COVID-19 Lockdown on Online Car-Hailing Travel in Shanghai

Subjects: Transportation

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Due to the restriction policies and people's fear of contracting COVID-19, the riding of means of transportation decreased sharply, including trains, metros, taxis, and online car-hailing, both for inter-city and intra-city transportation modes. The way people travel and live was significantly affected. People needed to work from home or conduct online meetings if the working conditions permitted. Students needed to take classes online.

Keywords: online car-hailing ; COVID-19 ; lockdown ; impacts on travel

1. Introduction

The COVID-19 pandemic swept through the world from the end of 2019. As of 13 September 2023, there have been 770,563,467 confirmed cases of COVID-19, including 6,957,216 deaths worldwide [1]. The pandemic of coronavirus has brought tremendous impacts on the production and life of human beings, and many countries have taken various measures (e.g., mask-wearing, restrictions on gatherings, and even lockdowns) to control its spread.

Few industries have been hit as severely by COVID-19 as transportation [2]. Due to the restriction policies and people's fear of contracting COVID-19, the riding of means of transportation decreased sharply, including trains, metros, taxis, and online car-hailing, both for inter-city and intra-city transportation modes. The way people travel and live was significantly affected. People needed to work from home or conduct online meetings if the working conditions permitted. Students needed to take classes online. Fortunately, e-shopping, takeaways, and other online consumption modes enabled people to live and stay at home to some extent [3].

Tougher measures, like grid management (people are restricted to moving within the grid) and even lockdowns (blockades of large areas within the city), were adopted in China before 2023. Metropolises like Shanghai and Wuhan and small cities (especially at the border) like Ruili, Yunnan experienced lockdown. In Shanghai, the number of infected individuals suddenly increased in March 2022. To quickly curb the spread of the pandemic, the government announced that Pudong (the part east of Huangpu River in Shanghai) and Puxi (the part west of Huangpu River in Shanghai) would be closed off at 5:00, 28 March 2022, and 3:00, 1 April 2022, respectively. Shanghai is divided by the Huangpu River into two regions, i.e., Pudong and Puxi, both administrative and natural areas. The government probably implemented lockdowns in Pudong and Puxi separately and successively to facilitate management and reduce economic losses. As a result, these two parts of Shanghai showed a certain degree of independence during the lockdown, and communication between them became minimal, which would be conducive to rapid control of the pandemic. However, almost all aspects of residents' lives, such as travel, work, medical treatment, and education, were greatly affected due to the lockdown. The riding of urban transportation including online car-hailing dropped precipitately as Pudong and Puxi were sealed off in turn. External traffic in Shanghai was nearly completely halted to prevent the spread of the pandemic, so the throughput of transportation hubs declined significantly. Almost all regular activities were required to be brought online or suspended. It is worth noting that residents were told in advance of the lockdown. Due to the uncertainty of the actual time of lockdown, specific crowd behaviors emerged, including snapping up food, medicines, and other daily essentials, namely, panic buying [4][5]. These behaviors of the crowd could also be reflected in residents' travel. As an important mode of transportation, car-hailing provides a common, point-to-point, and private service. Especially during the pandemic, people tended to travel via more independent modes like ride-hailing to mitigate infection risks. As a result, it is meaningful to research the impacts of the pandemic and particular crowd behaviors with the car-hailing data, which may help to enhance the resilience and sustainability of the city.

2. Studies Related to COVID-19

As a typical case of a public health emergency, the COVID-19 pandemic has caused profound impacts on various aspects worldwide, such as the economy [6][7], employment and production [8][9], society [10], as well as transportation [11], and logistics [12]. Few industries have been hit as severely by COVID-19 as transportation, especially the lockdown which directly imposes restrictions on residents' movement. Borkowski, Jazdzewska-Gutta [13] used a CATI (computer-assisted telephone interviewing system) survey and revealed significant reductions in daily travel during the pandemic. The effectiveness of mobility restrictions like lockdowns was confirmed, and other discoveries concerning changes in crowd behaviors were also made. Yu, Xie [3] conducted a regression analysis for the productivity of ride-sourcing and taxi markets and unraveled the impact of the pandemic. Silveira-Santos, Gonzalez [14] attempted to determine whether ride-hailing prices were affected due to the COVID-19 pandemic using time series forecasting and machine learning. Shen [15] studied the commute in Shanghai during post-pandemic rehabilitation and provided a clearer understanding of the health and sustainability challenges for policymakers. Yang [16] also proposed a collaborative use of location-based datasets, statistical datasets, and theoretical urban economic models to build a planning support framework. A novel public health concept, Fangcang Shelter Hospitals, was implemented to tackle the coronavirus disease 2019 outbreak in China [17]. It should be noted that in many Western countries, the policies and measures to cope with COVID-19 were not as stringent as those in China. In Italy, initiatives including city time planning, decentralization of public facilities, and lockdowns in some regions [18] were implemented. The roles of public transport [19] and transport accessibility [20] during the COVID-19 pandemic were also studied in Italy, to facilitate the definition of possible policies or best practices.

A specific mode of transportation is often used as a sample to reflect and analyze the changes in human mobility in the context of the pandemic, especially for public transport in a broad sense including public mass transit, bike-sharing, and ride-hailing. Hu, Xiong [21] leveraged two-year bike-sharing trips to examine spatiotemporal changing patterns during the epidemic. Zhou, Liu [22] researched the impact of COVID-19 on microtransit (between individual private transport and public mass transit) using eigen decomposition and K-clique percolation and tracked the variation in and evolution of spatiotemporal mobility patterns. The impact of COVID-19 on an individual's travel mode choice was also studied [23]. They found that public mass transit was a trend on long trips, and the industry of online car-hailing had received a sharp shock.

3. Studies Based on Online Car-Hailing Data

The vast quantity of online car-hailing data collected by TNCs (Transportation Network Companies) provide researchers with a golden opportunity to study residents' travel behavior and human mobility from a new perspective. Copious studies based on ride-hailing (or taxi) data have been conducted in numerous aspects such as spatiotemporal patterns [24][25][26], traffic congestion [27], land use [28], travel for specific purposes [29][30], the competitive relationship between online car-hailing and the cruise car market [2][31], and so on. Liu, Kang [32] researched intra-urban trip patterns in Shanghai using online car-hailing data containing approximately one and a half million trips. Bi et al. [33] successfully identified job-housing sites using online car-hailing data. Notably, machine learning (especially deep learning) methods were also introduced into the study of online car-hailing data, to predict variations in patterns [34], changes in the supply and demand [35], and so on.

Since the onset of COVID-19, the car-hailing industry has been remarkably affected, which has attracted much attention from scholars. Zheng, Zhang [2] utilized the taxi data covering the lockdown period and phased reopening in Shenzhen, China, to analyze the relationship and variations in the supply and demand. Many insights were gained in their study and suggestions were made. Yu, Xie [3] empirically revealed the impact of the epidemic on the ride-sourcing and taxi markets in Ningbo, China. Li, Bao [36] explored spatio-temporal and behavioral variations in taxi travel in New York City during COVID-19. They found that the hotspots of travel destinations had changed by spatial clustering.

Additionally, the modifiable areal unit problem (MAUP) is a well-known problem in geographical studies, which is a source of statistical bias that often occurs in spatially aggregated data. The MAUP was first addressed by Openshaw [37] in 1984: "The areal units (zonal objects) used in many geographical studies are arbitrary, modifiable, and subject to the whims and fancies of whoever is doing, or did, the aggregating". Some scholars have conducted research [38][39] based on online car-hailing data in the context of MAUP. Approaches to handle the MAUP include simply acknowledging its presence and performing multiscale and multizonal system analyses. The other extreme is to develop scale-independent or insensitive analytical techniques, but it has little success [40].

References

1. WHO. Coronavirus (COVID-19) Dashboard. Available online: https://covid19.who.int/ (accessed on 13 September 2023).
2. Zheng, H.Y.; Zhang, K.N.; Nie, Y. Plunge and rebound of a taxi market through COVID-19 lockdown: Lessons learned from Shenzhen, China. Transp. Res. A-Policy 2021, 150, 349–366.
3. Yu, J.R.; Xie, N.K.; Zhu, J.T.; Qian, Y.W.; Zheng, S.J.; Chen, X.Q. Exploring impacts of COVID-19 on city-wide taxi and ride-sourcing markets: Evidence from Ningbo, China. Transp. Policy 2022, 115, 220–238.
4. Kogan, K.; Herbon, A. Retailing under panic buying and consumer stockpiling: Can governmental intervention make a difference? Int. J. Prod. Econ. 2022, 254, 108631.
5. Lavuri, R.; Jaiswal, D.; Thaichon, P. Extrinsic and intrinsic motives: Panic buying and impulsive buying during a pandemic. Int. J. Retail Distrib. 2022, 51, 10.
6. Nicola, M.; Alsafi, Z.; Sohrabi, C.; Kerwan, A.; Al-Jabir, A.; Iosifidis, C.; Agha, M.; Agha, R. The socio-economic implications of the coronavirus pandemic (COVID-19): A review. Int. J. Surg. 2020, 78, 185–193.
7. Sharif, A.; Aloui, C.; Yarovaya, L. COVID-19 pandemic, oil prices, stock market, geopolitical risk and policy uncertainty nexus in the US economy: Fresh evidence from the wavelet-based approach. Int. Rev. Financ. Anal. 2020, 70, 101496.
8. Paul, S.K.; Chowdhury, P. A production recovery plan in manufacturing supply chains for a high-demand item during COVID-19. Int. J. Phys. Distrib. Logist. 2021, 51, 104–125.
9. Selden, T.M.; Berdahl, T.A. COVID-19 And Racial/Ethnic Disparities in Health Risk, Employment, And Household Composition. Health Affair 2020, 39, 1624–1632.
10. Chakraborty, I.; Maity, P. COVID-19 outbreak: Migration, effects on society, global environment and prevention. Sci. Total Environ. 2020, 728, 138882.
11. Tirachini, A.; Cats, O. COVID-19 and Public Transportation: Current Assessment, Prospects, and Research Needs. J. Public Transp. 2020, 22, 1–21.
12. Singh, S.; Kumar, R.; Panchal, R.; Tiwari, M.K. Impact of COVID-19 on logistics systems and disruptions in food supply chain. Int. J. Prod. Res. 2021, 59, 1993–2008.
13. Borkowski, P.; Jazdzewska-Gutta, M.; Szmelter-Jarosz, A. Lockdowned: Everyday mobility changes in response to COVID-19. J. Transp. Geogr. 2021, 90, 102906.
14. Silveira-Santos, T.; Gonzalez, A.B.R.; Rangel, T.; Pozo, R.F.; Vassallo, J.M.; Diaz, J.J.V. Were ride-hailing fares affected by the COVID-19 pandemic? Empirical analyses in Atlanta and Boston. In Transportation; Springer: Cham, Switzerland, 2022.
15. Shen, Z.Y. Workplace commute in Shanghai under post-pandemic rehabilitation: Health and fitness problems in planning and sustainability challenges. Front. Environ. Sci. 2022, 10, 1037363.
16. Yang, T.R. Understanding commuting patterns and changes: Counterfactual analysis in a planning support framework. Environ. Plan B-Urban 2020, 47, 1440–1455.
17. Chen, S.M.; Zhang, Z.J.; Yang, J.T.; Wang, J.; Zhai, X.H.; Barnighausen, T.; Wang, C. Fangcang shelter hospitals: A novel concept for responding to public health emergencies. Lancet 2020, 395, 1305–1314.
18. Angiello, G. Toward greener and pandemic-proof cities: Italian cities policy responses to COVID-19 outbreak. Tema 2020, 13, 271–280.
19. Carteni, A.; Di Francesco, L.; Henke, I.; Marino, T.V.; Falanga, A. The Role of Public Transport during the Second COVID-19 Wave in Italy. Sustainability 2021, 13, 11905.
20. Cartenì, A.; Di Francesco, L.; Martino, M. The role of transport accessibility within the spread of the Coronavirus pandemic in Italy. Safety Sci. 2021, 133, 104999.
21. Hu, S.H.; Xiong, C.F.; Liu, Z.Q.; Zhang, L. Examining spatiotemporal changing patterns of bike-sharing usage during COVID-19 pandemic. J. Transp. Geogr. 2021, 91, 102997.
22. Zhou, Y.R.; Liu, X.C.; Grubesic, T. Unravel the impact of COVID-19 on the spatio-temporal mobility patterns of microtransit. J. Transp. Geogr. 2021, 97, 103226.
23. Luan, S.L.; Yang, Q.F.; Jiang, Z.T.; Wang, W. Exploring the impact of COVID-19 on individual's travel mode choice in China. Transp. Policy 2021, 106, 271–280.
24. Ferreira, N.; Poco, J.; Vo, H.T.; Freire, J.; Silva, C.T. Visual Exploration of Big Spatio-Temporal Urban Data: A Study of New York City Taxi Trips. IEEE Trans. Vis. Comput. Graphs 2013, 19, 2149–2158.

25. Liu, Y.X.; Zhang, L.; Zhou, Y.X.; Xu, Q.; Fu, W.; Shen, T. Clustering-Based Decision Tree for Vehicle Routing Spatio-Temporal Selection. Electronics 2022, 11, 2379.
26. Li, T.; Jing, P.; Li, L.C.; Sun, D.Z.; Yan, W.B. Revealing the Varying Impact of Urban Built Environment on Online Car-Hailing Travel in Spatio-Temporal Dimension: An Exploratory Analysis in Chengdu, China. Sustainability 2019, 11, 1336.
27. Zhang, K.S.; Sun, D.; Shen, S.W.; Zhu, Y. Analyzing spatiotemporal congestion pattern on urban roads based on taxi GPS data. J. Transp. Land Use 2017, 10, 675–694.
28. Gong, L.; Liu, X.; Wu, L.; Liu, Y. Inferring trip purposes and uncovering travel patterns from taxi trajectory data. Cartogr. Geogr. Inf. Sci. 2016, 43, 103–114.
29. Zhou, Y.; Zhang, L.; Xu, Q.; Liu, Y.; Fu, W. Characteristics Exploration of Hospitals in Shanghai through Spatial Relationship Using Taxi Data. In Proceedings of the IEEE 2022 7th International Conference on Image, Vision and Computing (ICIVC), Xi'an, China, 26–28 July 2022; pp. 287–292.
30. Liao, C.W.; Chen, C.; Zhang, Z.Q.; Xie, H. Understanding and visualizing passengers' travel behaviours: A device-free sensing way leveraging taxi trajectory data. Pers. Ubiquit Comput. 2012, 26, 491–503.
31. Nie, Y. How can the taxi industry survive the tide of ridesourcing? Evidence from Shenzhen, China. Transp. Res. C-Emerg. 2017, 79, 242–256.
32. Liu, Y.; Kang, C.G.; Gao, S.; Xiao, Y.; Tian, Y. Understanding intra-urban trip patterns from taxi trajectory data. J. Geogr. Syst. 2012, 14, 463–483.
33. Bi, S.B.; Wang, L.Y.; Liu, S.L.; Zhang, L.L.; Yuan, C. Identification of Urban Jobs-Housing Sites Based on Online Car-Hailing Data. Sustainability 2023, 15, 1712.
34. Bi, S.B.; Yuan, C.; Liu, S.L.; Wang, L.Y.; Zhang, L.L. Spatiotemporal Prediction of Urban Online Car-Hailing Travel Demand Based on Transformer Network. Sustainability 2022, 14, 13568.
35. Ge, H.X.; Li, S.T.; Cheng, R.J.; Chen, Z.L. Self-Attention ConvLSTM for Spatiotemporal Forecasting of Short-Term Online Car-Hailing Demand. Sustainability 2022, 14, 7371.
36. Li, S.; Bao, S.T.; Yao, C.Y.; Zhang, L. Exploring the Spatio-Temporal and Behavioural Variations in Taxi Travel Based on Big Data during the COVID-19 Pandemic: A Case Study of New York City. Sustainability 2022, 14, 13548.
37. Openshaw, S. In Modifiable Areal Unit Problem. In Proceedings of the ACM SIGSPATIAL International Workshop on Advances in Geographic Information Systems, Irvine, CA, USA, 5–7 November 2008.
38. Wang, Z.B.; Gong, X.; Zhang, Y.C.; Liu, S.Y.; Chen, N. Multi-Scale Geographically Weighted Elasticity Regression Model to Explore the Elastic Effects of the Built Environment on Ride-Hailing Ridership. Sustainability 2023, 15, 4966.
39. Duan, Y.; Yuan, C.; Mao, X.; Zhao, J.; Ma, N. Influence of the built environment on taxi travel demand based on the optimal spatial analysis unit. PLoS ONE 2023, 18, e0292363.
40. Pearce, J.R. International Encyclopedia of Human Geography; Elsevier: Amsterdam, The Netherlands, 2009.