Advances in Social Science, Education and Humanities Research, volume 517
Proceedings of the 6th Annual International Conference on Social Science and Contemporary Humanity Development (SSCHD 2020)

Research on the Development Path of China's Rail Transit TOD in the Post-Epidemic Era

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ABSTRACT
The epidemic of COVID-19 has not only aroused strong concern in the fields of public health and healthcare, but also requires a re-examination of urban planning and public transport organizations. This paper analyzes the impact of the epidemic of COVID-19 on rail transit, including the impact of the epidemic of COVID-19 on passenger traffic flow and traveler's willingness and mode choice. It analyzes the development opportunities of rail transit TOD in the post-epidemic era from the macro policy supply and micro traveler demand levels, and finally makes recommendations from both long-term and short-term perspectives: enhancing the service level of rail transit TOD, leading the economic development of new kinetic energy with multiple business forms, and improving the intelligent level of rail transit by combining 5G and AI technologies.

Keywords: *Epidemic of COVID-19, TOD, 5G technology.*

1. INTRODUCTION

Epidemic of COVID-19 outbreak at the end of 2019, urban epidemic prevention and control faces severe challenges, provinces and cities have launched response to major public health emergencies I response. Under the epidemic of COVID-19, urban railways around the world actively take preventive and control measures to prevent the spread of the epidemic. Subways in Ningbo, Hohhot, Urumqi, Xuzhou and Wenzhou have taken measures to suspend operations. Subways in Shanghai, Zhengzhou, Tianjin, Shijiazhuang and other cities have taken measures to suspend the operation of some lines. Subways in Shenzhen, Xiamen, Nanjing and other cities have taken measures to adjust operating hours or travel intervals. Wuhan, as a key area in the prevention and control of the epidemic, suspended all public transportation in the city from January 23, 2020, and all Wuhan Metro lines were suspended from that day onwards[1].

The urban public transportation system is the basic guarantee of urban production and life, in which the rail transit TOD is the place where the population gathers in high density, with the characteristics of dense personnel, relatively confined space and high mobility of passenger flow. Under the full and effective prevention and control of the Chinese government and all sectors of society, domestic production and life have basically returned to normal under the normalization of epidemic prevention and control. Public transport as quasi-public goods, strong support for enterprises to resume work and production and the smooth operation of the economy and society. The Ministry of Transport has recently issued a number of circulars instructing local transport authorities, under the leadership of local epidemic prevention and control mechanisms, to implement zoning and grading control requirements based on lists of low-, medium- and high-risk counties (cities, districts and flags) within their jurisdictions, in order to resume transport services such as road passenger transport, urban public transport (including urban rail transit) and rental cars (including net-booking vehicles) in a scientific and orderly manner.

2. LITERATURE REVIEWED

Domestic and international research has focused on the relationship between rail transportation and epidemic transmission, travel choices under epidemic conditions, and public transportation management strategies during epidemics. In the study of rail transportation and epidemic transmission, Liu (2020) applied the theory of indoor virus transmission in the air through droplets to the interior space of buses and found that the transmission of virus in the bus was mainly

related to the number of susceptible people in the bus, the number of infected people in the bus, the exposure time in the bus and the rate of air supply outside the bus, and with reference to the indexes of bus operation and management characteristics, they determined the specific virus in the bus that had a higher correlation with the number of susceptible people in the bus[2]. Cooley et al. (2011) extrapolated the epidemic situation in New York from 1957-1958 and found that 4.4% of the 2.6 million cumulative cases of infection came from the subway, with commuters accounting for 3.6% and non-commuters less than 1%. The results indicate that implementing interventions for subway passengers is not effective in curbing the development of infectious disease epidemics [3]; Xiong et al. (2018) analyzed the effect of passenger flow on the transmission rate of rail transit congestion with the help of the SIR infectious disease model [4]. In terms of epidemics and travel options. Hui (2020) used an online questionnaire to investigate the public's willingness to choose and use bicycle sharing before and after the epidemic, and concluded that the main transportation function of bicycle sharing during the epidemic changed from connecting to other modes of public transportation to taking complete trips[5]. Kan (2020) analyzed the spatial distribution of commuting flows of the working population returning to work during the epidemic and measured the average daily commuting passenger flow intensity of the city's bus and rail lines based on Baidu spatiotemporal big data, which showed that the overall passenger flow intensity of rail transit decreased significantly, and the number of sections with relatively high passenger flow was small, scattered, and the overall pressure was relatively small [6]. Zhao et al. (2020) compared the difference between the passenger flow of Shanghai's rail transit network and that of typical stations during the epidemic and under normal conditions according to the prevention and control measures taken during different periods, and analyzed the changes in the passenger flow influenced by the changes of the epidemic, prevention and control measures and other factors [7]. Regarding public transport management strategies during the epidemic, Zhou et al. (2020) concluded that urban rail transit should adopt a three-level combination of epidemic prevention strategies under the new coronary pneumonia epidemic, i.e. the strategy of suspending operations, the strategy of isolating carriages for epidemic prevention, and the demand-response epidemic prevention strategy[8]. Wang and Lu (2020) summarized the epidemic prevention measures in rail transit, which mainly include station train ventilation, carriage station disinfection, and passenger flow density control, strengthening temperature measurement, and implementing real name registration [9]. Liu et al. (2020) summarized the passenger management measures of Wuhan Metro during the prevention and control of novel coronavirus pneumonia outbreak [1]. Li and Zheng (2020) reflect on Wuhan's epidemic resistant traffic management and planning in terms of urban road network capacity, legal guidance, and emergency security mechanisms [10]. Wang et al. (2020) reflect on urban transportation issues from the perspective of telecommuting, car purchase quota policy, and customized public transportation and make suggestions [11].

3. THE EPIDEMIC OF COVID-19 AND RAIL TRANSIT

3.1. The Impact of the Epidemic of COVID-19 on Rail Passenger Traffic

Affected by the epidemic, Europe, Asia, North America, a number of countries in the region of urban traffic in the significant decline in traffic, especially public transport. The largest U.S. public transportation agency MTA (New York Metropolitan Area Transit Authority) data show that in March, New York subway traffic than normal levels of about 60% decline in passenger traffic, surface bus traffic fell by about 49% [12]. Wuhan, the worst hit city in China from January to March, was completely closed on January 23, with buses, subways, ferries, and long-distance passenger transport suspended until April 22, when the city's rail transit network returned to normal. Affected by the epidemic, the total passenger traffic in 35 central cities across the country fell sharply in February, averaging 12.89% of the total passenger traffic in the same month last year.

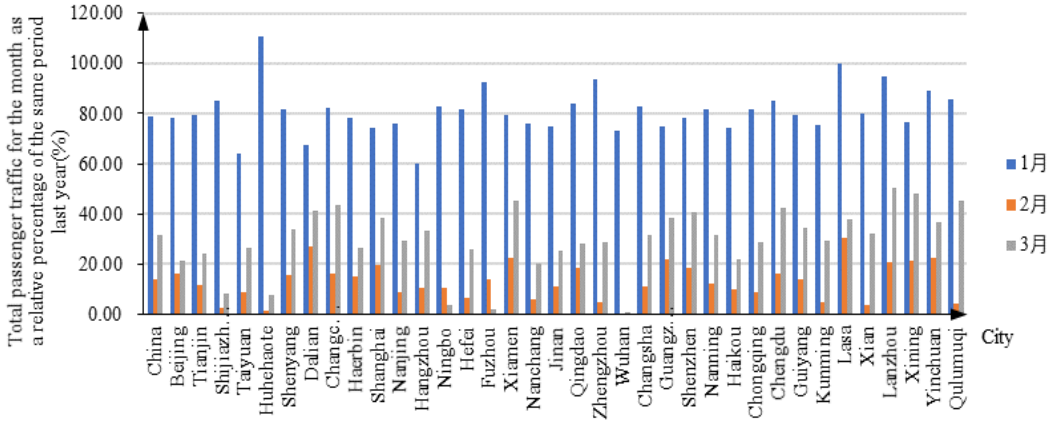

Figure 1 Comparison of the total passenger transport volume for the month of January-March 2020 nationwide and by provinces and cities with the same period last year.
Source: Ministry of Transport of the People's Republic of China

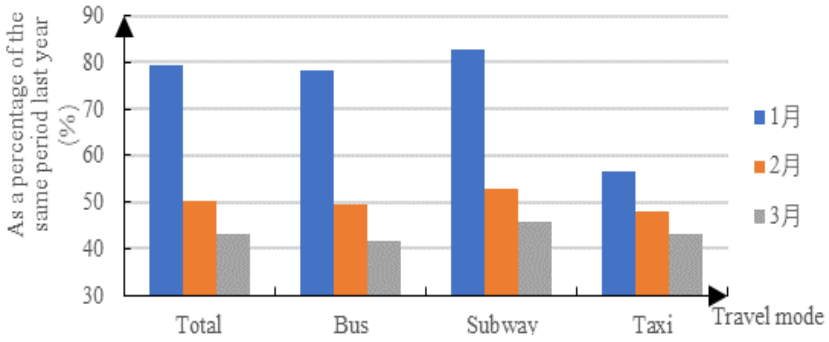

Figure 2 Changes in passenger traffic in central cities, January-March 2020
Source: Ministry of Transport of the People's Republic of China

In terms of different modes of transportation, the total passenger traffic, public steam and tram passenger traffic, rail transit passenger traffic, and taxi passenger traffic in 35 central cities across the country in March was still in a significant decline compared to the cumulative value of 2019, which was 43.3%, 41.7%, 45.7%, and 43.2% of the cumulative value of the same period last year, respectively, with rail transit having the lowest percentage of decline and remaining the main urban residents' Traffic Mode.

3.2. The Impact of the Epidemic of COVID-19 on Travel Intentions and Mode Choice

Affected by the epidemic, the overall decline in urban travel demand, urban residents will put forward higher requirements for travel quality, customized public transport and other more individualized travel, no contact travel demand has increased significantly. During the epidemic, public transportation companies in many places helped scientific prevention and control by improving the intelligence level. Beijing, Shenzhen, Chengdu, Dalian and other places launched customized bus lines for the public to resume work and production to provide online reservations, one person, fast and direct customized public transport commuting services.

50 major cities in China selected by Gaode Maps, according to the proportion of bus & subway, cycling, walking route planning to the total number of planning, after standardization to obtain the "Green Travel Willingness Index" of each city. In the first quarter of 2020, due to the Spring Festival and the epidemic, the green travel intentions of major cities gradually decreased in January, and then stabilized [13]

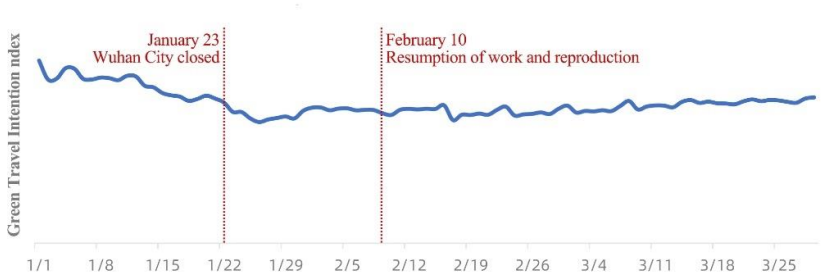

Figure 3 Trends in travel intentions in major cities, first quarter 2020
Source: Traffic Analysis Reports for Major Cities in China 2020Q1

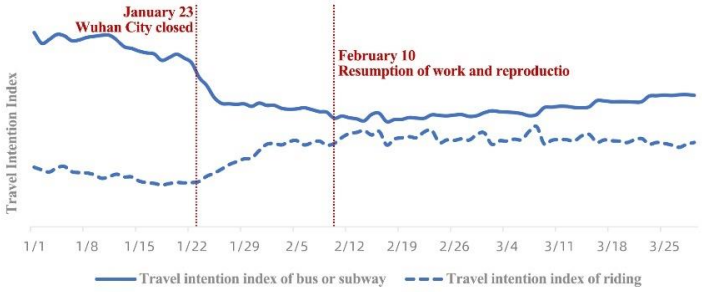

Figure 4 Trends in travel intentions in major cities, first quarter 2020 (by mode)
Source: Traffic Analysis Reports for Major Cities in China 2020Q1

During the first quarter of 2020, green travel willingness in major cities gradually declined in January due to the Spring Festival and the epidemic, and then stabilized. By mode, affected by the epidemic, the bus & subway travel willingness index fell rapidly before the Spring Festival, while the cycling travel willingness index rose rapidly during the same period. 10 February after the city gradually entered into the resumption of production, the bus & subway travel willingness index began to rise slowly, while the cycling travel willingness is basically stable.

4 OPPORTUNITIES FOR RAIL TOD DEVELOPMENT IN THE POST-EPIDEMIC ERA

4.1. Macro Level: Policy Support and New Infrastructure Development

4.1.1. TOD Development and Construction Requirements in the Post-Epidemic Era

After the epidemic of COVID-19, infrastructure development shows an open pattern, China's TOD will usher in a new round of high-speed development period. The regional development and reform commission data statistics show (as of March 10), in 2019, 12 regions of urban rail transit projects (subway, tram) received national and provincial development and reform commission approval and consent, involving about 59 urban rail transit lines, the total project investment of about 970 billion yuan. Rail transit TOD should respond to the development opportunities of infrastructure construction and become an important engine for high-speed urban development.

4.1.2. New Infrastructure Drives Smart Rail TOD Development

New infrastructure construction in the impact of the epidemic is seen as an important support means to hedge the economy affected by the epidemic, promote industrial transformation and upgrading and power the digital economy, including 5G infrastructure, ultra-high voltage, intercity high-speed rail and intercity rail transit, new energy vehicle charging stations, big data centers, artificial intelligence, industrial Internet and other seven fields. Rail transit TOD is an important infrastructure in urban development, and "new infrastructure" helps rail transit TOD information transformation and upgrading.

4.2. Micro Level: Travel Demand and Distributed Supply

4.2.1. Analysis of Projected Demand for Rail Transit in the Post-Epidemic Era

Under the impact of exposure in the post-epidemic era, the demand for passenger transport has shifted from intensive public transport such as railways and buses to

individual transport such as private cars, walking and bicycles [14]. The core of TOD is to build a good slow-moving transportation environment, and the increase of the proportion of slow-moving transportation in the post-epidemic era is conducive to promoting TOD development. The planning and construction of TOD in the post-epidemic era should fully consider the connection with slow traffic, forming a convenient and fast travel chain that connects slow traffic and rail transit, and attracting more travelers to gather in the rail transit TOD.

4.2.2. Distributed Transport Supply as a Trend in the Post-Epidemic Era

Maas-based travel chain traceability plays an important role in epidemic prevention and control, and rail transit TOD should be actively integrated into the Maas travel chain to build a distributed and personalized travel service scenario. Distributed transportation supply is a transportation service provided in response to temporal and spatial heterogeneity, which is different from large-scale plan-led supply and resource-lost fragmented supply, and is characterized by end-oriented demand, small size, decentralization and flexibility of the supply body, and reliance on Internet information technology [15]. During the epidemic, to ensure the smooth return of people returning to work, many localities have opened a number of customized bus lines, a strategy that can be based on the actual passenger demand and generate customized routes, and through the use of electronic information technology combined with "health codes", tracing the complete travel chain of passengers and other functions. The integration of bus and rail transport into a travel service product that meets individual travel needs will attract more travelers to use public transport.

5. THE DEVELOPMENT PATH OF CHINA'S RAIL TRANSIT TOD IN THE POST-EPIDEMIC ERA

5.1. Long-term Trends

5.1.1. Enhanced Rail TOD Service Levels

The outbreak has placed new demands on urban rail transit in dealing with such public health emergencies. The main precautionary measure for the SARS outbreak in 2003 and the new coronary pneumonia epidemic is to train staff to protect themselves from infection and maintain normal service through training courses and workshops. During the epidemic period, the Government encouraged home working and the number of MTR passengers dropped significantly.

5.1.2 . TOD Various Types of Business Leading the New Economic Development Momentum

Make full use of the advantages of TOD's multiple business forms to build a service system that combines online and offline. Take the airline industry as an example, during the epidemic, the passenger flow of Shanghai Pudong Airport dropped, but the sales business of Nikko Duty Free Shop was still in full swing. Many people place orders through the Nikko App, which is sent directly from duty-free shops without the need to go to the airport to pick up the goods. There are many unique shops at the airport, which can make full use of the Internet to carry out online shopping and offline delivery business to increase non-airport revenue. Railway TOD has a large number of businesses that can meet various needs, which should be combined with online technology to stimulate offline businesses [16].

5.2. Short-term Enablement

5.2.1. 5G+ Enabling Rail Transit Technology Upgrade

Rail transit TOD is an important node of the urban rail transit network, providing places to gather and stay. In the post-epidemic era, the planning and design of rail transit TOD should give full play to the place function and transportation function, explore the carrying of the 5G + intelligent transportation system based on the coordinated joint control system of major public health events, and set up the necessary specific places that can provide basic medical care to form a dynamic tracking, traceability function of the prevention and control system.

5.2.2. Combining AI technology to Improve Intelligence Level

Rail transit TOD, as a place of high passenger flow and high population density, should actively introduce AI intelligent technology and equipment. AI devices such as drones, unmanned vehicles, face recognition and body temperature long-range measuring machines have been applied on a large scale in epidemic mobile inspection and propaganda, distribution of goods in highly contaminated areas, and mobile personnel control, providing strong technical support for blocking the spread of the virus.

6. CONCLUSION

This paper analyzes the impact of the epidemic of COVID-19 on rail transit, dissects the development opportunities of rail transit TOD in the post-epidemic era at the macro policy supply and micro traveler demand levels, and concludes with recommendations in

both the long and short term. The results of the study show that the global public transportation travel volume has dropped significantly due to the epidemic, but rail transit is still the main travel mode in public transportation. Travelers' willingness to travel green is on the rise, and rail transit TOD design should fully integrate green transportation. Under the popularity of 5G technology, TOD should give full play to place function and transportation function, and explore to carry a collaborative joint control system of major public health events based on 5G + intelligent transportation system.

ACKNOWLEDGMENTS

This paper is based on research funded by Capital City's High-end Think Tank Project "Innovative Paths and Planning Study on the Development of Beijing Regional Express Line Using Suburban Railways (1)" (B19ZK00090).

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