted of reviews of relevant documentary materials and semi-structured interviews conducted in a semi-structured manner. Our first step was to select six projects from this total of 38 for further investigation (see Table 4). The 38 projects can be divided into two categories. Firstly, projects are located in cities where they already operate metros or LRTs. Secondly, projects are located in cities that have not been successful in building metros or LRTs, albeit sometimes with approval of NDRC. This exploratory study utilized these streetcar projects to investigate the factors and rationales that motivate such a relatively expensive urban mega-project development in Chinese cities.

Table 4. Selected six representative projects from the total 38 projects.

Projects	Year of Streetcar in Operation	Operates Subway/Light Rail or NOT
1. Shenyang Hunnan Modern Tramway	2013	Yes (in 2010)
2. Nanjing Metro Politan Tram	2014	Yes (in 2005)
3. Suzhou New Distinct Tram	2014	Yes (in 2012)
4. Huaian Modern Tram	2015	No
5. Qingdao Modern Tram	2016	Yes (in 2015)
6. Jiaxing Rail Transit	2021	No

We studied these six projects in more detail that included document analysis of relevant exchange of information (project proposal plan, expert reviews, and minutes of

meetings) between the local and national governments involved in these projects; mission statements, newspaper accounts, and promotional materials for streetcars were used as well. In addition, 22 semi-structured interviews were carried out in order to gain perspectives and a more in-depth understanding of project motivations. These respondents from local government and expert groups were influential in and well-informed about different parts of these streetcar projects development, including ex-ante research, network planning, proposal making, project financing, and project implementation. The face-to-face interviews were conducted with project planners (8), policymakers (political and administrative) at regional and national level (6), and transportation experts (8) between May to October 2020 (see Table 5).

Table 5. Key Respondents for Interviews in Six Case Cities.

Respondent Role	1-Shenyang	2-Nanjing	3-Suzhou	4-Huaian	5-Qingdao	6-Jiaxing
Planner (PL)	PL-1a PL-1b	PL-2	PL-3a PL-3b		PL-5	PL-6a PL-6b
Expert (EX)	EX-1	EX-2a EX-2b	EX-3	EX-4a EX-4b	EX-5	EX-6
Local Administrative leader (LAL)	LAL-1	LAL-2a LAL-2b		LAL-4		LAL-6a LAL-6b
Total [21]	4	5	3	3	2	5

Using national and local transportation policy resources, streetcar-related documentary materials, key decision-maker, planner, and experts' interviews, the decision-making process for these six projects was charted and analyzed. The most salient, official descriptions, mission statements, and respondents' answers of the projects were selected for the qualitative content analysis in next step. After a thorough review of all the texts in question, we conducted qualitative content analysis by making a code out of the very words and phrases that actually appear in the text, such as "transit demands," "public transit," "strengthen new urban district," or "inter-city competition". Then, these codes were reviewed, refined, classified, and conceptualized, and used as the sets of codes to synthesize and characterize the themes regarded to motivations for streetcar implementation.

The study was conducted in two phases. The results of the first phase were recorded in an interim report that presented the most important explanations for integrated motives and substantial dynamics for streetcar development in these projects. This report was then discussed in the second phase at an expert meeting with twelve experts involved in the various projects. The aims of the expert meeting focus on three aspects:

1. To enrich perspectives on streetcar development, including their opinions on streetcar effects and controversial issues about the projects.
2. To establish whether the identified key motives are acknowledged by experts and those directly involved in the streetcar.
3. To categorize and discuss the key motives and dynamics.

The expert meeting is organized with the assistance of Group Support Technology [65,66]. Based on the results of the expert meeting, the interim report was amended and incorporated in the final report. The conclusions are presented below.

5. Findings and Discussion

5.1. China's Rapid Urbanization Process

5.1.1. Meeting the Increasing Transit Demands

The Nobel laureate in economics Joseph E. Stiglitz once said, "high-tech development in the United States and China's urbanization would be two key factors affecting the process of human society development in the 21st century". A wave of urbanization has swept over China in the past two decades. Since the Chinese economic reforms of 1978, and particularly

since the 1990s, China has entered a stage of unprecedented rapid urbanization, which has manifested as rapid urban population growth and urban expansion onto previously rural land (see Table 6). From 1990 to 2020, the urban population share increased from 29% to 63.89%. Built-up areas have more than a quintuple 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 97.2-fold over the 30 years to 2020. Unlike the relatively slow urbanization process in European countries and America, China's urbanization is characterized by a burst of urban expansion in a short time. Such a large-scale, rapid, and profound urbanization process has not only brought about great achievements but also caused a series of complex and special social problems. In terms of urban transportation, this has resulted in serious traffic congestion and wider concerns about social justice issues relating to transport provision.

Table 6. Changes in urbanization in China, 1990 and 2020.

Indicator	Unit	1990	2020	1990–2020 Change
Urban population share	%	29.0	63.89	+34.89 percentage points
Urban population	million	302	902	3.0 times
Built-up area	km^2	12,855	60,721	4.7 times
Private vehicles	10^4 Cars	250	24,291	97.2times

Note: data were collected from reference [67].

Urbanization development produces new transportation demands and promotes the development of urban transit. One of the administrative leaders interviewed noted that rapid urbanization means that residents will generally improve their living standards and that the demand for urban infrastructure will improve further (Respondent: LAL-4). Urban transit provides liquidity for people and goods and affects the growth of economic activity through land accessibility mode and level of economic activity. Because of the need to overcome space and time obstacles, urban transit becomes the key role in influencing the urbanization level [68]. In Chinese cities, both local leaders and the public believe that the development of an urban rail transit project could bring prosperity to the local economy and urban transportation infrastructure (Respondent: PL-1a, EX-4b, LAL-4, LAL-6b). As the population size of a city increases, the use of a rail-based system becomes more appealing because it is more efficient to move people along busy traffic corridors with metro systems, as stated by one planner interviewed (Respondent: PL-2).

From the interviews, it clearly emerged that the great faith placed in the metro project to match the need of urbanization for transportation infrastructure construction had been passed on to the streetcar project. One of the investment experts interviewed (Respondent: EX-4b) noted that many policymakers believe that fixed-guideway transit systems create a value premium, meaning an increase in property values or related economic factors, as a result of the increased access and desirability of the land served by the fixed guideway transit. As well, an urban planning expert (Respondent: EX-6) stated that streetcar has the potential to anchor high-density development in a way that a bus cannot by providing a permanent infrastructure investment. Further, the streetcar made the concept of sustainability more popular under rapid urbanization. Some experts and planners (Respondent:PL-2, PL-6a, EX-2a, EX-2b, EX-4b) we interviewed admitted that streetcar laid the foundation for a much larger discussion about other types of traffic demand growth that valued the environment and added to the social connections. All the projects have emphasized the recognition of streetcar as a form of "sustainable transportation" in their planning and feasibility study reports in order to make it easier to attain government approval for streetcar implementation.

5.1.2. Changes in Urban Transit Development Strategy

The development of urbanization changes the transportation demand, thus affecting the urban transit development strategy. In the early stage of China's urbanization, 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 private vehicles (Table 6). In this period, China's cities need to provide a large supply of road construction to meet the demand for automobile development. Then, a USA-style approach was adopted, with a number of large-scale road-building programs [69]. Around this time, the financial issues caused by an overambitious rail scheme in Shenyang led the Chinese government to suspend any approval of urban metro and light rail systems [70]. This also reflects that with the prevalence of a policy of prioritizing individual travel, public transportation was largely ignored. Yet from the early 2000s, the explosive growth of private cars had greatly increased the severity of urban traffic congestion, parking chaos, and deteriorating air quality. Several major Chinese cities expressed a desire to learn from the motorization experience of Western countries and considered prioritizing public transportation. There was renewed enthusiasm for public transport and a new wave of large-scale investment in urban rail systems.

Given the huge population, space constraint, cost constraint, and environmental considerations, China focuses on an alternative approach to discourage private transport by the provision of a well-developed public transport network consisting of rail transit systems and buses, and supplemented by paratransit. During the interviews, both the local government and planner (Respondent: LAL-1, LAL-4, LAL-6a, LAL-6b, PL-1a, PL-3a, PL-5, PL-6b) expressed positive expectations concerning the improvement of traffic congestion and parking chaos incited by the streetcar project. It is impossible to keep finding land in cities for the continual expansion of roads and car parks under rapid urbanization, and the growth rate of roads can seldom catch up with the increase in car ownership and car usage. All of the elite interviewees (Respondent: all) believed that China's rapid urbanization had brought about urban transit issues that should be solved by supporting and promoting the development of public transportation, such as Hong Kong and Singapore, which focus on the development of urban mass transit systems and adopt a policy of suppressing the growth of private modes. Some experts interviewed (Respondent: EX-2a, EX-2b, EX-3, EX-6) described their viewpoint that a city with a healthy reliance on public transport could provide mobility to those who cannot drive, the under-aged, the elderly, the poor, and those incapable of driving, and this contributes to the social sustainability of the transport system.

5.2. Supportive Policy Environment

Cities worldwide are pursuing policies to reduce car use and prioritize public transit as a means to tackle congestion, air pollution, and greenhouse gas emissions. Particularly, urban rail transit is considered the most effective means of public transportation to deal with these issues. Due to the differentiated travel demands, there is intense competition between private car trips and urban rail transit trips [71]. International experience demonstrates that urban rail transit can have only limited success unless measures are taken to ensure that private vehicles pay for the costs they impose on cities in the form of congestion, traffic accidents, and air pollution. Such measures can take many forms, including parking charges, higher vehicle registration charges, fuel taxes, congestion charges, and restrictions such as limitations on speed and vehicle entry in designated downtown areas. The experts interviewed (Respondent: EX-2b, EX-3) also note that if municipalities are unwilling to take reasonable actions to limit the use of cars in core urban areas, urban rail transit may be unable to compete for choice riders and thus may not be able to achieve their primary objectives. This is no less true in China than it has been elsewhere.

Nevertheless, some cities have been still continuing a series of programs of major roadway expansion that may help fuel an overall move to automobile commuting. There has also been political pressure to relax some parking restrictions in the downtown area. This is broadly consistent with the Chinese experience. Many Chinese cities are going

through a transition phase from accommodating automobiles, often at the expense of other road users, to managing automobiles by actively prioritizing and promoting alternatives. While this broad strategy is now generally accepted at the national level in China, more work needs to be performed at all levels of government to actively manage automobile use in urban areas to achieve the stated goals of an urban rail transit system.

In this context, Chinese cities have been drawing on many successful experiences and have been relatively progressive. In response to a series of transportation issues brought about by rapid urbanization, Chinese cities have made adjustments in their transportation development strategies, leaning toward urban rail transit development.

Limitations on the use of cars in Chinese cities will likely be difficult to achieve since the central government has focused on the development of automobile manufacturing as a national key industry. However, recent efforts in some China cities have shown that municipalities faced with rapidly increasing congestion are willing to implement unpopular policies. For instance, in Suzhou, significant downtown areas have been converted to pedestrian malls with no car access, and a system of traffic impact analysis for new developments has been instituted that can be used to limit parking supply. As well in Nanjing, the program of major roadway expansion in the old town that is supposed to help fuel an overall move to automobile commuting was called off. At the same time, parking fees in some areas of the central city have recently tripled, which led to a rapid response in parking demand numbers. All of the interviewees (Respondent: all) affirmed a growing willingness for policymaking to impose the costs of automobile commuting directly on users.

The transportation experts (Respondent: EX-1, EX-2b, EX-4b) emphasized that the most likely route to follow would be to find appropriate mechanisms for these restrictions, focusing on limiting the use of the vehicle rather than the ownership of the vehicle. Given the rise in vehicle ownership and the continued expansion of road capacity, China's urban rail transit system may not be able to operate without simultaneous vehicle restrictions. The Chinese government needs to strengthen macroeconomic regulation and require whole planning, a unified layout, and rational adjustment of the transportation structure, based on the traffic accessibility and liquidity, noted by one local government leader (Respondent: LAL-6a). These restriction measures are politically difficult but necessary to ensure that urban transportation policies do not run counter to the primary goal of investing in urban rail transit.

5.3. Less-Restrictive Approval Mechanisms

Since 2003, the national approval process framework related to the development of urban rail in China from planning to operation has expanded to the following stages: Rail Network Plan, Construction Plan, Pre-feasibility Study, Feasibility Study, Overall Design, Construction Drawing Design, Construction, and operation. As a mega infrastructure investment project, the Construction Plan, which is the crucial stage for the whole approval process, must comply with a rigorous approval process and need to be approved by the State Council; otherwise, the rail transit project cannot proceed to the next stage.

In order to initiate an urban rail transit project, Chinese mainland cities were required to meet several requirements proposed by the NDRC in 2003 (in Document (2003) No. 81) [46]. The Chinese central government sets strict numerical criteria in national policy to define the ability of a city to undertake urban rail development. A city is only considered eligible to develop a metro or LRT by meeting the required numerical thresholds with respect to population size, transport requirements, and economic development level.

In 2018, the General Office of the State Council of China raised the numerical criteria to tighten the development of urban rail transit, especially for metros and LRTs. Cities have to meet higher standards in fiscal revenue, permanent populations, and economic size to attain approvals from the central government to build subways, said a recent guideline released by the State Council (see Table 7) [46,47]. The most eye-catching section is that only cities with fiscal revenue of more than 30 billion yuan ($4.5 billion), GDP of more than

300 billion yuan, and a permanent urban population of three million or more can apply for subway projects. These numbers are three times that of previous standards decided 15 years ago, setting a much higher threshold for cities to build subways, especially those in less-developed areas. Once the new numerical criteria were increased, cities not meeting the requirements were forced to halt subway planning and construction. Such as: Hohhot, capital of the Inner Mongolia autonomous region, and Xi'an, capital of Shaanxi province, whose subway projects were not approved by the central government in the year the new guideline was promulgated, Baotou, a city of the Inner Mongolia autonomous region, whose metro was called off by the NDRC three months after the start of construction. As well, the new standard means dozens of cities are excluded from consideration for such subway projects. According to the Top 100 Cities in 2017, released by the National Bureau of Statistics, China has 76 cities above the threshold of 300 billion yuan in GDP, of which 73 have more than three million residents. They have to wait for several years for subways to allow the population and fiscal revenue to grow to meet the new standards.

Table 7. Numerical thresholds of criteria for urban rail construction in China.

Declaration for Strengthening Rapid Urban Rail Construction Management (No. 81), 2003			
	Metro	**LRT**	**Streetcar**
Population size	≥3,000,000	≥1,500,000	-
Gross Domestic Product (GDP)	≥CNY 100 billion	≥CNY 60 billion	-
Local government fiscal revenue	≥CNY 10 billion	≥CNY 6 billion	-
Passenger flow scale Peak time, one-way	Peak time, one-way ≥ 30,000 persons/hour	Peak time, one-way ≥ 10,000 persons/hour	-
Initial passenger flow	-	-	-
Declaration for Further Strengthening Rapid Urban Rail Construction Management (No. 52), 2018			
	Metro	**LRT**	-
Population size	≥3,000,000	≥1,500,000	-
Gross Domestic Product (GDP)	≥CNY 300 billion	≥CNY 150 billion	-
Local government fiscal revenue	≥CNY 30 billion	≥CNY 15 billion	-
Passenger flow scale Peak time, one-way	Peak time, one-way ≥ 30,000 persons/hour	Peak time, one-way ≥ 10,000 persons/hour	-
Initial passenger flow	≥7000 persons/day.km	≥4000 persons/day.km	-

Note: data were collected from reference [46,47].

The adjustment of approval criteria creates a regulatory environment that facilitates streetcar development as compared to the other costlier yet higher potential productivity transit modes. By comparison, streetcars are not required to meet the numerical criteria specified (see Table 7). In this context, streetcars are easier to attain permission and are expected to be constructed rapidly and widely across China. Some respondents (Respondent: PL-1a, PL-6b, EX-5, LAL-4, LAL-6a) stated that the streetcar is not limited by the national policy's numerical criteria will "usher in new opportunities for the streetcar" and "lay the foundation for what role the streetcar will play". The Chief Engineer commented (Respondent: EX-6) that if streetcars can meet the needs of a city, then it is not necessary to insist on building subways or LRTs. Because by the time the conditions are met, the streetcar may have been on service for the city for several years.

Another important factor in the urban rail transit approval process is that there are distinctions in the approval procedures for the metro (including LRT) construction and streetcar construction. Specifically, metro/LRT construction requires approval from the General Office of the State Council of China (GoSC) at the national level. In contrast, construction plans for a streetcar system can be approved at either the provincial or municipal Development Reform Commissions without being elevated to the national level,

therefore reducing bureaucratic layers. This led to the argument that a streetcar system is a viable alternative to higher-level urban mass transit because of new policy constraints for higher-level urban rail projects and allowance for local-level decision-making powers. This point emerged from respondent interviews (Respondent: PL-3a, EX-4a, EX-6, LAL-6a) and from academic research [58]. While these motivations are not illegal, they may conflict with the original intent of streetcar implementation as primarily a transportation investment and raises significant questions about the primary goals for streetcar development in the future.

5.4. Goal-Seeking for Streetcar Development

If rapid urbanization is regarded as the external driver for the development of streetcars, the goal-seeking for streetcar implementation is the internal driver for its development in China.

With the wave of streetcar reemergence in China, streetcars are given many glamorous labels, including rapidity, passenger comfort, relatively low construction cost, and environmentally-friendly vehicles. Further, other characteristics have been highlighted as inherent additional advantages: its potential to encourage walkable neighborhoods, providing an effective alternative to private car use, and construction and operational cost advantages when compared to other urban mass transit modes. These advantages are presented in different cities with different key themes and evolved into the expected goals to persuade the decision-makers and government to support streetcars.

5.4.1. Providing a New-Style Transit Service

First, the predominant theme is that the streetcar serves as a new-style public transit mode wherever it is built, and every single project analyzed in this study argued that the streetcar would be a mobility option to the city.

Given the Chinese streetcar's physical and operating characteristics and the fact that it does offer moderate capacity during strong peaks, the expected goal of streetcar implementation in China may be consistent with respect to their functioning as a backbone or feeder line. To further enhance this transportation role's expected goal, streetcars in China typically have semi-dedicated RoW in order to offer more efficient transportation services. The RoW of all the streetcar projects is almost the same (see Figure 1). This means that streetcars in China do not interact with street traffic except at intersections, such as the streetcar operation along New Orleans' St. Charles line or that of many light-rail systems in Europe. That is, it is fundamentally a transportation technology. Message from each project emphasized that the streetcar would benefit urban transit, placing the transportation role as central to planning efforts. The Huaian streetcar, for instance, is said to connect popular destinations as a backbone of the urban transit system and play a useful role in commuter transit modes for work. Likewise, Suzhou state that the Suzhou streetcar line is designed to "serve as an extension of metro system", and that it will be converted to be a feeder line to address a blind zone in metro services once the metro network is formed.

Further, all the projects write streetcars as a form of high-quality transit that can attract new transit users in their Proposal Plan and Feasibility Study Report. The projects refer to streetcars as a comfortable, convenient, reliable, and modern mode of transport, which, in direct contrast to buses, offer a smoother and quieter ride with no smelly and toxic exhaust. Aside from these descriptions, this stamp of high-quality is itself explicitly stated. For example, both Huaian and Shenyang stated that the streetcar project would provide a new perspective on quality transit and encourage people who previously did not see themselves as transit patrons to consider using all forms of transit and establish excellent transit as an important aspect of high quality of life. Or, in Qingdao, the streetcar is argued to increase walkability, which is seen as encouraging safe and vibrant urban street life, and referred to as a supplementary public transport facility serving new districts.

5.4.2. Serving as a Catalyst for Promoting TOD

A second overarching theme that was prominent in all projects documents is that the streetcar's function as a catalyst for promoting TOD. Significantly, while mentions of the streetcar promoting TOD are common, TOD improvement is generally argued either alongside or through an economic and vitality logic.

The reemergence of the streetcar has also led to it being considered a new transportation investment inserted in an existing urban environment [33]. This could result in conflicts between streetcar construction and the existing environment. Consequently, many Chinese cities plan new streetcar routes along the "path of least resistance" [58]—along a wide artery road with no more cars—in newly developing districts, such as the Suzhou National High-tech District Trams, the Hunnan New District Streetcar of Shenyang, and the Tianjin Economic-Technological Development Area streetcar. This approach of route decision increases the expectation of policymakers that streetcar could enhance TOD. The experts (Respondent: EX-1, EX-3, EX-5) emphasized that the motivation behind planning such streetcar is typically development-oriented rather than for addressing traffic congestion. In this model, streetcars are typically associated with spurring economic development, encouraging new commercial and residential investment, attracting new residents, and increasing property values. In order to gain government approval, most feasibility studies and funding applications emphasize the TOD improvement benefits of streetcars, even placing it at the top of the reasons for funding and pursuing streetcars. What becomes clear from the analysis is the confident and consistent argument that a streetcar would be an economic boon for its environs. For instance, Qingdao's documents pointedly argue the TOD development potential of streetcars through subheadings such as streetcars provide "more accessibility" for the new district to "encourage new commercial and residential investment" and "stimulate the vitality of the new areas". Likewise, Nanjing and Shenyang have written the role of 'promoting TOD' as a secondary goal in their streetcar planning report. Furthermore, Suzhou has taken 'promoting TOD' as one of the guidelines for streetcar route planning in their reports.

5.4.3. Serving as a Symbol for Improving Urban Quality

A comparison of the streetcar projects found that the streetcar's role as a symbol to improve urban quality is another notable goal that emerges from the analysis of project documents and interviews, yet this occurs when there are already adequate and diverse public transit services. This theme is typically associated with vibrant and livable urbanity, progressive and world-class city image, and quality of life.

Due to the lesser weight and smaller scale, the operating and construction costs of streetcar are lower than for heavy rail. The smaller scale means streetcar can penetrate into city centers without the need for heavy investments in underground infrastructure such as required for the metro or LRT, stated by some planners and experts interviewed (Respondent: PL-1b, EX-1, EX-4a, EX-5, PL-6a). The physical and operational characteristics of the streetcar provide great flexibility in developing route alignment options. The streetcar vehicles can generally operate effectively in shared traffic lanes with automobiles, allowing consideration of much of the local street network for streetcar use. The quiet nature of the vehicles makes them compatible with most types of land uses found along downtown streets. Furthermore, streetcars are considered as a unique alternative transportation mode, which expands the boundaries of downtown, enriches the community's sense of place, expands walkability options, and strengthens a vibrant and dense urban environment where more people can live, work, visit and enjoy the community (Respondent: PL-2, EX-2a, PL-3b). From the interview, many respondents (Respondent: PL-2, EX-2a, EX-3, EX-4a, LAL-4, LAL-6a) noted the use of the streetcar could advance the city's image as a progressive and robust community symbol and market a city to tourists, conventioneers, and other visitors. For instance, The Shenyang streetcar's website states that the "streetcar makes transit to be a life-style". Likewise, Nanjing operated its first streetcar just before the opening of the 2014 Nanjing Youth Olympic Games (YOG) due to the fact that the streetcar

provided both a transit service and projected "an image of a modern and innovative city to show Nanjing city to the world during the YOG". It is worth mentioning that the expected goal of the streetcar to improve the city image is deemed to be an additional benefit rather than a fundamental objective for the streetcar project. For instance, the official website of the Huai'an Modern Tram states that the streetcar is "a new-style mode of public transit", and then it will "become a city name card to show the image of the city".

5.5. Potential Inter-City Competition

The transition from state socialism to a market economy has posed great challenges to cities in China. Cities are keen on inter-city competition instead of cooperation [72,73]. Cities compete in many ways [74]. In the competition to attract investment to their cities, local governments are keen on enhancing the attractiveness and competitiveness of the city. Those cities that are already experienced and well advanced in their transportation planning practices may serve as role models for follower cities, and this raises pressure on laggard cities that have not been considered to adapt their transportation planning practices [75]. A social survey conducted by the Social Survey Center of China Youth Daily in 2008 found that 84.1% of the 4702 respondents considered the urban rail transit is a key symbol of modernization of the city and an obvious way to experience urban life [76]. The public discourse echoed the perspective of "improving the city image" from the respondents in our study. In our interview, the local officials (Respondent: LAL-2b, LAL-6b) regarded the urban rail transit as a key feature of modern cities, and this perception makes cities with and without urban rail transit projects different. Therefore, as a transportation expert noted (Respondent: EX-6), the pursuit of a better life is the original intention of urban development, and no city is willing to be the laggard.

When considering urban rail transit development as a brand of modern metropolis and a "best practice" for local growth, no city is willing to fall behind in the urban rail development. While, regarding whether there was an inter-city competition, the responses from all the interviewees are vague. There were no distinct inter-city competitions in streetcar proposal plan approvals since the government's approvals of one streetcar project proposal would not cause the denial of others. However, the potential inter-city competition would become noticeable when all other cities in the region of the same level and scale had rail transit approved or operated except the city. One transit expert (Respondent: EX-4b) described that once one city makes the achievements of best practice adoption in streetcars, all cities are motivated to gain experience from it, aiming to chase it and surpass it.

Notably, low-carbon travel and eco-transportation planning, epitomizing sustainable development, has become a catchphrase in contemporary Chinese New-style Infrastructure Construction policy. Thus, the rapid policy response without lagging behind may have further motivated the initial pursuit of mega-project development, such as a streetcar, from the side of local leaders. An example was made to describe how this kind of competition emerged: When the interviews referred to the development of streetcar in other cities, the municipal leaders of Jiaxing interviewed (Respondent: LAL-6a) strongly ask rhetorically about that "why my city cannot build a streetcar [when it has] the same development level?" At the time of the interview, Jiaxing did not yet operate streetcars, while during the past decade, all other prefectural-level cities in the Yangtze River Delta Metropolitan Area had been operating or been approved to develop their own urban rail systems. Table 8 shows that Jiaxing economically performed as well as these cities in terms of local economic power in the current situation. This led to the proposal of streetcars in Jiaxing and resulted in the achievement of putting it into operation today, two years later.

Table 8. Comparison of major economic and population indicators for eight cities in Yangtze River Delta Metropolitan Area.

Indicators		Approval of Urban Rail Project Proposal			Current Situation (Data in 2020)		
City	Time	Population in Urban Area (Million)	GDP (Billion CNY)	Planned Mileage (km)	Completed Mileage (km)	Population in Urban Area (Million)	GDP (Billion CNY)
Suzhou	2007	2.353	591.43	210.13	186.6	6.716	2017.05
Wuxi	2008	2.374	446.06	114.46	88.6	7.464	1237.04
Changzhou	2012	2.305	396.99	53.54	28	3.866	780.53
Xuzhou	2013	3.135	541.98	64.22	71.7	3.208	731.98
Nantong	2014	2.128	565.27	59.55	60	3.144	1003.63
Ningbo	2008	2.201	396.41	247.5	124.7	3.063	1240.87
Shaoxing	2016	2.198	471.02	264.6	44.9	2.242	600.10
Jiaxing						3.674	550.95

Notes: data on local population as well as economic power in the years when approval was gained to build a metro system and in 2020 were collected from the statistic yearbooks of Suzhou, Wuxi, Changzhou, Xuzhou, Nantong, Ningbo, Shaoxing and Jiaxing published by local authorities; mileage data were collected from Statistical Yearbooks of Urban Rail Transit published by the China Association of Metros.

6. Conclusions

Delving into the motivations of transport infrastructure development in Chinese cities is relatively unique in the literature, and this study aims to study the rise of streetcar development from socioeconomic, environmental, and political aspects. Drawing on an analysis of local planning documents, relevant socioeconomic data comparisons, and in-depth interviews with elite figures, including both local decision-makers and planning experts in our case study, we conducted the study on the motivations of the reemergence of streetcars in China. Five core themes are proposed and discussed that contribute to an explanation of the reemergence in terms of essential requirements, policy environment, expected goals, potential driving forces, and direct causes of the development.

The increasing traffic demands and changing strategic preference of urban transportation development caused by China's rapid urbanization make the construction of more streetcar projects to be essential. On the one hand, the Chinese government has to take active actions to develop rail transit, including streetcars, to cope with the increasing traffic demands and issues. On the other hand, the favorable macro-economy and strategical policy inclination make it possible for Chinese cities to vigorously develop streetcar construction.

In addition, the Chinese central government sets strict numerical criteria in national policy to define the ability of a city to undertake urban rail transit. A city is only considered eligible to develop urban rail transit by meeting the required numerical thresholds with respect to population size, transport requirements, and economic development level. Yet, the streetcar is an exception, with no need regarding the national approval criteria and approval decision-making at the state level. This indirectly ushers in new opportunities for the streetcar in China. This driving effect is mainly manifested as creating a regulatory environment that facilitates streetcar development as compared to the other costlier yet higher potential productivity transit modes.

Furthermore, we see that the development of such a relatively mega-project often reflects a goal-seeking strategy that, with some issues as point of departure, the solution may be that streetcar should be implemented, and other goals could equally well arise. In China, this distribution of goal-seeking for streetcar development is expected to primarily accrue through improved transit mobility and travel accessibility. There are also additional benefits of promoting economic improvements and the city's image. Still, considering streetcar development as a showcase for the urban development level, in which no one city wants to fall behind, has made local politicians willing to chase such projects. This means that inter-city competition acted as an invisible but key driving force for the will of embarking on streetcar amongst local decision-makers.

Typical for case studies, there were limitations in the range and design of this qualitative case study. Future studies should include more interviews about both the future development of other cities' ongoing streetcar projects and about the development review of operating streetcar systems. In addition, statistics and analyses of relevant operating, performance, land-use, urban design, demographic and socioeconomic data should be applied in future research. This requires overcoming the significant barrier caused by limited data about Chinese streetcar projects. In the current contexts of new-style urbanization in China, decision-makers at both the central and local levels ought to evaluate these ambitious urban mega-projects with an in-depth understanding of the economic–political reasons and motivations behind them and work towards their life-cycle sustainability. This is a major concern that informs this study's recommendations and is especially relevant when more than 425 km of additional streetcar lines are being planned and constructed in China.

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