

An Analysis of Maglev Trains via Clustering in China for Balanced Logistic Region Development

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ABSTRACT

Maglev trains are one of the most significant modes of transportation in existing case. It is a transport mode that exist on mobility through urbans by high speed, high capacity, and high comfort. This mode of transportation has a major position on tourism attractiveness too. It is an effective sub issue of sustainable transport policies that helps inter urban tourism connections too. It is an also significant dynamic for developing countries. On this study, a cluster-essential calculation was done for China, that has just in establishing period on Maglev train investments via usage of population, gross domestic product, and related parameters by clustering statistic ways. Line proposals were emerged via analyzing competitive operation distances of Maglev trains trough emerging cluster urban areas, and results and suggestions were shared under this conditions.

Keywords— Clustering analysis, urban, high speed, tourism, economy

I. INTRODUCTION

Transportation is in the center of development that attracts tourism, social effectiveness, economical enhance and cultural relations. Transport service increases emphasis tourism travels in terms of city, region, nation and international levels. Nowadays tourism is one of the main arms of economic development for countries. Especially for developing countries, multi sectoral improvement is a challenging issue.

China is the world's most populous country and has recently shared its leadership in this regard with India. In terms of population, it is also one of the countries with the largest population in the world. This is the case despite the fact that it is one of the largest countries in the world by land area. China is the world's 3rd largest country by area. Together with its populous neighbor India, it constitutes a significant portion of the world's population. When neighboring countries such as Japan, South Korea, North Korea, the Philippines, Thailand, Vietnam, Cambodia, Bangladesh, Indonesia, Malaysia, and others are added,

Southeast Asia represents a very substantial part of the world's population. The largest and most important part of this is China, which is significant militarily, economically, demographically, and politically. China also includes regions such as East Turkestan, Tibet, Inner Mongolia, and Manchuria. Over 90% of China's population lives in the eastern and southern halves. Historically, the mainland is also constituted by the region in question. China has achieved dramatic economic growth and asymmetric economic development with its unique form of governance over the past half-century. Although social and economic inequalities in the country are abnormal and of tragic proportions, it is possible to talk about an ultra-rich Chinese class of 100 to 150 million in a country with a massive population. Although China has hundreds of millions of extremely poor people, it has developed cities across the country, at least in terms of infrastructure and appearance, thru its massive infrastructure and transportation projects. At this point, it presents a rather different picture from India. China's steps in heavy industry, advanced technology, value-added products, unmanned systems, and the space industry, and the progress it has made, are also at the forefront globally.

While France and Japan were the traditional leaders in high-speed trains, followed by Germany, Germany has fallen behind in the last quarter of a century, while Spain and China have shown extremely rapid development. Today, the global leaders in high-speed rail systems are France, China, Spain, and Japan. China is increasingly solidifying its leadership in this area and is also a global leader in Maglev systems. China's development in both technology and infrastructure in transportation is clearly high-speed and rapidly advancing toward world leadership, with this being particularly evident in high-speed trains and Maglev systems. While China is the world leader in maglev systems, it is followed by Japan and, to a lesser extent, France. Maglev systems are magnetic levitation systems that operate on the principle of leaving a gap of less than a millimeter between the wheel and the track, and keeping the wheel and track in orbit using magnetic attraction systems. As expected, the system has eliminated the frictional force between the wheel and the rail, which acts as a speed-limiting obstacle. It is one of the leaders of China's Maglev system in both technological and infrastructural contexts. In recent years, it can even be said to be the leader, but it is clear that there is still a long way to go globally regarding Maglev systems, similar to autonomous vehicles. However, when looking at it globally, China stands out as the most likely country for a national-level Maglev system, despite its vast land area. In this study, major cities in China were listed based on indicators such as population, economic development, and level of advancement, and then subjected to cluster analysis using statistical methods in the R Studio program. As a result, the most accurate clustering method, the associated cluster list, and the number of clusters were determined. In this context, a potential Maglev network proposal for China was developed by evaluating the resulting clustered cities based on distance.



Fig. 1. Big Urbans of China (Maps China, 2025)

China has a large land area of 9.596.961 km² (United Nations Annual Demographic Reports, 2025). Population of the country is 1.416.096.094 (Worldometer, 2025). The country has a variable climate structure. China has tens of cities that are on the list of biggest metropolians of the world. The infrastructure development process is ongoing. Transport and traffic-related problems and data show local similarities with Turkey. Demand and volumes for inter-city travel and mass transport are very high. Above on Figure 1 are the biggest cities of China. In Figure 2 China state map is shared (Maps China, 2025). Figure 3 shows China Geographical Map (Maps China Geographic, 2025). Table 1 shows Mexico cities' populations (OECD, 2020).



Fig. 2. China State Map (Maps China, 2025)



Fig. 3. China Geographical Map (Maps China Geographic, 2025)

TABLE 1

CHINESE BIG CITIES POPULATIONS AND LIVABILITIES (OECD, 2020)

City	Liveability	POP
Hong Kong	91	7500000
Macau	78	682000
Shenzhen	81	17500000
Shanghai	78	24900000
Beijing	77	21900000
Gaungzhou	76	18700000
Chengdu	73	20900000
Hangzhou	73	11900000
Tianjin	73	13900000
Nanjing	73	9310000
Xi'an	72	13000000
Ningbo	71	9400000
Wuhan	71	12300000
Fuzhou	71	8290000
Qingdao	71	10100000
Shenyang	71	9070000

Chongqing	70	7740000
Suzhou	68	12700000
Zhengzhou	68	12600000
Zhuhai	62	2440000
Pudong	60	5680000
Changchun	58	9070000
Foshan	58	9500000
Kunming	58	8460000
Haikou	57	2870000
Dongguan	56	10500000
Dalian	56	7450000
Nanchang	55	6260000
Shaoxing	55	5270000
Guiyang	55	5990000
Zhongshan	55	4420000
Langfang	55	5460000
Changsha	55	10000000
Xiamen	55	5160000
Jiangmen	54	4630000
Quanzhou	54	8780000
Harbin	54	10000000
Nanning	54	8740000
Jinan	54	9200000
Hefei	54	9370000
Xianyang	53	3960000
Kunshan	53	2090000
Xiaogan	52	4270000
Kowloon	52	2110000
Qingyuan	52	3970000
Taicang	52	831000
Yantai	52	7100000
Jianyang	52	1050000
Lanzhou	52	4360000
Taiyuan	52	5300000
Zhuzhou	52	3900000
Wuxi	51	7460000
Binhai	51	2480000
Wenzhou	51	9570000
Zhangzhou	51	5050000
Hohhot	51	3450000
Chongzhou	51	664000
Urumqi	51	4050000
Huanggang	51	5880000

Fushun	51	1860000
Tai'an	50	5470000
Jinjiang	50	2060000
Huizhou	50	6040000
Jiaxing	50	5400000
Zhangjiagang	50	1430000
Guilin	50	4930000
Nantong	50	7730000
Xiangtan	50	2730000
Changshu	50	1680000
Deyang	50	3460000
Ziyang	50	2310000
Zhoushan	50	1160000
Zhenjiang	50	3210000
Meishan	50	2950000
Ma'anshan	49	2160000
Huzhou	49	3370000
Changzhou	49	5280000
Jiaozhou	49	901000
Pengzhou	49	771000
Hanchuan	49	1090000
Jieyang	49	6090000
Jurong	49	618000
Weinan	49	4690000
Zhuozhou	49	604000
Zhaoqing	49	4110000
Xingping	49	542000
Guanghan	49	591000
Sanhe	49	652000
Xinzheng	48	990000
Dengta	48	496000
Yangzhou	48	4560000
Xinxiang	48	5710000
Rui'an	48	1420000
Ningde	48	2910000
Shijiazhuang	48	10060000
Ningxiang	48	1370000
Benxi	48	1330000
Shantou	48	5500000
Qidong	48	973000
Tieling	48	2390000

II. LITERATURE REVIEW

Urban development also plays an important role in transportation. Sustainability, urbanization, and digitalization are the movements of the 21st century. Transportation plays a central role in bringing all of this together.

Urbanization has always been the driving force behind development throughout history. Because it forms the main turning point of the economy. From ancient cultures to the present day, urbanization, rural life, and migration have evolved as the three main forms of human settlement. However, in modern times, its content and features have changed significantly. Urbanization and urban development have been steadily increasing over the past 300 years. In this century, the proportion of people living in cities within the global population has risen to an unprecedented level, and this trend continues to increase.

In the 21st century, in addition to urbanization, digitalization and sustainability also seem to be at the forefront. What strengthens the trend of digitalization is a continuous and uninterrupted process of technological development and innovation. This has created a constant dynamic of change in our lives. Transportation and urbanization have been and will continue to be affected by this dynamic. Sustainability trends have strengthened even further today. Western countries and developed countries have a role to play in this regard. In this context, sustainability, digitalization, and urbanization indicate that more investment is needed in high-speed train lines, metro lines, and high-capacity high-speed bus lines. These three systems could be the initial driving force for autonomous transportation systems in developing countries (Givoni, 2006).

III. METHODOLOGY

Clustering Analysis

Clustering statistical analysis have been conducted via K means method, PAM and Clara method.

1. K Means Method

Here are results for number of clusters and cluster visulation in terms of K means method in Figure 4 and Figure 5.

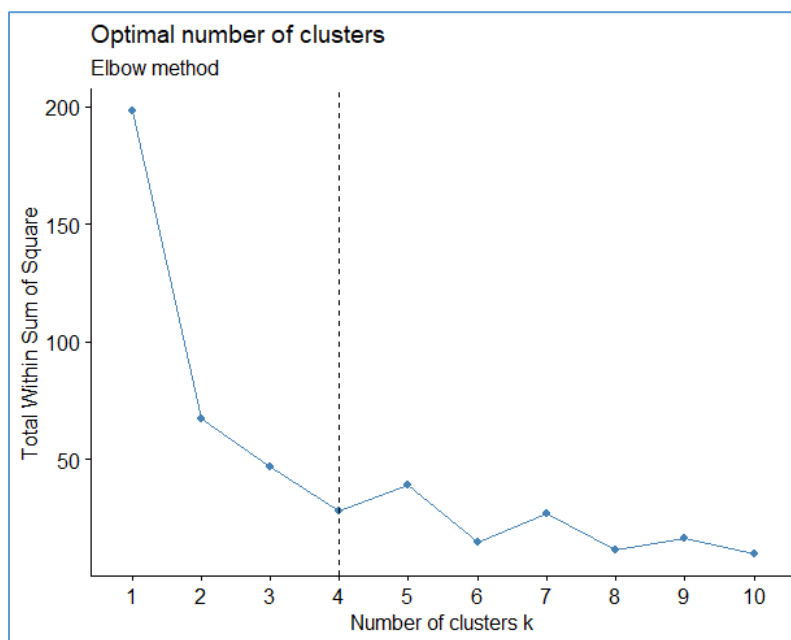


Fig. 4. Number of Clusters in Terms of K Means Method

Cluster Visulation

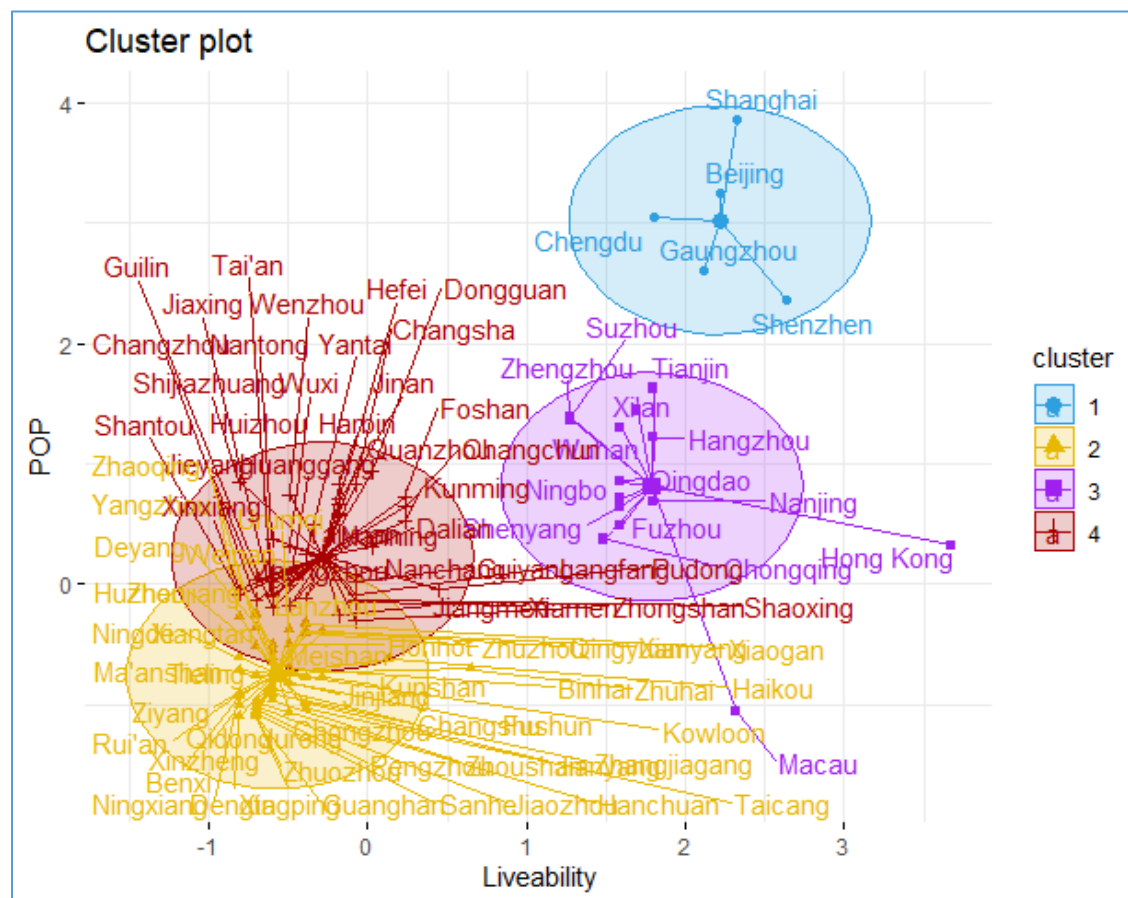


Fig. 5. Cluster Visulation In Terms Of K Means Method

2. PAM

Here are results for number of clusters and cluster visulation in terms of PAM in Figure 6 and Figure 7.

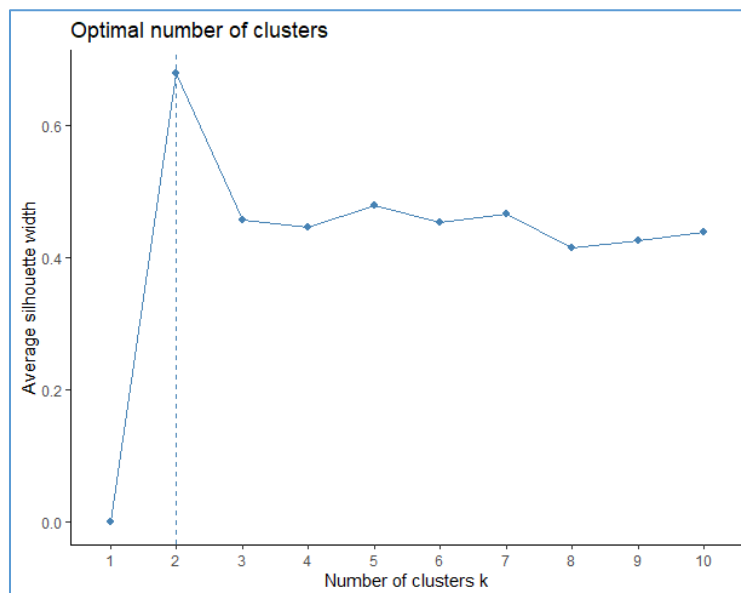


Fig. 6. Number of Clusters in Terms of PAM

Cluster Visulation

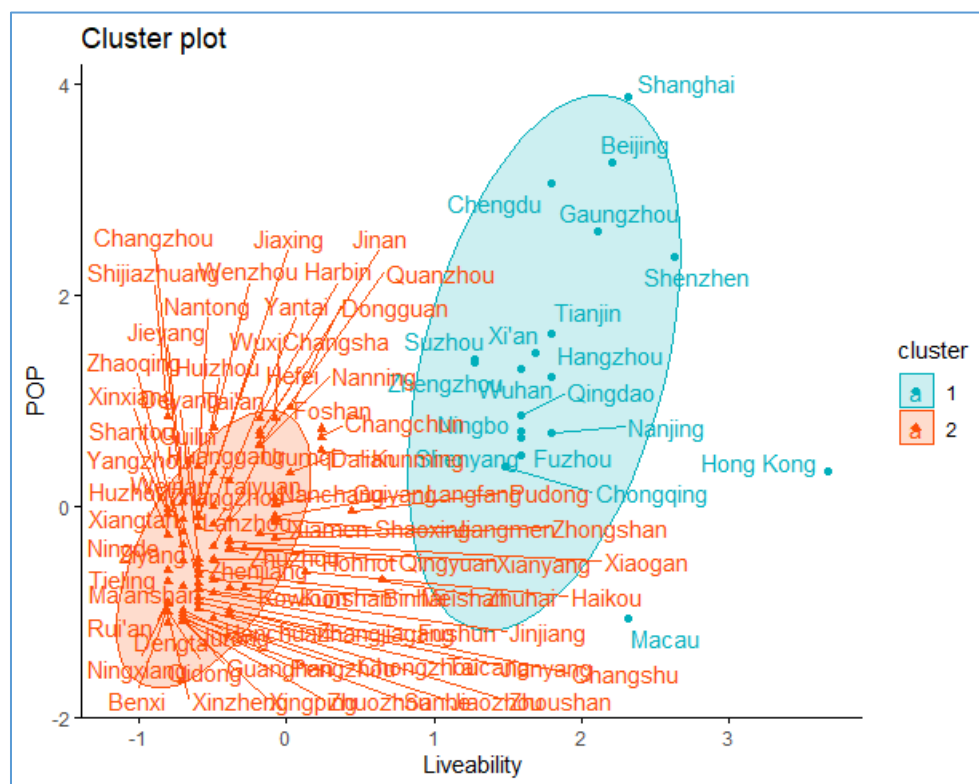


Fig. 7. Cluster Visulation In Terms Of PAM

3. Clara Method

Here are results for number of clusters and cluster visulation in terms of Clara method in Figure 8 and Figure 9.

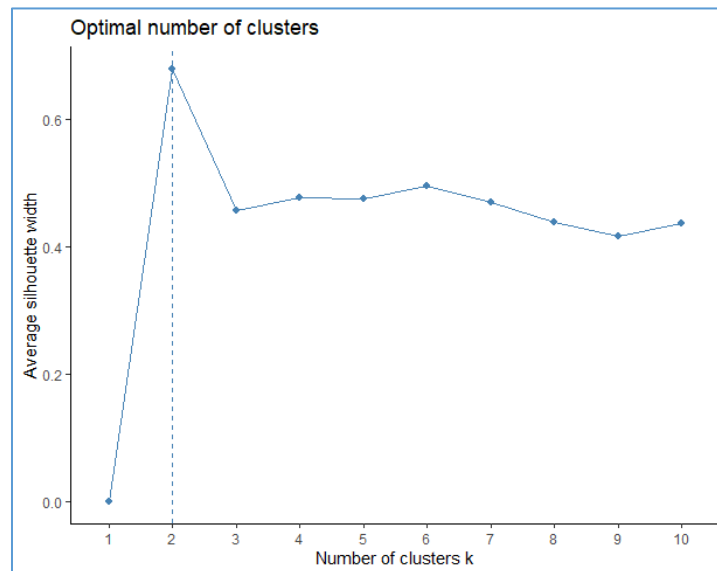


Fig. 8. Number of Clusters in Terms of Clara Method

Cluster Visulation

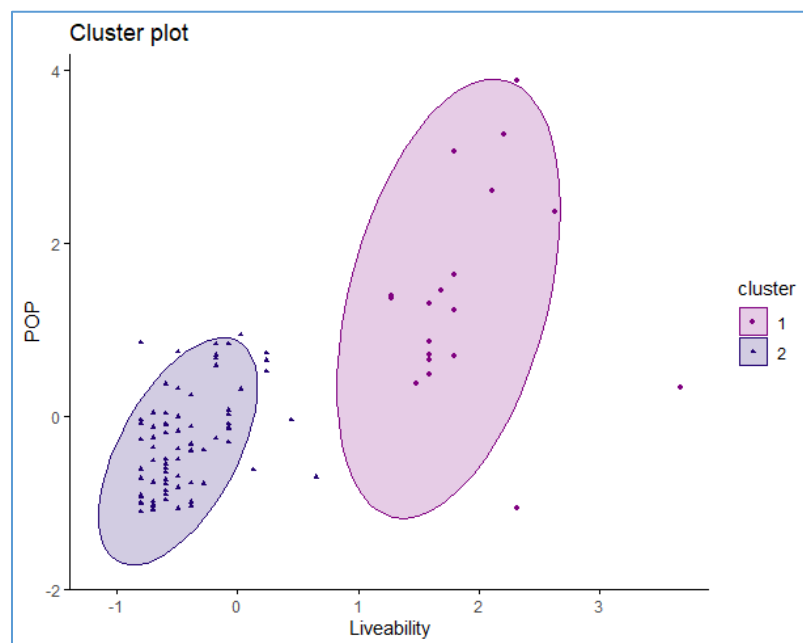


Fig. 9. Cluster Visulation In Terms Of Clara Method

As a result of all methods and agglomerations, the biggest cities has been emerged into two clusters, four main clusters has emerged for these dataset. On Table 2, clustering list of the cities has been given.

TABLE 2.

CLUSTER LIST OF CHINESE CITIES

City	Cluster	Population
Hong Kong	3	7500000
Macau	3	682000
Shenzhen	1	17500000
Shanghai	1	24900000
Beijing	1	21900000
Gaungzhou	1	18700000
Chengdu	1	20900000
Hangzhou	3	11900000
Tianjin	3	13900000
Nanjing	3	9310000
Xi'an	3	13000000
Ningbo	3	9400000
Wuhan	3	12300000
Fuzhou	3	8290000
Qingdao	3	10100000
Shenyang	3	9070000
Chongqing	3	7740000
Suzhou	3	12700000
Zhengzhou	3	12600000
Zhuhai	2	2440000
Pudong	4	5680000
Changchun	4	9070000
Foshan	4	9500000
Kunming	4	8460000
Haikou	2	2870000
Dongguan	4	10500000
Dalian	4	7450000
Nanchang	4	6260000
Shaoxing	4	5270000
Guiyang	4	5990000
Zhongshan	4	4420000
Langfang	4	5460000
Changsha	4	10000000
Xiamen	4	5160000
Jiangmen	4	4630000

Quanzhou	4	8780000
Harbin	4	10000000
Nanning	4	8740000
Jinan	4	9200000
Hefei	4	9370000
Xianyang	2	3960000
Kunshan	2	2090000
Xiaogan	2	4270000
Kowloon	2	2110000
Qingyuan	2	3970000
Taicang	2	831000
Yantai	4	7100000
Jianyang	2	1050000
Lanzhou	2	4360000
Taiyuan	4	5300000
Zhuzhou	2	3900000
Wuxi	4	7460000
Binhai	2	2480000
Wenzhou	4	9570000
Zhangzhou	4	5050000
Hohhot	2	3450000
Chongzhou	2	664000
Urumqi	2	4050000
Huanggang	4	5880000
Fushun	2	1860000
Tai'an	4	5470000
Jinjiang	2	2060000
Huizhou	4	6040000
Jiaxing	4	5400000
Zhangjiagang	2	1430000
Guilin	4	4930000
Nantong	4	7730000
Xiangtan	2	2730000
Changshu	2	1680000
Deyang	2	3460000
Ziyang	2	2310000
Zhoushan	2	1160000
Zhenjiang	2	3210000
Meishan	2	2950000
Ma'anshan	2	2160000
Huzhou	2	3370000
Changzhou	4	5280000
Jiaozhou	2	901000

Pengzhou	2	771000
Hanchuan	2	1090000
Jieyang	4	6090000
Jurong	2	618000
Weinan	2	4690000
Zhuozhou	2	604000
Zhaoqing	2	4110000
Xingping	2	542000
Guanghan	2	591000
Sanhe	2	652000
Xinzheng	2	990000
Dengta	2	496000
Yangzhou	2	4560000
Xinxiang	4	5710000
Rui'an	2	1420000
Ningde	2	2910000
Shijiazhuang	4	10060000
Ningxiang	2	1370000
Benxi	2	1330000
Shantou	4	5500000
Qidong	2	973000
Tieling	2	2390000

IV. RESULTS

After statistical analysis, prior urbans were gathered on 1-3 numbered clusters and more than 8 million populated cities of 4 numbered cluster. On Table 3 selected cities are listed below.

TABLE 3.

SELECTED CITIES VIA CLUSTERING ANALYSE

City	Cluster	Population
Hong Kong	3	7500000
Macau	3	682000
Shenzhen	1	17500000
Shanghai	1	24900000
Beijing	1	21900000
Guangzhou	1	18700000
Chengdu	1	20900000
Hangzhou	3	11900000
Tianjin	3	13900000

Nanjing	3	9310000
Xi'an	3	13000000
Ningbo	3	9400000
Wuhan	3	12300000
Fuzhou	3	8290000
Qingdao	3	10100000
Shenyang	3	9070000
Chongqing	3	7740000
Suzhou	3	12700000
Zhengzhou	3	12600000
Changchun	4	9070000
Foshan	4	9500000
Kunming	4	8460000
Dongguan	4	10500000
Changsha	4	10000000
Quanzhou	4	8780000
Harbin	4	10000000
Nanning	4	8740000
Jinan	4	9200000
Hefei	4	9370000
Wenzhou	4	9570000
Shijiazhuang	4	10060000

These modes of transportation involve the priority, integration or substitution of cities according to their size, human characteristics, demand for transportation, urban features, interconnected spatial and technical locations, requirements, distances between cities and a number of fundamental parameters. Among the various cities in Western Europe, this is the case with high-speed trains and airlines (Marta et al, 2010).

High-speed trains are currently the most competitive mode of passenger transport for distances between 400 and 600 kilometers (HST). Air passenger transport is predominant on distances over 600 kilometers. Experiences and experiments in many Western and developed countries show that high-speed trains outperform road and air passenger transport at speeds of 200 km/h and above for distances of 400-600 km. A significant part of the vision transportation projects initiated by the European Commission are high-speed rail projects. In transportation over 600-800 kilometers interval is competitive operation distance for Maglev trains (Kiziltas, 2020).

The studies have measured the levels of competitiveness of high-speed railways, airlines, Maglev trains and highways, and the competitive mode varies according to the distance assessed. Within this scope, Maglev trains on distances of 600-1000 km appear to be the most competitive mode (Kiziltas, 2020).

V. DISCUSSION AND CONCLUSIONS

In this context, it is recommended that Maglev train lines between the cities in the Table 3 below be constructed as a priority. Figure 10 shows Maglev train line proposal map of China.

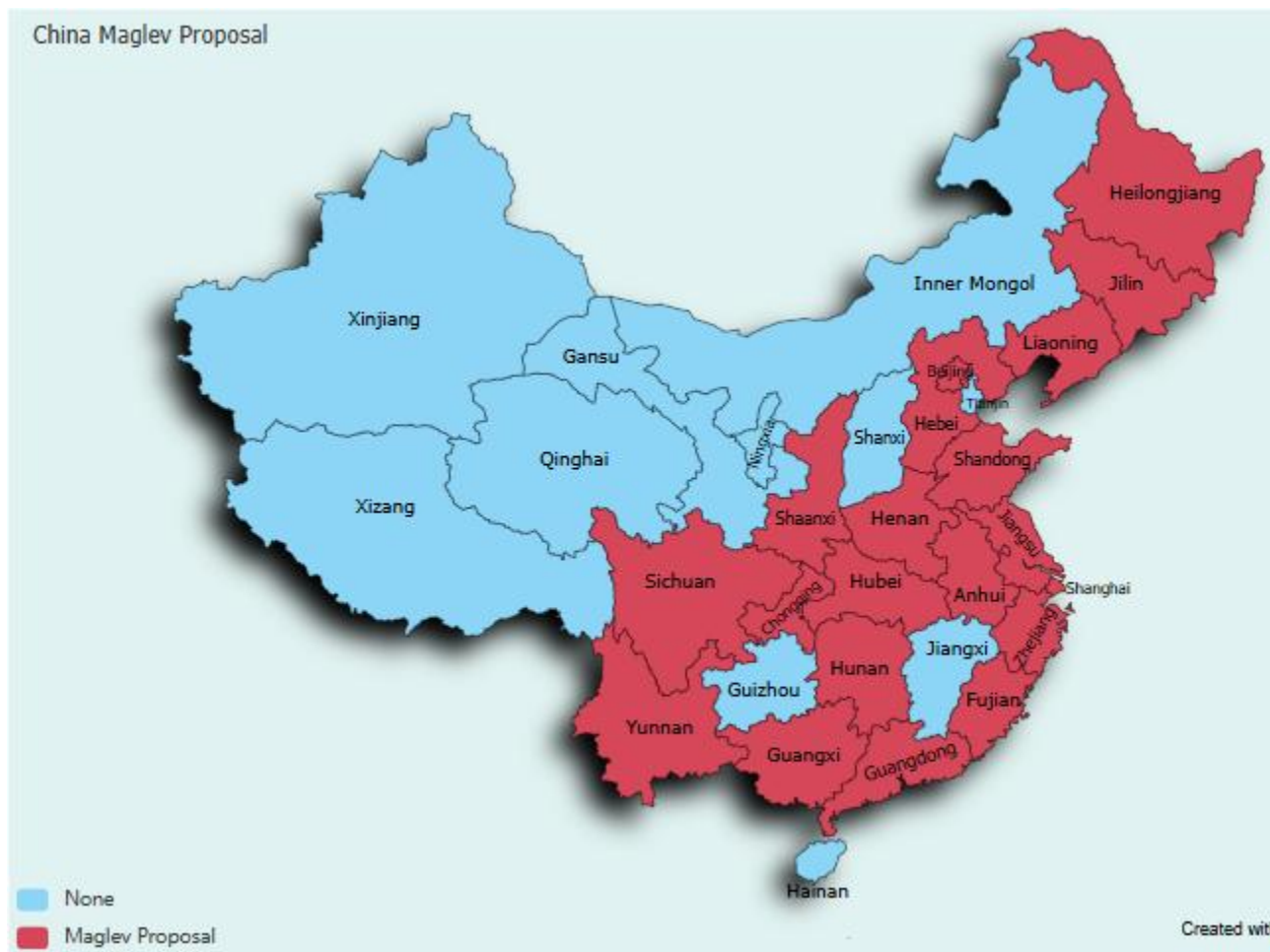


Fig. 10. Maglev Train Proposal Regions on Map (Red Legend: Proposals)

As shown in the map, the cities proposed for Maglev connections under this study also include most of China's central and densely populated areas. These areas mostly on the east and southeast parts of the country. When these areas are equipped with Maglev trains, a robust, high speed, reliable, strong and highly comfortable inter-urban mobility network will be emerged in the country's geographically central, inner, peripheral and inland areas. On the other hand, by the completion of all the proposed Maglev lines projects, Maglev connections from the country's south to the north, to the border areas of Mongolia and

Russia, and from the east coast to far southwest will be provided without interruption. This strong connection can be provided from coastal areas to Guangxi Zhuang autonomous region (Thai) and whole of Manchuria region (include center of Manchuria) too.

REFERENCES

- [1] United Nations Annual Demographic Report, 2025
- [2] Worldometer China, 2025
- [3] <https://tr.maps-china-cn.com/%C3%87in-haritas%C4%B1-%C5%9Fehirler>, 2025
- [4] <https://tr.maps-china-cn.com/%C3%87in-gibi-b%C3%BCy%C3%BCK-%C5%9Fehirler-ile-harita>, 2025
- [5] <https://tr.maps-china-cn.com/%C3%87in-co%C4%9Frafya-haritas%C4%B1>, 2025
- [6] OECD China City Populations, 2020
- [7] Givoni, Moshe. Development and impact of the modern high-speed train: A review. *Transport reviews*, 2006, 26.5: 593-611.
- [8] Sanchez-Borras, Marta, et al. Rail access charges and the competitiveness of high speed trains. *Transport policy*, 2010, 17.2: 102-109.
- [9] Kiziltas, M.C., High-speed Railways, Study of Impact on Production and Economic Development, BEU Journal of Scientific Sciences, 9 (4), 1844-1853, 2020