Transportation policy profiles of Chinese city clusters - guest contribution

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Registered offices:
Bonn and Eschborn

Address:
Tayuan Diplomatic Office Building 2-5
14 Liangmahe South Street, Chaoyang District
100600 Beijing, P. R. China
T +86 (0)10 8527 5589
F +86 (0)10 8527 5591
E info@giz.de
I www.sustainabletransport.org

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Responsible:
Alexander von Monschaw, GIZ China

Layout and Editing:
Elisabeth Kaufmann, GIZ China

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In Brief

Transportation experts at MIT have developed new insights into how decision makers in hundreds of Chinese cities design and adopt policies relating to transportation — policies that could together curtail the rapidly growing demand for personal vehicles in China. Based on a mathematical analysis of historical data plus text analysis of policy reports, the team concludes that Chinese cities that have experienced similar urban development and motorization trends over time prioritize the same types of transportation policies to deal with their local conditions. Such a pattern is of interest to urban decision makers seeking role models for developing transportation policies.

In addition to looking to Beijing and Shanghai — the trendsetters for innovative policymaking — decision makers can now learn by working with cities that face transportation challenges more similar to their own. The researchers' novel methodology combining data and text analysis can be applied in other rapidly developing countries with heterogeneous urban areas.

Abstract

Chinese cities have experienced diverse urbanization and motorization trends that present distinct challenges for municipal transportation policymaking. However, there is no systematic understanding of the unique motorization and urbanization trends of Chinese cities and how physical characteristics map to their transportation policy priorities. The authors adopt a mixed-method approach to address this knowledge gap. They conduct a time-series clustering of 287 Chinese cities using eight indicators of urbanization and-motorization from 2001 to 2014, identifying four distinct city clusters.

Moody et al. compile a policy matrix of 21 policy types from 44 representative cities and conduct a qualitative comparison of transportation policies across the four city clusters. They find clear patterns among policies adopted within city clusters and differences across clusters. Wealthy megacities (Cluster 1) are leveraging their existing urban rail with multimodal integration and transit-oriented development, while more car-oriented wealthy cities (Cluster 2) are building urban rail and discounting public transport. Sprawling, medium-wealth cities (Cluster 3) are opting for electric buses and the poorest, dense cities with low mobility levels (Cluster 4) have policies focused on road-building to connect urban cores to rural areas. Transportation policies among Chinese cities are at least partially reflective of urbanization and motorization trends and policy learning needs to account for these distinct patterns in both physical conditions and policy priorities. Their mixed-method approach (involving time-series clustering and qualitative policy profiling) provides a way for government officials to identify peer cities as role models or collaborators in forming more targeted, context-specific, and visionary transportation policies.

Transportation policymaking in Chinese cities

In recent decades, urban populations in China's cities have grown substantially, and rising incomes have led to a rapid expansion of car ownership. Indeed, China is now the world's largest market for automobiles. The combination of urbanization and motorization has led to an urgent need for transportation policies to address urban problems such as congestion, air pollution, and greenhouse gas emissions.

For the past three years, an MIT team led by Joanna Moody PhD '19, research program manager of the MIT Energy Initiative's Mobility Systems Center, and Jinhua Zhao PhD '09, the Edward H. and Joyce Linde Associate Professor in the Department of Urban Studies and Planning (DUSP) and director of MIT's JTL Urban Mobility Lab, has been examining transportation policy and policy-making in China. "It's often assumed that transportation policy in China is dictated by the national government," says Zhao. "But we've seen that the national government sets targets and then allows individual cities to decide what policies to implement to meet those targets."

Many studies have investigated transportation policymaking in China's megacities like Beijing and Shanghai, but few have focused on the hundreds of small- and medium-sized cities located throughout the country. So Moody, Zhao, and their team wanted to consider the process in these overlooked cities. In particular, they asked: How do municipal leaders decide what transportation policies to implement, and can they be better enabled to learn from one another's experiences? The answers to those questions might provide guidance to municipal decision makers trying to address the different transportation-related challenges faced by their cities.

The answers could also help fill a gap in the research literature. The number and diversity of cities across China has made performing a systematic study of urban transportation policy challenging, yet that topic is of increasing importance. In response to local air pollution and traffic congestion, some Chinese cities are now enacting policies to restrict car ownership and use, and those local policies may ultimately determine whether the unprecedented growth in nationwide private vehicle sales will persist in the coming decades.

Policy learning

Transportation policymakers worldwide benefit from a practice called policy-learning: Decision makers in one city look to other cities to see what policies have and haven't been effective. In China, Beijing and Shanghai are usually viewed as trendsetters in innovative transportation policymaking, and municipal leaders in other Chinese cities turn to those megacities as role models.

But is that an effective approach for them? After all, their urban settings and transportation challenges are almost certainly quite different. Wouldn't it be better if they looked to "peer" cities with which they have more in common?

Moody, Zhao, and their DUSP colleagues — postdoc Shenhao Wang PhD '20 and graduate students Jungwoo Chun and Xuenan Ni MCP '19, all in the JTL Urban Mobility Lab — hypothesized an alternative framework for policy-learning in which cities that share common urbanization and motorization histories would share their policy knowledge. Similar development of city spaces and travel patterns could lead to the same transportation challenges and therefore to similar needs for transportation policies.

To test their hypothesis, the researchers needed to address two questions. To start, they needed to know whether Chinese cities have a limited number of common urbanization and motorization histories. If they grouped the 287 cities in China based on those histories, would they end up with a moderately small number of meaningful groups

of peer cities? And second, would the cities in each group have similar transportation policies and priorities?

Grouping the cities

Cities in China are often grouped into three "tiers" based on political administration, or the types of jurisdictional roles the cities play. Tier 1 includes Beijing, Shanghai, and two other cities that have the same political powers as provinces. Tier 2 includes about 20 provincial capitals. The remaining cities — some 260 of them — all fall into Tier 3. These groupings are not necessarily relevant to the cities' local urban and transportation conditions.

Moody, Zhao, and their colleagues instead wanted to sort the 287 cities based on their urbanization and motorization histories. Fortunately, they had relatively easy access to the data they needed. Every year, the Chinese government requires each city to report well-defined statistics on a variety of measures and to make them public.

Among those measures, the researchers chose four indicators of urbanization — gross domestic product (GDP) per capita, total urban population, urban population density, and road area per capita — and four indicators of motorization — the number of automobiles, taxis, buses, and

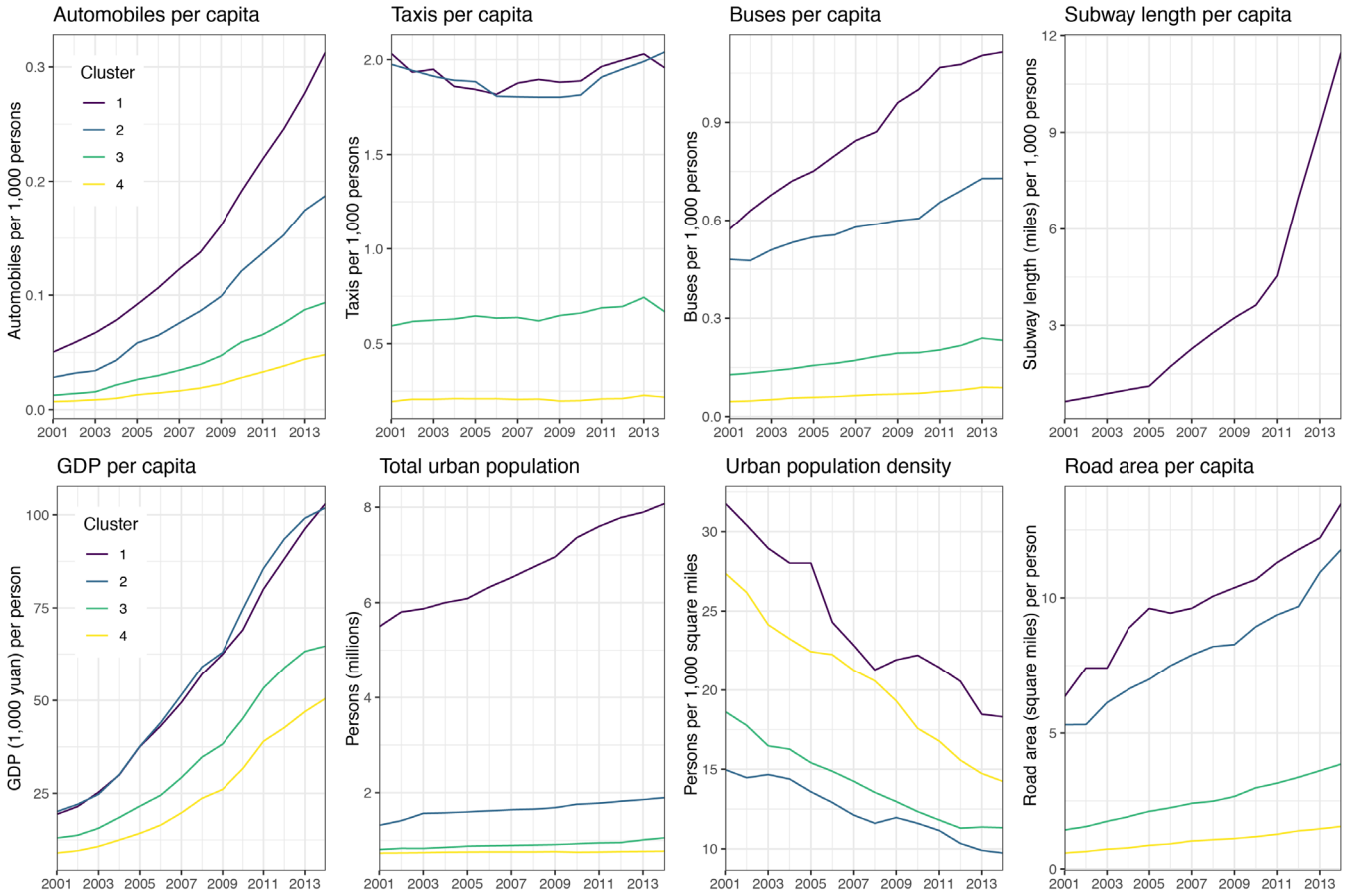

Figure 1: Trajectories of the eight motorization and urbanization indicators used in the clustering analysis. These curves show the average time series trajectories of the four city clusters on the four motorization indicators (top row) and four urbanization indicators (bottom row) that the researchers used in their clustering analysis for the 287 Chinese cities. The "Subway length per capita" display shows data for only Cluster 1 cities; the other three clusters had no subway systems by 2014 so would all appear at zero. Moody et al. 2019: 4.

subway lines per capita. They compiled those data from 2001 to 2014 for each of the 287 cities.

The next step was to sort the cities into groups based on those historical data sets — a task they accomplished using a clustering algorithm. For the algorithm to work well, they needed to select parameters that would summarize trends in the time series data for each indicator in each city. They found that they could summarize the 14-year change in each indicator using the mean value and two additional variables: the slope of change over time and the rate at which the slope changes (the acceleration).

Based on those data, the clustering algorithm examined different possible numbers of groupings, and four gave the best outcome. "With four groups, the cities were most similar within each cluster and most different across the clusters," says Moody. "Adding more groups gave no additional benefit.". The four groups of similar cities are as follows.

Cluster 1: 23 large, dense, wealthy megacities that have urban rail systems and high overall mobility levels over all modes, including buses, taxis, and private cars. This cluster encompasses most of the government's Tier 1 and Tier 2 cities, while the Tier 3 cities are distributed among Clusters 2, 3, and 4.

Cluster 2: 41 wealthy cities that don't have urban rail and therefore are more sprawling, have lower population density, and have auto-oriented travel patterns.

Cluster 3: 134 medium-wealth cities that have a low-density urban form and moderate mobility fairly spread across different modes, with limited but emerging car use.

Cluster 4: 89 low-income cities that have generally lower levels of mobility, with some public transit buses but not many roads. Because people usually walk, these cities are concentrated in terms of density and development.

The figure 1 plot the central trajectories for the four clusters on each of the eight urbanization and motorization indicators used in the analysis. For every indicator, there are clear differences in the trajectories of the four clusters.

City cluster and policy priorities

The researchers' next task was to determine whether the cities within a given cluster have transportation policy priorities that are similar to each other — and also different from those of cities in the other clusters. With no quantitative data to analyze, the researchers needed to look for such patterns using a different approach.

First, they selected 44 cities at random (with the stipulation that at least 10% of the cities in each cluster had to be represented). They then downloaded the 2017 mayoral report from each of the 44 cities.

Those reports highlight the main policy initiatives and directions of the city in the past year, so they include all types of policymaking. To identify the transportation-oriented sections of the reports, the researchers performed keyword searches on terms such as transportation, road, car, bus, and public transit. They extracted any sections highlighting transportation initiatives and manually labeled each of the text segments with one of 21 policy types. They then created a spreadsheet organizing the cities into the four clusters. Finally, they examined the outcome to see whether there were clear patterns within and across clusters in terms of the types of policies they prioritize.

"We found strikingly clear patterns in the types of transportation policies adopted within city clusters and clear differences across clusters," says Moody. "That reinforced our hypothesis that different motorization and urbanization trajectories would be reflected in very different policy priorities.".

Figure 2 provides an overview of the cluster, their characteristics and their transportation policy profiles of the year 2017. For a detailed listing and description of the city cluster, see the following pages.

Cluster	Characteristics	Transportation policy priorities in 2017
Cluster 1	– 23 cities, most of the Tier 1 and Tier 2 cities – Large, dense, wealthy megacities – Rapid growth of population & GDP and heavy urban rail – Highest overall mobility levels	– Expanding existing urban rail and improving bus services – Improving multimodal connectivity through transfer hubs and nonmotorized transport – Only Cluster to mention transit-oriented development (TOD) – Intelligent transport systems and traffic demand management (TDM) – Continuing to invest in urban expressways
Cluster 2	– 41 cities – Low-density, sprawling and wealthy cities – Rapid growth of GDP but not population – Auto-oriented pattern of mobility – Increasing urban sprawl by significant investment in road infrastructure	– Developing new urban rail – Intelligent transportation systems and TDM – Improving and expanding (clean energy) bus service – Continuing to invest in urban expressways – Providing public transport discounts to decrease auto-oriented travel
Cluster 3	– 134 medium-wealth cities (the "most common city in China") – Low-density – Moderate mobility, limited but emerging car use	– Emphasizing clean energy (electric) buses – Improving and expanding bus service – Continuing significant investment in additional parking spaces as well as in urban expressways and rural roads
Cluster 4	– 89 low-income cities – High density and low-wealth cities ("walking" cities) – Low levels of mobility. Lowest number of buses & taxis with highest growth in automobiles – Lowest levels and growth of road investment	– Expanding road development to connect the urban core to rural areas on the periphery – Prioritizing interconnection with other cities in the region by heavy investments in roads, intercity highways, intercity rails and airports

Figure 2: Overview of the Chinese city clusters, their characteristics and their transportation policy priorities. Own illustration based on Moody et al. 2019: 6.

Cluster 1 - wealthy dense mega cities with high mobility

The cities in Cluster 1 have urban rail systems and are starting to consider policies around them. For example, how can they better connect their rail systems with other transportation modes — for instance, by taking steps to integrate them with buses or with biking and walking infrastructure? How can they plan their land use and urban development to be more transit-oriented, such as by providing mixed-use development around the existing rail network?

	Nanjing	Wuxi	Suzhou	Shenyang	Guangzhou	Shenzhen	Foshan	Dongguan	Zhongshan	Harbin	Chongqing	Chengdu	Kunming
Completed urban rail lines	X	X	X	X	X	X		X		X	X	X	X
Planned/ongoing urban rail construction	X	X	X	X	X	X	X	X	X	X		X	X
Multimodal (transfer) hubs	X	X	X		X	X		X					
Transit-oriented development					X		X	X	X				
Increase public transit mode share	X	X					X						X
Public transport discount													
New or optimized bus routes	X	X	X	X	X	X	X	X	X	X	X		X
“bus metropolis”				X	X					X			X
Clean energy buses	X	X	X	X						X		X	
Clean energy cars and/or charging infrastructure					X	X	X		X				X
Public bike share	X	X					X	X					X
Bike lanes and greenways												X	X
Non-motorized transport				X	X			X				X	
Intelligent transportation system	X		X	X			X	X	X			X	X
Traffic demand management (TDM) / signage				X			X	X	X			X	X
Urban roads/expressway	X	X	X	X	X	X	X		X	X	X	X	X
Additional parking spaces	X			X			X			X			X
Rural roads										X			
Intercity highway	X								X				
Intercity (high-speed) railway	X				X			X		X	X		X
Airport							X	X		X	X		X

Figure 3: Policy priority matrix for the 13 representative cluster 1 cities. Moody et al. 2019: 10.

Cluster 1 cities are characterized by high urbanization and motorization trends across all modes and are particularly distinguished by the existence of urban rail systems by 2014 (see Figure 1).

Laying out the transportation policy profile of a subset of these Cluster 1 cities, we see that these high urbanization and motorization levels are accompanied by active policymaking and huge investments across all modes of transportation (see Figure 3). In line with the subway per capita physical characteristic used in the clustering analysis, Cluster 1 cities are the only cities to highlight completed urban rail lines in their city government reports. Furthermore, 12 of the 13 cities highlight planned or ongoing expansion of these existing urban rail systems.

In addition to massive investment in urban rail, every single selected city from Cluster 1 highlights the purchase of new buses, the addition of new bus lines (on dedicated infrastructure), and the optimization or increased frequency on current bus routes. Multiple cities use the term "bus metropolis" to highlight their strategy of expanding bus-based public transit infrastructure in addition to urban rail lines. They also have a much greater focus on multimodal transfer hubs between rail, bus, and non-motorized or "slow" or "green" modes of transport. Cluster 1 cities have the highest mention of public bike share systems and the prioritization of non-motorized transport. Furthermore, Cluster 1 cities are the only cities (with the exception of Urumqi in Cluster 2) to mention transit-oriented development (TOD) and therefore to recognize the key connection between transportation and land use.

While there is a clear focus on public transit expansion as well as increasing mode share for public transit and non-motorized transport, almost every single city from Cluster 1 also mentions significant investment in new urban expressways, roads, and bridges in their government reports.

Figure 4: The city of Nanjing, Jiangsu Province.

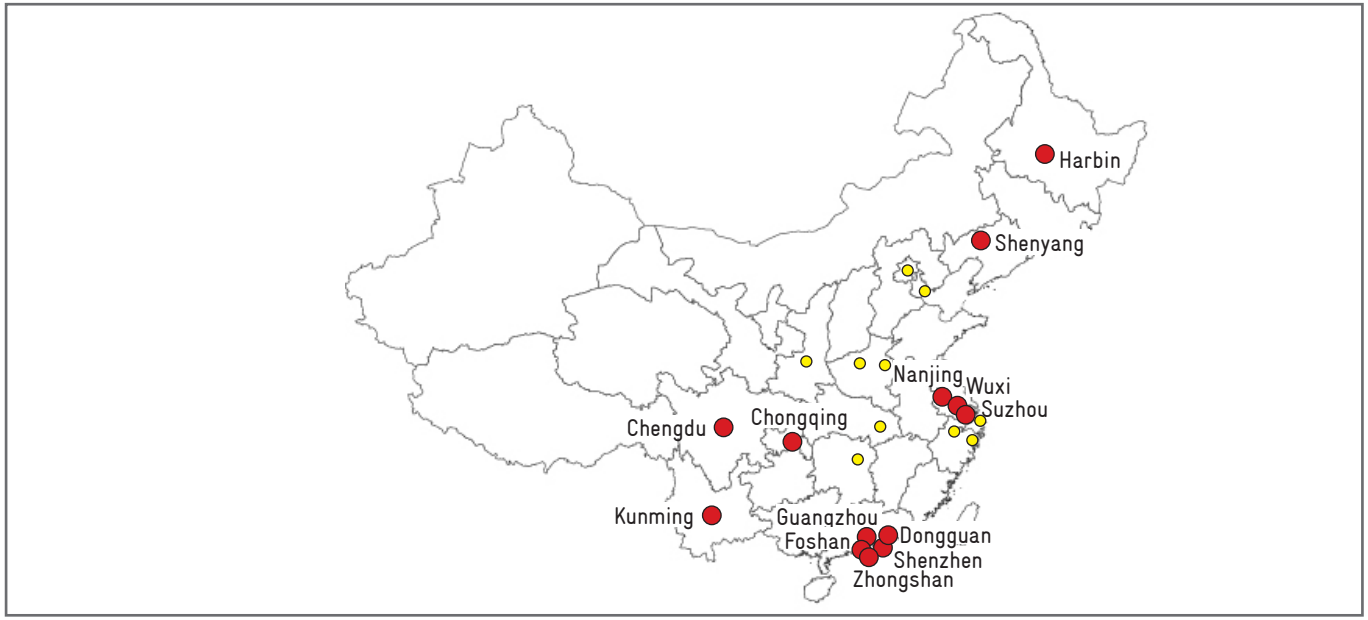

Figure 5: Overview of the 13 representative cities of the Chinese city cluster 1 (in total 23).

Cluster 2 - wealthy sprawling medium-sized auto-oriented cities

Cluster 2 cities are building urban rail systems, but they're generally not yet thinking about other policies that can come with rail development. They could learn from Cluster 1 cities about other factors to take into account at the outset. For example, they could develop their urban rail with issues of multi-modality and of transit-oriented development in mind.

	Changzhou	Urumqi	Jinan	Qingdao	Weihai	Karamay	Daqing	Zhuhai	Dalian
Completed urban rail lines									
Planned/ongoing urban rail construction	X	X	X	X				X	X
Multimodal (transfer) hubs					X				
Transit-oriented development		X							
Increase public transit mode share	X								
Public transport discount			X	X	X			X	
New or optimized bus routes		X	X	X	X	X	X	X	
"bus metropolis"		X							
Clean energy buses			X	X	X			X	X
Clean energy cars and/or charging infrastructure			X						
Public bike share			X						
Bike lanes and greenways								X	
Non-motorized transport			X	X					
Intelligent transportation system		X	X	X	X			X	X
Traffic demand management (TDM)/signage			X					X	X
Urban roads/expressway	X	X	X	X	X		X	X	
Additional parking spaces				X	X				
Rural roads							X		
Intercity highway		X					X		
Intercity (high-speed) railway	X	X	X		X	X	X		
Airport	X	X			X	X	X	X	X

Figure 6: Policy priority matrix for the nine representative cluster 2 cities. Moody et al. 2019: 11.

Cluster 2 cities are wealthy, medium-sized cities that have lower density and more auto-oriented mobility patterns than their Cluster 1 counterparts. While the presence of subway lines per capita (by 2014) was a key differentiator of Cluster 1 cities from Cluster 2 cities in the clustering analysis, it is clear that the transportation policy priorities of Cluster 2 cities includes development of new urban rail systems (see Figure 6).

While no city mentioned completed urban rail lines, most (7 out of 9) highlighted planned or ongoing urban rail construction in their 2017 city government reports. However, the policy priorities of these cities suggest that many are as focused on improving and expanding bus services as they are on urban rail development. All but one city (Dalian) mentioned new or optimized bus routes. Taken together, this suggests that Cluster 2 cities are focused on improving public transit mode share through new infrastructure development. Interestingly, the only 4 cities in the qualitative policy matrix that mention public transport discounts are all in Cluster 2, suggesting that infrastructure investment is being complemented by other policies to improve public transit mode share. Despite continued investment in urban roads, this suggests that Cluster 2 cities are looking to move away from existing auto-oriented mobility patterns to foster greater public transit mode share. Notably, this push for new public transit infrastructure is not complemented by discussion of multimodal integration or TOD as seen in Cluster 1.

Weihai, Karamay, and Daqing do not mention planned or ongoing urban rail construction, instead focusing public transit investment on new and optimized bus routes. While supplemental searches of additional policy documents suggest that Weihai and Daqing have released plans for urban rail for 2020 and 2030, these cities are outliers to the overall trends discussed above for other Cluster 2 cities.

Figure 7: The city of Zhuhai, Guangdong Province.

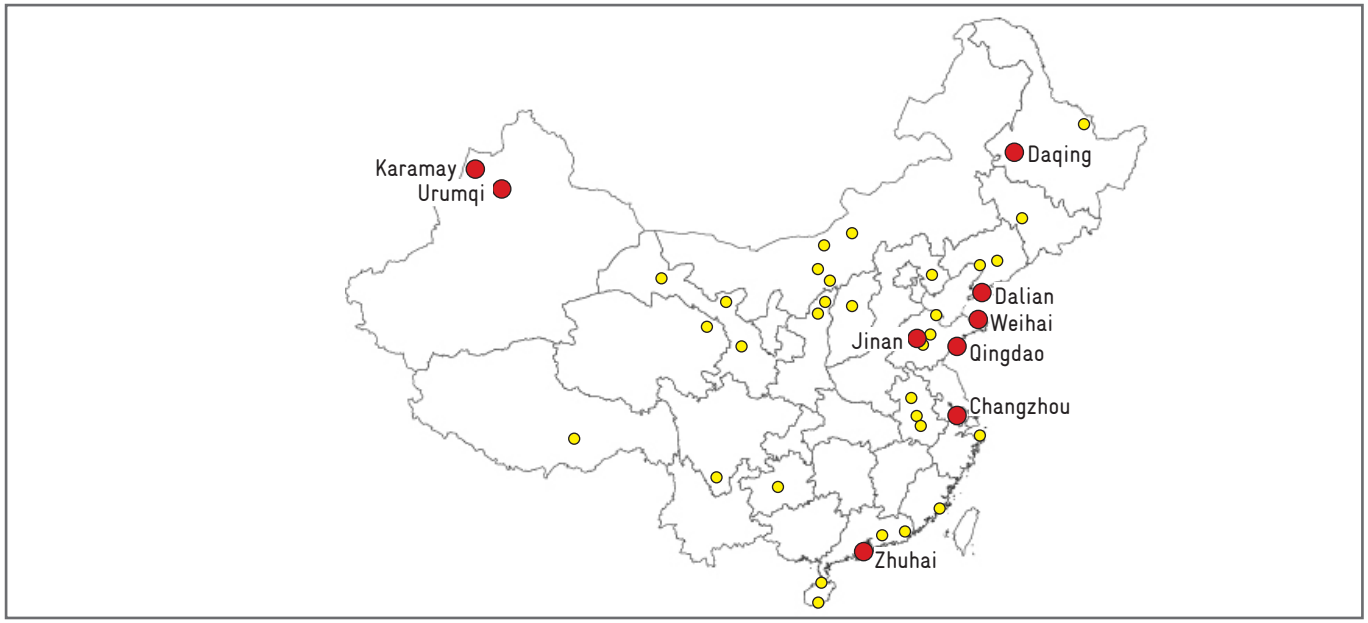

Figure 8: Overview of the nine representative cities of the Chinese city cluster 2 (in total 41).

Cluster 3 – the „most common city" with moderate mobility and low-density

In Cluster 3 cities, policies tend to emphasize electrifying buses and providing improved and expanded bus service. In these cities with no rail networks, the focus is on making buses work better.

	Rizhao	Linyi	Zigong	Yuxi	Weifang	Tieling	Lianyungang	Yangzhou	Dandong	Jinzhou	Jining	Mudanjiang	Anshan	Jiamusi
Completed urban rail lines														
Planned/ongoing urban rail construction														
Multimodal (transfer) hubs														
Transit-oriented development														
Increase public transit mode share							X	X						
Public transport discount														
New or optimized bus routes	X		X				X	X						
"bus metropolis"								X						
Clean energy buses	X				X	X	X	X	X	X	X		X	X
Clean energy cars and/or charging infrastructure	X			X			X				X			
Public bike share	X										X			
Bike lanes and greenways				X			X							
Non-motorized transport	X													
Intelligent transportation system	X		X					X					X	
Traffic demand management (TDM) /signage	X						X	X	X					
Urban roads/expressway		X				X		X			X	X		X
Additional parking spaces	X		X				X	X	X	X	X	X	X	X
Rural roads		X	X	X	X	X	X	X		X				
Intercity highway	X	X	X								X			
Intercity (high-speed) railway		X		X							X		X	
Airport		X									X			

Figure 9: Policy priority matrix for the 14 representative cluster 3 cities. Moody et al. 2019: 12.

Cluster 3 cities are low-density, medium-wealth cities with moderate mobility. This cluster represents the largest number of Chinese cities (in total 134), which are distinguished by their moderate-to-low levels across all urbanization and motorization indicators (see Figure 1). From the relative sparseness in Figure 9, we see that these cities only have a moderate focus on transportation in their 2017 city government reports. Unlike Cluster 1 and Cluster 2 cities, cities in Cluster 3 make no mention of either ongoing or planned urban rail construction. Instead, the public transit focus is on expanding and optimizing bus routes. Of all clusters, Cluster 3 cities have the greatest focus on clean energy buses, with 10 out of the 14 representative cities highlighting ongoing or planned procurement of electric buses.

While the 2017 city government reports in Cluster 3 highlight clean energy bus systems, they also show competitive investment in car-oriented (rather than public-transit-oriented) infrastructure. Cluster 3 cities have the highest mention of additional parking facilities compared to cities in the other clusters, with 10 out of the 14 representative cities referring to recent, ongoing, and/or planned parking space development. In addition, Cluster 3 cities also mention the construction of rural and urban roads. The relative focus between these two competing investment interests could have significant impact on how the motorization and urbanization in these cities continue to develop. Although the within-cluster patterns discussed above are clear, there is also significant variation among the representative cities in Cluster 3. In particular, three cities — Linyi, Yuxi, and Mudanjiang — appear to be outliers from the general trend of (clean energy) bus-focused public transport development in the other Cluster 3 cities.

These cities do not highlight bus investment (in terms of new routes or new fleets) in their 2017 government reports, instead Linyi and Mudanjiang focus exclusively on urban and rural road development while Yuxi mentions clean energy cars (private electric passenger vehicles) and bike lanes.

Figure 10: Aerial photo of the city of Yuxi, Yunnan Province.

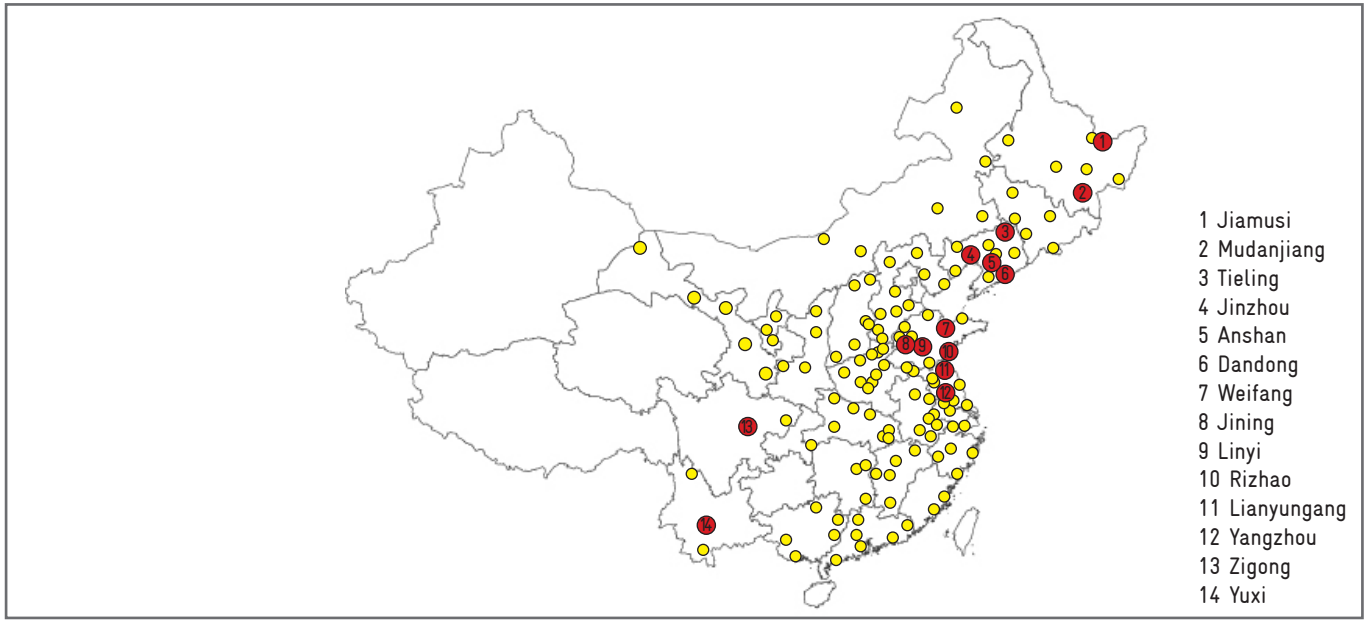

Figure 11: Overview of the 14 representative cities of the Chinese city cluster 3 (in total 134).

Cluster 4 - dense „walking“ cities with low levels of mobility and wealth

Cluster 4 cities are still focused on road development, even within their urban areas. Policy priorities often emphasize connecting the urban core to rural areas and to adjacent cities — steps that will give their populations access to the region as a whole, expanding the opportunities available to them.

	Suihua	Qujing	Bazhong	Ya'an*	Baoshan	Yibin	Zhaotong	Nanchong
Completed urban rail lines								
Planned/ongoing urban rail construction								
Multimodal (transfer) hubs								
Transit-oriented development								
Increase public transit mode share								
Public transport discount								
New or optimized bus routes					X	X	X	X
“bus metropolis”								
Clean energy buses								X
Clean energy cars and/or charging infrastructure	X							X
Public bike share								
Bike lanes and greenways								
Non-motorized transport								
Intelligent transportation system								
Traffic demand management (TDM)/signage								
Urban roads/expressway	X							
Additional parking spaces					X			
Rural roads	X	X	X		X		X	X
Intercity highway	X	X	X		X	X	X	X
Intercity (high-speed) railway	X	X	X		X	X	X	
Airport	X	X	X		X	X	X	X

*Ya'an had only one reference to transportation in the city government report, stating the goal to become the “West Sichuan transportation hub”.

Figure 12: Policy priority matrix for the eight representative cluster 4 cities. Moody et al. 2019: 12.

Cluster 4 cities are smaller, lower-income cities with dense urban cores and relatively low mobility patterns across all modes (see Figure 1). Overall, transportation policy is less of a priority among these cities compared to cities in other clusters as evidenced by very few transportation policies being highlighted in the city government reports (see Figure 12).

While some of these cities (about half) highlight efforts to optimize existing (mixed-traffic) bus routes within the urban core, their transportation policy priorities are much more focused on interconnections with the rural areas on the periphery of their urban core and with other cities in the region. For example, 6 of the 8 cities mention construction of significant lengths of rural roads (2500–8000 km in the past 5 years), with most cities planning to construct more. In addition to rural roads, 7 cities mention construction of expressways/highways and 4 mention the development of intercity rail to help connect the city with economic opportunities in other cities and parts of the region. Another key piece of the transportation policy profile of these cities is the construction of new, domestic airports to help solidify the city's position as a regional transportation hub.

While not highlighted in Figure 9, it was also observed that cities in Cluster 4 mentioned PPPs as a potential way to finance new transport and other infrastructure projects more than cities in other clusters (potentially to supplement their more limited municipal resources).

Figure 13: The city of Qujing, Yunnan Province.

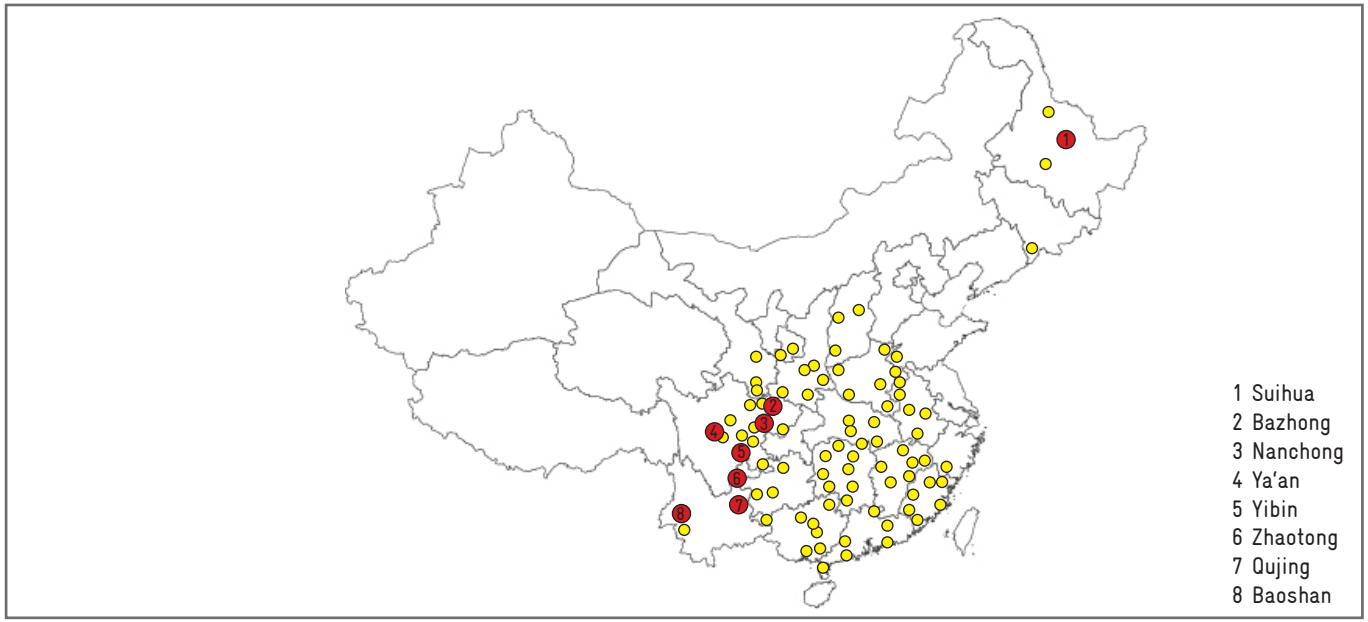

Figure 14: Overview of the eight representative cities of the Chinese city cluster 4 (in total 89).

Annex: Overview of the four clusters and the cities

Cluster 1

CITY	PROVINCE
Beijing	Beijing
Changsha	Hunan
Chengdu	Sichuan
Chongqing	Chongqing
Dongguan	Guangdong
Foshan	Guangdong
Guangzhou	Guangdong
Hangzhou	Zhejiang
Harbin	Heilongjiang
Kunming	Yunnan
Nanjing	Jiangsu
Ningbo	Zhejiang
Shanghai	Shanghai
Shenyang	Liaoning
Shenzhen	Guangdong
Suzhou	Anhui
Suzhou	Jiangsu
Tianjin	Tianjin
Wuhan	Hubei
Wuxi	Jiangsu
Xian	Shaanxi
Zhengzhou	Henan
Zhongshan	Guangdong

Cluster 2

CITY	PROVINCE
Baotou	Inner Mongolia
Benxi	Liaoning
Changchun	Jilin
Changzhou	Jiangsu
Dalian	Liaoning
Daqing	Heilongjiang
Dongying	Shandong
Erdos	Inner Mongolia
Guiyang	Guizhou
Haikou	Hainan
Hefei	Anhui
Hohhot	Inner Mongolia
Huainan	Anhui
Huizhou	Guangdong
Jiayuguan	Gansu
Jinan	Shandong
Jinchang	Gansu
Karamay	Xinjiang
Laiwu	Shandong
Lanzhou	Gansu
Lhasa	Tibet
Panjin	Liaoning
Panzhihua	Sichuan
Qingdao	Shandong
Sanya	Hainan
Shantou	Guangdong
Shizuishan	Ningxia
Taiyuan	Shanxi
Tangshan	Hebei
Tongling	Anhui
Urumqi	Xinjiang
Weihai	Shandong
Wuhai	Inner Mongolia
Xiamen	Fujian
Xining	Qinghai
Yichun	Heilongjiang
Yinchuan	Ningxia
Zhoushan	Zhejiang
Zhuhai	Guangdong
Zibo	Shandong

Cluster 3

CITY	PROVINCE
Anshan	Liaoning
Anyang	Henan
Baicheng	Jilin
Baishan	Jilin
Baiyin	Gansu
Baoding	Hebei
Baoji	Shaanxi
Bayannaoer	Inner Mongolia
Beihai	Guangxi
Bengbu	Anhui
Binzhou	Shandong
Cangzhou	Hebei
Changzhi	Shanxi
Chaoyang	Liaoning
Chaozhou	Guangdong
Chengde	Hebei
Chenzhou	Hunan
Chifeng	Inner Mongolia
Chizhou	Anhui
Chuzhou	Anhui
Dandong	Liaoning
Datong	Shanxi
Dazhou	Sichuan
Dezhou	Shandong
Ezhou	Hubei
Fangchenggang	Guangxi
Fushun	Liaoning
Fuxin	Liaoning
Fuzhou	Fujian
Ganzhou	Jiangxi
Guyuan	Ningxia
Handan	Hebei
Hebi	Henan
Hegang	Heilongjiang
Hengshui	Hebei
Hezhou	Guangxi

CITY	PROVINCE
Huaian	Jiangsu
Huaibei	Anhui
Huanggang	Hubei
Huangshan	Anhui
Huangshi	Hubei
Huludao	Liaoning
Hulunbeier	Inner Mongolia
Huzhou	Zhejiang
Jiamusi	Heilongjiang
Jiangmen	Guangdong
Jiaozuo	Henan
Jiaxing	Zhejiang
Jieyang	Guangdong
Jilin	Jilin
Jincheng	Shanxi
Jingdezhen	Jiangxi
Jinhua	Zhejiang
Jining	Shandong
Jinzhong	Shanxi
Jinzhou	Liaoning
Jiuquan	Gansu
Jixi	Heilongjiang
Kaifeng	Henan
Langfang	Hebei
Lianyungang	Jiangsu
Liaocheng	Shandong
Liaoyang	Liaoning
Liaoyuan	Jilin
Lijiang	Yunnan
Linyi	Shandong
Liuzhou	Guangxi
Luohe	Henan
Luoyang	Henan
Maanshan	Anhui
Maoming	Guangdong
Mudanjiang	Heilongjiang
Nanchang	Jiangxi
Nanning	Guangxi

CITY	PROVINCE
Nantong	Jiangsu
Pingdingshan	Henan
Pingxiang	Jiangxi
Puer	Yunnan
Qingyuan	Guangdong
Qinhuangdao	Hebei
Qiqihar	Heilongjiang
Qitaihe	Heilongjiang
Quanzhou	Fujian
Quzhou	Zhejiang
Rizhao	Shandong
Shaoxing	Zhejiang
Shijiazhuang	Hebei
Shiyan	Hubei
Shuangyashan	Heilongjiang
Shuozhou	Shanxi
Siping	Jilin
Songyuan	Jilin
Suizhou	Hubei
Suqian	Jiangsu
Taian	Shandong
Taizhou	Jiangsu
Taizhou	Zhejiang
Tianshui	Gansu
Tieling	Liaoning
Tongchuan	Shaanxi
Tongliao	Inner Mongolia
Weifang	Shandong
Wenzhou	Zhejiang
Wuhu	Anhui
Wulanchabu	Inner Mongolia
Wuwei	Gansu
Wuzhong	Ningxia
Wuzhou	Guangxi
Xiangtan	Hunan
Xiangyang	Hubei
Xingtai	Hebei
Xinxiang	Henan

CITY	PROVINCE
Xinyu	Jiangxi
Xuancheng	Anhui
Xuchang	Henan
Xuzhou	Jiangsu
Yanan	Shaanxi
Yancheng	Jiangsu
Yangquan	Shanxi
Yangzhou	Jiangsu
Yantai	Shandong
Yichang	Hubei
Yingkou	Liaoning
Yulin	Shaanxi
Yuncheng	Shanxi
Yuxi	Yunnan
Zaozhuang	Shandong
Zhangjiakou	Hebei
Zhangye	Gansu
Zhaoqing	Guangdong
Zhenjiang	Jiangsu
Zhongwei	Ningxia
Zhumadian	Henan
Zhuzhou	Hunan
Zigong	Sichuan

Cluster 4

CITY	PROVINCE
Ankang	Shaanxi
Anqing	Anhui
Anshun	Guizhou
Baise	Guangxi
Baoshan	Yunnan
Bazhong	Sichuan
Bozhou	Anhui
Changde	Hunan
Chaohu	Anhui
Chongzuo	Guangxi
Deyang	Sichuan
Dingxi	Gansu
Fuyang	Anhui
Fuzhou	Jiangxi
Guangan	Sichuan
Guangyuan	Sichuan
Guigang	Guangxi
Guilin	Guangxi
Hanzhong	Shaanxi
Hechi	Guangxi
Heihe	Heilongjiang
Hengyang	Hunan
Heyuan	Guangdong
Heze	Shandong
Huaihua	Hunan
Jian	Jiangxi
Jingmen	Hubei
Jingzhou	Hubei
Jiujiang	Jiangxi
Laibin	Guangxi
Leshan	Sichuan
Lincang	Yunnan
Linfen	Shanxi
Lishui	Zhejiang
Liupanshui	Guizhou
Longnan	Gansu
Longyan	Fujian
Loudi	Hunan
Lu'an	Anhui
Luzhou	Sichuan
Lüliang	Shanxi
Meishan	Sichuan
Meizhou	Guangdong
Mianyang	Sichuan
Nanchong	Sichuan
Nanping	Fujian
Nanyang	Henan
Neijiang	Sichuan
Ningde	Fujian
Pingliang	Gansu
Putian	Fujian
Puyang	Henan
Qingyang	Gansu
Qinzhou	Guangxi
Qujing	Yunnan
Sanmenxia	Henan
Sanming	Fujian
Shangluo	Shaanxi
Shangqiu	Henan
Shangrao	Jiangxi
Shanwei	Guangdong
Shaoguan	Guangdong
Shaoyang	Hunan
Suihua	Heilongjiang
Suining	Sichuan
Tonghua	Jilin
Weinan	Shaanxi
Xianning	Hubei
Xianyang	Shaanxi
Xiaogan	Hubei
Xinyang	Henan
Xinzhou	Shanxi
Yaan	Sichuan
Yangjiang	Guangdong
Yibin	Sichuan
Yichun	Jiangxi
Yingtan	Jiangxi
Yiyang	Hunan
Yongzhou	Hunan
Yueyang	Hunan
Yulin	Guangxi
Yunfu	Guangdong
Zhangjiajie	Hunan
Zhangzhou	Fujian
Zhanjiang	Guangdong
Zhaotong	Yunnan
Zhoukou	Henan
Ziyang	Sichuan
Zunyi	Guizhou

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn und Eschborn, Germany
E info@giz.de
I www.giz.de

Tayuan Diplomatic Office Building 2-5
14 Liangmahe South Street, Chaoyang District
100600 Beijing, P. R. China
T +86 (0)10 8527 5589
F +86 (0)10 8527 5591
I www.sustainabletransport.org