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COVID-19 PANDEMIC AND THE SUBSEQUENT EFFECT ON PUBLIC TRANPORT IN ASIA

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Final Draft

COVID-19 PANDEMIC AND THE SUBSEQUENT EFFECT ON PUBLIC TRANPORT IN ASIA[1]

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Abstract:

Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) outbreak was first reported in Wuhan, P. R. China (hereafter China) in December 2019 which caused global pandemic as COVID-19 disease leading to millions of infections and deaths worldwide. As a response, strict policy measures from social distancing to lock-down activities have been implemented all over the world to prevent further spreading of COVID and to protect human lives. This have significant implications for the mobility and connectivity of people and freight movement, and affected the overall transport system, particularly in major cities in Asia and the Pacific. Since railways and buses contribute to the intercity mobilities in Asia, the pandemic has had a large impact on the livelihood, health and economy of cities and the communities of the of Asia and Pacific who had to experience life without such default travel methods or last mile connectivity. Through this study, the issues in the intercity transportation in Asian cities during mobility restrictions have been analysed and highlighted. Since resilient and transportation infrastructures the sustainable urban development are significant aspects of the socio-economic transform of low-income and middle-income countries, identifying the problems faced during the COVID-19 pandemic such as cost, hygiene, perception and satisfaction of the customers and staffs, would help to adhere to necessary practices for a safe and sustainable future transport development.

Key words: - COVID-19 Impacts, Mobility, Connectivity, Public Transport, Asia

1. Introduction

Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) outbreak was first reported in Wuhan, China in December 2019 leading to a global pandemic (declared by the World Health Organization or WHO on 11 March 2020) called COVID-19 disease. Around mid-January 2020 imported cases of COVID-19 appeared in other Asian countries such as Thailand, Japan, Republic of Korea, Singapore and thereafter the virus quickly spread to around 56 countries. Since then millions of people have been quarantined in one of the histories' largest pandemics. The spread of the COVID-19 outbreak since December 2019 has been traumatic in the global scale. Due to globalization, the pandemic has spread to almost everywhere in the world and its socio-economic impact shook every corner of the globe. Aa of 9 November 2020, approxmately 1,264,147 people have died from the coronavirus COVID-19 outbreak (www.worldometers.info).

Studies show that as of 18 June 2020, around 8.39 million people were infected globally and 451 thousand died from the virus, whereas by 18 October 2020, 39.7 million people have

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[1] The views expressed in this paper are of the authors and do not necessarily reflect the views of the United Nations.

been infected worldwide from COVID-19 disease and around 1.11 million died, which revel significant casualties over time since COVID-19 pandemic started in December 2019 From June 2020 onward, upward trend of the infection was noticed in South Asia, particularly in India, which holds second position after the United States in number of infected cases and deaths occurred. . As a response to COVID-19, number of policy measure from simple social distancing to strict restrictions of complete lock-down were introduced by city authorities and governments. to curb the growth of the virus. The mandatory control procedures, strict restrictions and lockdowns imposed across the world to tackle the spread of the disease affected the whole transport system and transportation industry.

Transport played an important role in the spread of COVID-19 disease. Various industries have been affected due to successive lockdowns and mobility restrictions, but transportation also contributed towards success of the frontline workers in reaching the needy ones in time and saving them. Demand and supply of many good and services halted because of reduced mobility options and limited connectivity. However, demands for online deliveries increased due to the lockdown and hence some businesses particularly which are mainly based on the e-commerce flourished. Asia being home to some of the most polluted mega-cities and most populated countries in the world, showed unbelievable changes in the air quality because of travel restrictions.

The outbreak has caused profound impact on the mobility of passengers, employees and on freight connections. Bus and train networks across Asia have been hit by the pandemic. The public transit in buses, flight, railways, and ferry services were restricted first on 23 January 2020 in China and thereafter it was implemented in other countries. China holds an important role in marine freight and international trading which has been crippled due to the virus outbreak. Domestic travel or inter-state network is a key factor contributing to the national economies which was disturbed across Asia and the Pacific. Migration contributes to the urbanization since many people move to the cities from rural areas due to employment or education. As developing nations or low- and middle-income countries, restrictions on transportations imposed reduced economic activities for industries including bus and railway operators which in turn affected the fractured and fragmented urban transportation in Asian countries. During the economic crisis, passenger's behaviour further changed and the employment in the transportation sector suffered the most. Many lost jobs including in transportation and informal workers had to migrate back to their home regions. Work from home attributed to the new normal. The educational institutes have started online learning processes. Asia and the Pacific is world famous for attractive touristic locations and the lockdown affected the international as well as the domestic tourism. The sudden impact significantly declined passenger numbers in the airlines, national railways and the bus transportations. Since commuters were advised to avoid non-essential travels during the lockdown, passenger demand dropped, and transportation operators (both public and private sector) incurred huge financial losses.

The regulations governing restrictions, quarantines, and cost to manage the outbreak differed between cities and countries. It has been very challenging to deal with the high-risk countries with higher COVID-19 infections. The takeaway from the pandemic is the unique opportunity to reimagine a more resilient and sustainable transportation system in Asia and the Pacific for a seamless experience. In these scenarios, the present study focuses on the perception and satisfaction of the passengers and the employees in the transportation industry before and after the pandemic in Asian countries with respect to intercity travel. The study also highlights the pricing changes before and after the pandemic. The main objective of this research is to identify

the factors impacting the urban transportation systems of buses and railway networks in the Asian cities due to the pandemic. Currently countries are trying to move back to normal reopening businesses and lifting out travel restrictions. However, economic collapses and lack of vaccines are still affecting the approaches of both the commuters and workers in transportation. This study helps to provide suggestions for future mobility in Asia so that a cost effective, coordinated, and safe environment could be provided for all

2. Literature Review

Around half the world's population live in the cities, making the cities as the turning points in the development of a nation. The urban transportation has been greatly affected during the COVID-19 lockdown with respect to migration, infrastructure, people's perception, hygiene requirements and customer satisfaction level. Zhang et al. (2020) analysed and related the frequencies of air flight and high-speed trains services from Wuhan, China with the number of COVID-19 infection cases in the destination cities. Ai et al. (2020) found out significant relationship between mobility and COVID-19 infections. For COVID-19 disease, 194 countries adopted travel and visa restrictions, border closure etc. which is a sharp increase from the travel and trade restrictions imposed during 2009 H1N1 influenza pandemic and 2013-16 Ebola outbreak (Worsnop, 2017; The Lancet, 2020). Travel restrictions showed significant effects in France and the Islamic Republic of Iran but had perplexing impacts in the United States (Hsiang et al., 2020). A customer satisfaction study of Select Bus Service in New York attributed service quality as the most important factor influencing overall satisfaction influencing frequency, on-time performance and speed (Wan et al. 2016). Factors like bus-only lanes, three door buses, limited stops, real-time information, comfort and cleanliness and proximity to stoppage also influence the rider satisfaction levels (Wan et a. 2016). Due to highly contagious nature of SARS-CoV-2 virus there are risks associated in using public transportation and being in public spaces. Hence, social distancing and personal hygiene should be followed across the public transportation systems. Public transportation was reduced in many places due to the perception that it is riskier than private transportations and the discomfort has increased in crowded bus and trains since the COVID-19 pandemic due to the fear of being infected (Tirachini & Cats, 2020; UITP, 2020). The virus incubation period (1 to 14 days) and lack of control measures could lead to issues in identifying the passengers or workers who are sick. The virus can be spread through multiple common surfaces across bus and train networks such as seats, handrails, doors, ticket machines etc. (Tirachini & Cats, 2020; UITP, 2020) as well as being near other passengers and employees who have COVID-19 symptoms.

Public transport is essential to provide mobility, even during pandemics and the key objective of the transport operators should be to maintain the operation and to focus on the staff, protect them and to prepare dealing with absenteeism (UITP, 2020). The COVID-19 respiratory infection can be transmitted through droplets of 5 to 10 µm and aerosols of smaller than 5 µm exhaled from the infected individuals while speaking, breathing, sneezing or coughing (Tirachini & Cats, 2020; Prather et al. 2020). Hence, closed spaces in the public transportation is often challenging for daily commute during the pandemic. To resume general activities at the workplace and for safe mobility, sufficient ventilation, air filtration and strict hygiene protocols should be followed in the buses and railways and at the station facilities. Current research suggests maintaining social distancing of 2 meters from each other in public spaces and wearing face masks as precautionary measures. Only people suffering from respiratory conditions and the healthcare workers were first advised to use face masks by WHO (World Health Organization). Globally, there was much criticism about it. Face masks were

suggested by WHO later 5 June 2020 to be used in public places and while opting for public transportation.

Migration has been an integral part in the inter-state travels in Asian countries. Whether it is work, for education or after marriage, a vast majority of people move to cities from rural areas to earn a good livelihood or to support their families. For example, as per the Census, there were 45.6 crore migrants (38% of the total population) in India in 2011 compared to 31.5 crores in 2001 (31% of the total population) with 45% increase in migrants between 2001-2011 (Census, 2011). The migration pattern in India can be categorized mainly as rural-urban, urban-urban as well as inter-state and intra-state migration. As per 2011 Census, 70% of intra-state migration occurred due to marriage and family (83% for females and 39% for males) and 8% moved for work within a state (21% male and 2% females) whereas 50% males and 5% females moved inter-state for work (total 60 million inter-state migrant labourers) (Census, 2011). During lockdown, a vast majority of migrants travelled back to their home states in India. Due to lack of appropriate travel facilities, people even had to walk kilometres to reach home which showed the lag in transportation industry as well as the social and financial inequalities in Asian regions.

According to studies, women show different travel patterns compared to men. They normally use shorter trips, use more public transport and conduct more care providing trips (such as accompanying children to and from schools, accompanying dependents to hospitals, buying groceries etc.). In developing countries, women normally use different formal and informal modes of transport in a day to fulfil their multi-purpose trip needs. In developed countries women takes benefit of easier accessibility whereas in middle- or low-income countries women's transport depend on traditional and religious beliefs, poor road and transport connectivity, lack of streetlights, inadequate construction, safety, financial constraints etc.

2. **Methodology**

The goal of the study is to understand mobility in the urban transportation context in Asia in the wake of COVID-19 pandemic. The study has taken several parameters to interpret the ongoing situation and its impacts on several parameters such as safety and control procedures, changing ridership pattern, perception of passengers and employees, cost, and revenues. Online sources and secondary data resources has been extensively used in current uncertain scenarios. Through case studies, examples have been provided to know the differences and required actions for necessary measures.

Data Collection: In case of data collection, the following steps have been considered:
- Data mining – data mining has been used while interpreting the mobility data for Asian cities based on Apple organization's statistics, in understanding COVID-19 situation updates and while estimating patterns in examples and in case studies,
- Skimming through websites of WHO, UNESCAP (United Nations Economic and Social Commission for Asia and the Pacific) and other UN entities, different international organizations,
- Apple's COVID-19 data to check mobility patterns and the recent trends in Asian cities,
- Scanning through online information and news mediums,
- Keyword search methods in Google and social media platforms (mainly Twitter). Some examples of keywords used – "COVID-19", "Mobility", "Asia", "Bus", "Transportation", "Railways", "Intercity transport" etc.

A qualitative and quantitative analysis is conducted based on the data collected to draw the picture of the impacts caused by COVID-19 pandemic in the public transportation or shared mobility sector and the aftermath towards resilience. Through the study, crucial information are conveyed considering transport data gathered from various online resources currently available for different Asian regions to determine general perception and convenience about using public transportation, cost and safety factors in pandemic and suggestions to improve road connectivity in future.

3. Results and discussion

Travel restrictions in the Asian cities: very year more than one million people get killed due to driving crashes or from the air pollution caused by transport. The pandemic should be considered as an opportunity to rectify the drawbacks in transport to save life since death due to mobility is nothing but system failure. In major cities driving and public transit numbers went down from March end - June 2020. In August 2020, the mobility pattern slowly went up again as countries revived from lockdown restrictions. If we compare cumulative number of 14 days of COVID-19 cases per 100000, we can see that in the month of March 2020, Europe had the highest cases (34,530.97) leading to the highest cases in its peak in April 2020 (119,769.81) whereas Asia led the highest cases in June 2020 (69,0003.45). When the countries have slowly started to reopen, the risk of second wave increased again and cumulative cases suddenly increased in October 2020.
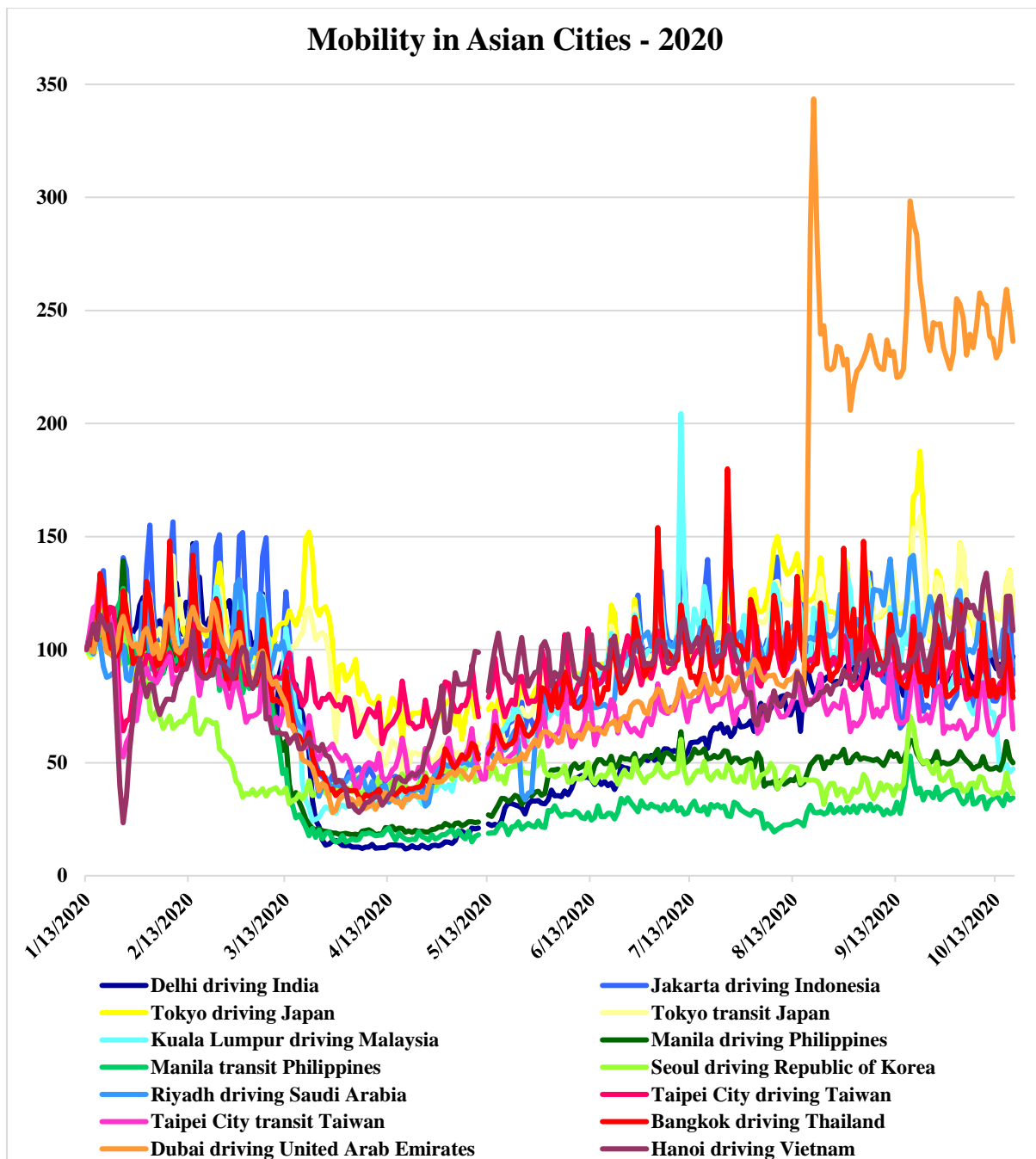
Figure 1: Comparison of city mobility in Asia in 2020. Below 100, the mobility is reduced and above 100, it has increased (source: Apple, https://covid19.apple.com/mobility).

Intercity and interstate trasnportation is largely connected with tourism industry and travellers from abroad. Across Asia, the reopening statuses vary. For India, though the intercity or interstate transport has been resumed, the country has had one of the worst outbreaks globally. From 15 July 2020, travelling is resumed to Maldives. Republic of Korea did not close its borders but took great meassures to control the infection rate. The borders were still closed in the East Asian countries in September 2020 apart from some travel corridors and travel bubbles while in Southeast Asia, Thailand started welcoming travellers in October while Indonesia halted reopening until further notice. The West Asian countries resumed transport and travelling quite early compared to other regions, however, countries like Israel and Georgia are still taking cautions.
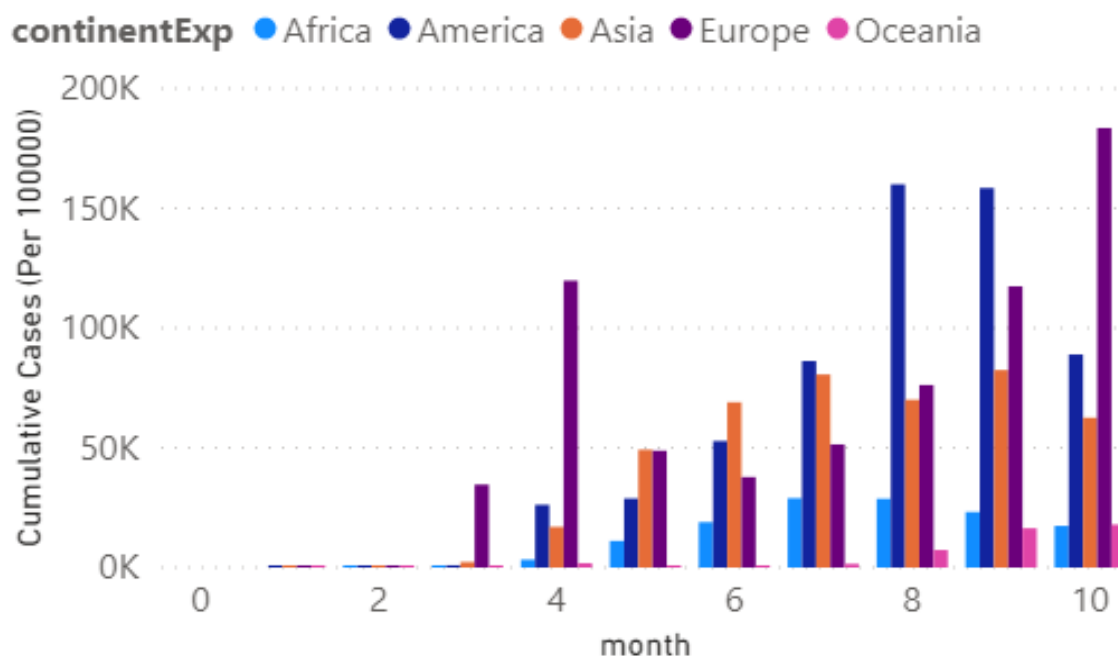
Cumulative Number for 14 Days of COVID-19 Cases

Figure 2: COVID-19 situation update worldwide (source: European Center for Disease Prevention and Control, https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases, accessed on 20 october 2020).

As per 20 october 2020, most of the Asian countries have lifted the internal restrictions. The policies related to internal travel and restrictions in some Asian countries are as followed:

Countries	Restrictions
China	Domestic travel restrictions have been lifted and local tourism industries have opened
Hong Kong, China	No restrictions, operation of public trasnportation
Japan	No restrictions on internal transportation
Taiwan, Province of China	Public transportation is operating
Republic of Korea	Businesses are open with social distanncing rules (region wise)
Vietnam	Domestic transportation is resumed as well as some tourist attractions
Singapore	No restrictions on internal travel
Indonesia	Phased reopening for businesses
Philippines	Restricted domestic travel

3.2 Safety and control measures: To improve air flow, ventilation systems were provided in the metro stations, platforms, trains and tunnels round the clock in China. The measures in buses and trains were almost similar during the beginning of the outbreak. The Shanghai metro and Guangfo metro (connecting Guangzhou with Foshan) are the biggest inter-city or cross-provincial metros providing rapid transits. In Wuhan, buses and metros were suspended from 24 January to 28 March 2020. Out of 40 Chinese cities with metros, 8 completely suspended operations, 13 closed some stations, 30 adjusted operating hours and 2 cities took no adjustments in operations (ITDP, 2020). In Beijing, metro stations were disinfected five times daily and commonly used surfaces such as security screening equipment, ticketing machines, elevators and entry gates were hourly disinfected (ITDP, 2020). In Shanghai, single ticket coins were sterilized after uses and extra measures were taken in hygiene in stations in proximity to hospitals. In Guangzhou, body temperatures were checked for the passengers with handheld devices, thermal imaging cameras were deployed for faster process, protective masks were made compulsory, QR codes were required later to prove their status as not high-risk and during busy hours, passengers were asked to que in open air with safe distancing. If proven high risk, passengers were taken to isolation areas in the stations by staff wearing PPE suits followed by medics to the hospitals and the passenger's residential community as well as institutions were notified. Masks and gloves were mandatory for metro staff and body temperature at the start and end of the shifts were monitored. Though extra trains were operated, and express trains were provided for high demand stations in Guangzhou, additional wait time during peak hours has been deterrent for passengers. Metro passengers were afraid to take the metros in the first months of the COVID-19 outbreak but had no choice for long trips; a Guangzhou rider told that she was scared to talk or touch anything inside metro and though clean, everything smelled like disinfectant; a Beijing passenger told that she opted for metros to avoid traffic and getting stuck in buses, took early train to avoid peak hours and wore masks for protection (ITDP, 2020). In Nepal, passengers received free face masks in electric bus if they did not have one. In September 2020, Kochi Metro Rail, India announced that passengers would be screened with infrared thermometers, thermal cameras would be installed at busy stations, communication via passengers and staff would be through speakers and microphones, contactless ticket machines and cash boxes would be installed (Kochi Metro Rail, 2020c).

To be used for general public, many Asian cities in countries like India, China, Republic of Korea etc. have introduced mobile apps, kiosks to check temperatures and smart bus shelters as businesses and workplaces have been starting to open again. Even with social distancing measures, hygiene and safety practices that have been followed, many people are still reluctant to use public transportation. But people also feel safer using the apps since they are quite convenient and provide safety to the commuters by showing in the app if someone sitting nearby in the particular journey is infected by COVID-19. In south China's Shenzen, east China's Ningbo and north-eastern China's Shenyang, passengers have to scan QR codes available through portals such as popular messaging application WeChat or via SMS while using various modes of public transportation. After confirming identities in the first-time logins, the passengers get warning messages if the nearby passenger is suspected of having COVID-19 and for passengers not using smartphone, the process is manual through transportation staff members. Minimal encrypted data is collected in Shenzen and Ningbo to ensure digital privacy.

Countries like China, Singapore and Republic of Korea were quick to use the technology for contract tracing. In China the outbreak started earlier, so the peak arrived earlier and hence control measures were taken earlier than other Asian countries. China's health app was one of the firsts to use technology to contract trace. By March 2020, China used Artificial

Intelligence (AI) technology to spot infections whereas in the Republic of Korea, cell phone and satellite technology was used to identify and track potential carrier. In Singapore digital maps have been used to see the crowded places. Now other Asian countries have been mandating control measures such as mobile apps, temperature scanning, facial recognition cameras, drones and digital check-ins as people are getting back to work, using transit inter-state or intra-state. In India, mobile app called "Aarogya Setu" has become mandatory to download while boarding flights or using the public transportations for contract tracing, monitoring people under quarantine though the authorities earlier said that using the app was voluntary. In March 2020 during the pandemic, Beijing planned for subway access through appointment to prevent crowding. Around 70% citizens supported the Singaporean government's "TraceTogether" application which connects Bluetooth signals between devices in close proximities. People coming to Hong Kong, China are asked to download "StayHomeSafe" application and wear a geofencing enabled wristband to stop intercity transmissions, violation of which lead to six months prison and $3,200 fine. One of the top applications for the Republic of Korea crowd is "Corona 100m", where passengers can check the proximity to Coronavirus patients since the application gathers demographic data and the places visited. To avoid COVID-19 increasing areas, another popular application is "Corona Map" (most downloaded application in Korea). Korean government considered strict approach to control the outbreak by passing laws after the MERS (Middle East Respiratory Syndrome) outbreak lesson in 2015. Seoul installed solar powered bus shelters equipped with temperature reading thermal imaging cameras and ultraviolet sterilizers and Singapore stated touch-free kiosks in 70 bus stops and train stations for temperature reading (green light showing safe and orange reading unsafe). Taiwan, Province of China is reportedly the first country to use mobile phone tracking during COVID-19 since it was hit the hardest during the 2003 SARS (Severe Acute Respiratory Syndrome) outbreak. Taiwan, Province of China also started filling up health declaration forms by passengers to know their travel history which was later shared to all medical facilities. According to a 1,000-participant survey conducted by Hallym University, Republic of Korea, the residents supported sharing of travel data amidst the debate of digital privacy and most participants preferred public good than individual.

According to the international organisations American Public Transportation Association (APTA) and the International Organisation for Public Transport Authorities and Operators (UITP), the following measures could be taken to protect the transport employees (APTA, 2020; UITP, 2020):

- Limited contact with others and maintaining social distancing
- Wearing face covering/masks
- Regularly washing hands with soap and water for at least 20 seconds and using at least 60% alcohol-based hand sanitizers, avoid touching eyes, nose, or mouth. Hand should be washed before and after shifts and work breaks, before eating food, avoid touching common surfaces like fareboxes and handrails. Hand should be washed before, during and after preparing food, after using toilet and after blowing nose, sneezing, or coughing
- Avoiding touching surfaces often touched by the passengers and routine cleaning of those common surfaces including those in the operator areas and if necessary, wearing gloves to touch the areas contaminated by body fluids. If cleaning in between shifts are not possible, employees should handle waste disposal and disinfecting surfaces
- Closing staff gathering spaces (lounges, gyms, locker rooms and common hangout areas) and minimize non-essential commodities and couches to practice social distancing; staff wash and dressing tooms, meeting rooms and offices should be equipped with hand disinfectants and paper tissues

- Manage reporting for duty/sign in and accident reporting by radios from assigned vehicles or through individually assigned tablets, conduct virtual meetings, and promote virtual bulletin boards. Remote working should be encouraged where the activities could be carried out without physically being present
- Installing temporary standee line with chains inside buses or trains or use operator shields if required
- Run additional railcars to support physical distancing for rail operators or engineers and have the operator/engineer to walk outside rather than through the cars to their operating cab.

In Guangzhou, metro staff found it challenging to adjust, inform, communicate and regulate the passenger flow to the changing threat levels of COVID-19 since there wasn't any pandemic related training and tasks complications were based on each day scenarios. During four months of lockdown in Nepal from March 24, few transportation services resumed from July 2020 onwards. Nepal was in lockdown from 24 March 2020 onwards when the infection cases were only two. On 21 July 2020, the lockdown was relaxed and then the infection cases rose to around 17,000. Sundar Yayat buses resumed its first electric feet in the country from 14 July onward at an affordable price. The bus was sanitized and disinfected regularly, and the drivers were provided with gloves, PPE (Personal Protective Equipment), boots and face masks. Various bus operators conducted PCR (Polymerase Chain Reaction) test for both the drivers and vehicle assistants since around 50 thousand people move daily from Kathmandu (where half of the infection occurred in the country) to other cities which increased the risk of COVID-19 in Nepal. Kochi Metro Rail asked its staff to deal with all cash related services wearing gloves and cleaning and disinfecting commonly used areas such as automatic fare collection gates, ticket counters, handrails of staircases, escalators, lift buttons and platform chairs etc. in every four hours interval (Kochi Metro Rail, 2020c). In Pune, India, buses were sanitized with calcium hypochlorite spray after each trip and washed at night as well.

Case Study: Shenzhen Bus Group
Shenzen is reportedly the city with biggest immigration population, specially from Hubei, the epicentre of the pandemic (TUMI, 2020). Measures were adjusted in the Shenzen buses during the pandemic for hygiene, robust management and movement of the employees and clear communication. The emergency measures included deploying managers to ensure that passenger load is not above 50%.and camera was installed to monitor the passenger flow. It was also influenced by Chinese New Year when people avail intercity transportation more to go home from work or study locations. All the passengers, drivers aboard and the staff were required to wear masks and the drivers had the right to deny commuters onboarding if they were not wearing masks. Sanitization was the most important aspect in the Shenzen buses during the pandemic and buses were sanitized after each trip. The commonly handled surfaces in buses like handrails, seats, armrest were disinfected regularly. All the transport offices, bus depots and other premises were ventilated 2-3 times daily for a minimum duration of 30 minutes to ensure that fresh air was circulated. This was also targeted to the emergency workforce. Routine monitoring and strategy planning were two important aspects in the Shenzen buses to help people moving and ease the mobility options for essential workers.

Hygiene and cleanliness was maintained in the 50 canteen areas in the transportation sector where three meals were served per employee. The seating arrangement was changed to one person sitting arrangement and masks was only allowed to remove while eating. There was different timing for different departments to allow socially distanced entry and exits. Thermal sterilizers were used to keep the tableware, cutleries clean and washed with appropriate

detergent contents. Commuters were asked to update the travel destinations for the transport employees to monitor the status. Since most people in the area are immigrated from Hubei, outward passengers to Hubei were told to stay put in Hubei and in case passengers were returning back, they were in mandatory quarantine for 14 days. During the severe outbreak period in China, there were 14 temperature checking stations and the staffs were dispatched 24/7 in different shifts to monitor passenger flow from the headquarters (TUMI, 2020). To ensure safety for staff and commuters, "One Route One Plan," "iShnzen," "Epidemic Prevention App" were used (TUMI, 2020). Drivers of evacuation buses were in full protective gear and were self-isolated for 14 days after the mission was completed. The passengers coming from Hubei were in quarantine centres assisted with dispatched vehicles to hospitals later. Online training courses were also provided to make the commuters and staff members aware about the required safety and health measures.

3.3 Ridership pattern

The pandemic has caused dramatic drop in the number of people using public transportation across Asia and the Pacific. Suddenly, the lives of busy business travellers, people going for education in other places than their home regions, bi-coastal travellers became grounded. Depending on the job occupation, the disruptions have affected different individuals differently.

Many argue that the transportation congestion is the result of work culture and not of infrastructure. However, this raises debates on both the topics. People who have sufficient internet connections, computer and tools to work from home do not have to go physically to work. Work from home also provides a balance between private life and professional life since the person can spend enough time with family as well as work. However, shifting from a traditional work system could also lead to social isolation, greater issues while trying to solve technical problems, problems due to power cuts and connectivity and hence disrupts meeting target goals of the organization. Though many universities and educational institutes have transitioned to online education, adjusting to remote education compared to traditional face-to-face education might be a challenge for the students as well as for the educators. A slight shift to work from home and reduction in the number of vehicles, public transportation could reduce congestion. Clear skies in Delhi, Seoul or Wuhan, shocking pollution differences in Asian cities in the lockdown compared to prior to the pandemic, rebounding marine life and wild animals enjoying the freedom in the quieter world are the startling climate change scenarios observed during lockdown.

As per the UITP MENA region, the primary observations found during COVID-19 travel restrictions in urban context were – re-defined peak periods, shorter trips, preferred mode of walking, cycling etc., rise of online medium for education, work from home and ecommerce for deliveries. In a recent survey it was noticed that 35% were likely to change their mode of transport for work trips post COVID-19 (TERI, 2020). Decrease in ridership was noticed in Indian buses and metro train services. Comparing pre and post COVID-19 service, largest decrease was seen in metro services (9%), followed by buses (4%) and local trains (1%) (TERI, 2020). The shift to private vehicles included both high- and lower-income residents in India. In Jakarta, TransJakarta services were first built targeting the middle- and high-income groups towards shared mobility and to reduce traffic congestions. Post COVID-19, financial crisis can potentially improve shared mobility depending on household income, route convenience and safety measures provided in the public transportations. Subway ridership in Singapore fell by around 84% after partial lockdown was placed in early April 2020, passenger levels dropped by around 90% in Beijing in mid-February 2020 which was known to have 10 million subway

riders daily during normal times and in Hong Kong, China, the ridership on the Mass Transit Railway fell to about half from the normal passenger load (The Washington Post, 2020). According to Tom Tom traffic website, in January 2020 the traffic density was around 60% in Wuhan and around 80% in Shanghai and Beijing. The traffic density was more than 60% in cities like New Delhi and Mumbai during March 2020 which dropped to around 10% after the lockdown in April 2020. In Delhi, before the pandemic there were 3,500 fleet of interstate buses and more than 200,000 commuters every day including local bus passengers in its three interstate bus terminal stations. The number of buses would be 50% compared to pre-COVID-19 times when the ISBT stations would reopen in November 2020 which would influence the numbers of commuters. Rapid/RT-PCR tests would be done at the ISBT stations for riders' safety. In Hong Kong, China, ridership fell by 40-45% in February 2020 and started to increase in April 2020 (47%); in Japan the ratio was 88% in April 2020 compared to January 2020 and in Seoul, it fell by 44% in April 2020 beginning compared to January 2020 (Global Mass Transit, 2020).

Case Study: Singapore
      In 2019, commuters used public transportation more. According to the data of the Land Transport Authority (LTA), bus ridership grew by 1.5% (daily average riders = 4,099,000) whereas train ridership grew by 2.6% (daily average riders = 3,592,000) in 2019 and altogether there was 2% increase in public transportation trips per day (Tan, 2020). Public transportation has been growing in Singapore for more than a decade. Expansion of the train network and higher number of buses as well as increased services were the main reason of such high ridership in buses and trains. Some studies also suggested that the growing population of Singapore could be another reason of such growth. During the Chinese New Year, the ridership typically decreases. During the 2003 SARS outbreak, the ridership declined by 30%. In January-March 2020, the ridership declined by 20% followed by 68% in the last two weeks in March 2020.

3.4 Public Perceptions
      Some Asian cities are compared for using public transportation based on Citymapper Mobility Index. The users of Citymapper Mobility Index are public transportation users as well as other modes (walking, cycling, micromobility and cabs) except driving. Mobility dropped to 60% to more than 90% in April 2020.
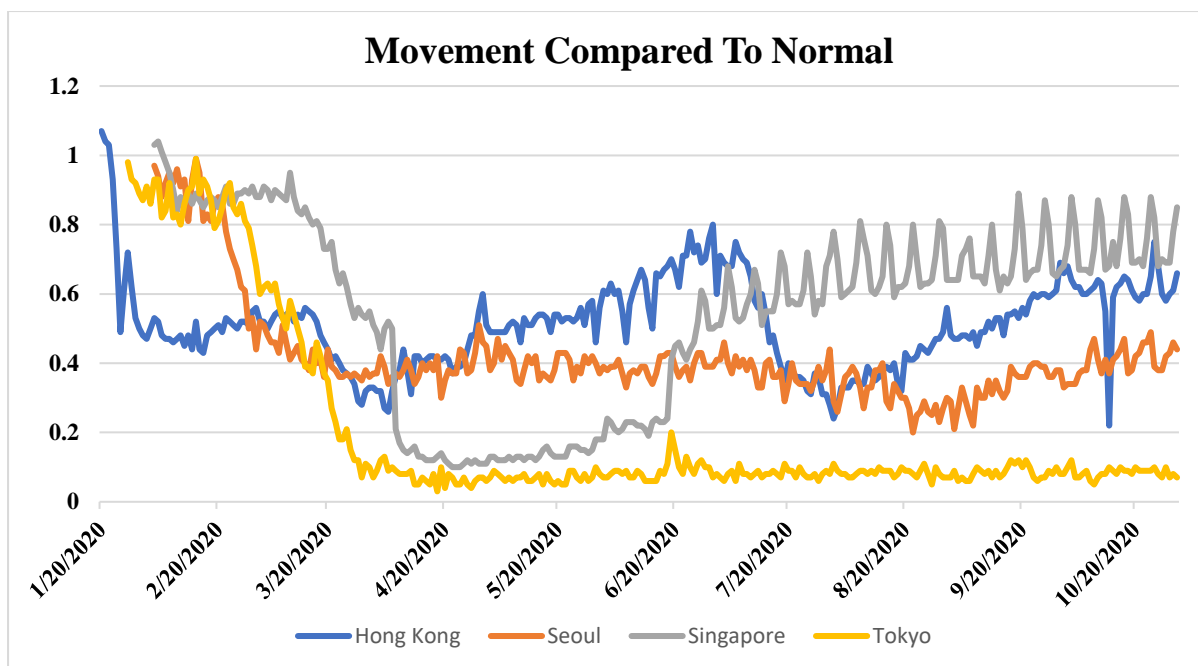
Figure 3: Comparison of mobility in cities including public transportation (source: https://citymapper.com/).

According to Marion Terrill, director of the transport and cities in Melbourne, "Even with distancing, hygiene and safety measures in place, though, many people will still avoid public transport. I expect to see a greater share of trips by car, as well as by cycling and walking" (World Economic Forum, 2020a). Intercity buses resumed its services from 10 October 2020 in Israel after the national media reported that cutting down the public transportation (around 75% in lockdown) actually increased the virus risk due to overcrowding. It was reportedly making hard for the essential worker to avail transportation and come to work. Commuters were complaining about the limited services since they had to board overcrowded buses or wait for one hour to get the next bus to work.

In a recent traveller sentiment survey in nine countries, it was found that more than half respondents felt uncomfortable while using public transportation like buses and subways. Working from home ratios are expected to increase. 41% of regular users of mass transit told that they would use it less after the pandemic, 59% demanded regular disinfection of vehicles, 49% supported safe social distancing marks on the ground, 52% respondents wanted to make wearing face masks mandatory, 69% and 49% Chinese participants wanted mandatory masks for the riders and more invasive measures such as taking passengers' temperatures before or during the trip respectively (World Economic Forum, 2020b). In another IIT (Indian Institute of Technology) survey including Tier-1 (63.6%), Tier-2 (20.6%) and Tier-3 (15.8%) cities, it was found that 12% (Tier-1), 9% (Tier-2) and 7% (Tier-3) commuters shifted from public to private transportation during the third week of COVID-19 during pre-lockdown in India and 93% respondents favoured private transportation compared to public transportation in safety (Telangana Today, 2020). 20% also cancelled their train journeys (Telangana Today, 2020).

Some of the plights and reviews of the commuters, employees (bus drivers, labourers) and operators (such as in roles of Director General, General Secretary etc. in transportation) are:

Country	Passenger	Employees	Operators or Business Owners	Source
Nepal		"I haven't received my salary for three months" "I have been sustaining my family using relief materials provided by the owner of the bus" "My company owner has bank loans to repay, nut business is nil"	"We are not sure when we can resume public vehicles as the number of COVID-19 cases has increased rapidly" "We have been unable to pay the salary of our 300 staffers, but we have been providing them relief food, so that their family will not die of starvation" "Nearly 80 percent of public transport vehicle owners have loan to pay for banks and finances, but they are not earning, the situation is very difficult for them, but the government is too indifferent to their problem"	The Kathmandu Post (2020)
India			"The construction of Terminals are progressing at various locations. The new 8 terminals will ensure connectivity between rural parts of Kochi and the mainland. The construction of these terminals will be completed in early 2021" "For the residents of Kochi, it's business as usual. Rest assured; you are in safe hands"	Kochi Metro Rail (2020a), Kochi Metro Rail (2020b)
Israel			Curtailing public transportation would increase virus incidences and would harm the poor, "who had no alternative"	Haartez, 2020
Indonesia	"I queued for two hours because they reduced the buses' headway" "I get that they want to minimise the risk of infection but if the que is like this, the plan has totally backfired" "This is not social distancing but killing us slowly (for) sure"	"My office needs to set up the IT system and workflow. Had (the government) given time for companies to adjust and implement the recommendation, there wouldn't be chaos like this" "We will limit the number of passengers boarding the buses and trains, as well as entering the stations and bus stops" "The government should have been more firm because this is an outbreak" "If people are still allowed to go to work and leave their houses, there must not be any restrictions on the use of public transportation"	"While many of the city's workers are currently working from home, essential services remain open in the city and there are many workers whose livelihoods depend on the jobs in these sectors. For many communities, the bus system is their only method of transport. Therefore, UNDP's partnership with Transjakarta drives home the message that we care about all communities – especiay the most vulnerable- as we deal with the current pandemic. Through this partnership, UNDP remains committed to helping all communities and ensuring no one is left behind"	UNDP, 2020; cna, 2020

Dubai, United Arab Emirates		"We had started the installation of 151 smart screens at public bus stops, and 9 of them will be fully installed before the end of this year"					Intelligent Transport, 2020
China				"Independent rail ticket retailers are pleased to support this initiative by the rail industry to help visitors from China obtain fee-free refunds so that they are not financially affected and can plan future rips to Britain"			Global Railway Review, 2020

3.5 Convenience and Comfort

Comfort and fleet convenience are the main aspects which influence success in transportation industry. BRT or Bus Rapid Transit is a cost-effective arrangement compared to the costly railway investments and hence, it is gaining popularity in Asian mobility. Due to high quality, and inherent flexibility, rubber-tyre transit proves as a convenient mobility service for small to medium sized cities.

	Passenger per hour per direction	Passengers per day	BRT standard	Corridor length (km)	Buses per hour per direction	Total cost per kilometer (in US dollar million per km)	User Rating
Lahore, Pakistan	10,000	180,000	Basic	27	30	11	
Hanoi, Vietnam	520	8,000		14.5	14		
Jakarta, Indonesia (Corridor 3)			Basic	19	40		
Jaipur, India	1,046	6,622					Good
Seoul, ROK (Siheung Hangang-ro)			BRT	17.7			
Tehran, Iran (I. R. of)		40,000	BRT	6.2			
Beijing, China	8,000	150,000	Bronze	16	60	6.84	
Bangkok, Thailand	1,200	15,000	Bronze	15.3	14		
Taipei, Taiwan, Province of China	9,500	1,200,000		60		0.35	

Figure 4: City transit analysis (source: https://brtdata.org).

Case Study: TransJakarta

With a ridership of around one million people daily, TransJakrta is the very first BRT in the Southeast Asia and the longest BRT (251.2 km) in the world. Winning the 2021 Sustainable Transport Award in November 2020, it boasts of comfort and a convenient network of around 3900 buses in 13 primary BRT corridors with dedicated bus lanes, 36 cross corridor routes, 14 cross border feeder routes, 9 free tour rotes, 69 Mikrotrans routes etc. connecting to tourist spots, train stations and satellite cities. From 2019, it started testing electric fleet after commuters' numbers increased by 40% compared to 2018. All the TransJakarta vehicles operate from Sunday to Thursday (5 am to 11 pm) and operate till 12 am on Friday and Saturday. The seats are arranged front facing to prevent sexual harassment and the network has women-only areas at the front of the buses and women-only buses. The bus shelters are located in the middle of the road, ventilated and the platform screen door is equipped for passenger safety, some fitted with escalators or lifts and reachable by elevated bridges. The fare for TransJakrta services are a fixed rate of Rp. 3.500 (around 24 US cents) and a discount price of

Rp 2.000 between 5-7 am. The cost doesn't change while changing fleet unless one exits the shelter completely. Throughout TransJakarta network, commuters can use compulsory e-tickets/prepaid cards which can be bought at Rp. 40,000 (with Rp. 20,000 balance money) and topped up in any bus shelter. Tap-On-Bus payment through bank card is also used in feeder routes. The services have free bus ride facilities for students, 60+ senior citizens, disabled commuters, low-income household members or in certain professions like teaching, mosquito control, mosque related, police and armed forces on showing specific cards (Jakarta Smart Card, TJ card). In an attempt to encourage use of public transportation, 'TransJakarta goes to school' dedicated service and odd-even traffic policy (in 2018) were introduced. Issues identified for TrasnJakarta services are - unauthorized vehicles illegally using dedicated bus lanes, pedestrian control, thorough security from looters and vandalizers.

For better post-COVID resilience, TransJakarta has added integrated systems through Transfer Ticket, Digital QR Ticketing, Smart Assistance and Real Time facilities to allow seamless digital payment systems where passengers can buy tickets for friends and family, scan QR codes to purchase tickets, can be reminded about upcoming trips, can check the TransJakarta's schedule in real time for comfortable journeys. Installation of high-speed internet and WIFI services are planned to start with installing services in 1-12 corridors by 2020 end.
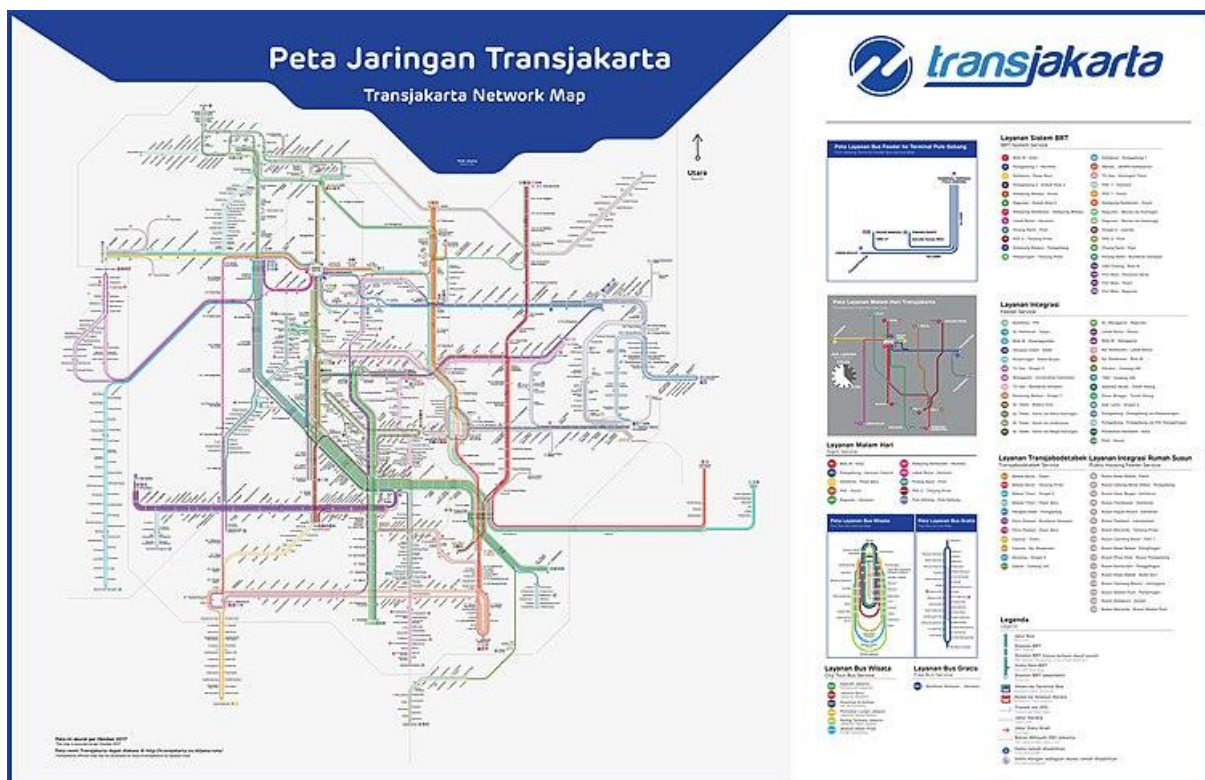

Figure 5: TrasnJakarta network map as of 2016 (source: https://en.wikipedia.org/wiki/TransJakarta#/media/File:Transjakarta_Route_per_2016.jpg).

In a TransJakarta and UNDP (United Nations Development Programme) collaborated effort, COVID-19 related messages have been displayed in the shelters informing commuters about the best practices to follow. Using infographics, importance of safe social distancing and wearing face masks properly are conveyed. The aim of such posters are to educate the commuters who may not have access to vital pandemic related rules and regulations released

online or in other information media. TransJakarta also placed drivers at bus stations and deployed officers to ensure and enforce physical distancing between commuters across BRT stations and other additional routes. To minimize contact between the passengers, seat arrangements were done with sufficient social distancing. The reduced bus fleet services also faced criticism due to higher commuters as schedules changed and hundreds of meters of ques with long waiting time.

3.6 Pricing and Revenue

Since the metro lines are mostly operated by states, the operation quality was not affected in the Chinese public transportation, but the drop in riders affected the revenue for the operators and the increased cost towards integrating COVID-19 measures in the buses and train networks. Government of Nepal allowed transport companies to resume services from 17 September 2020 onwards following health guidelines. However, commuters were charged 50% extra fares. As per Federation of Nepalese National Transport Entrepreneurs, over 400,000 buses run in Nepal including intercity buses and many of the business owners are in financial loss since they need to pay back the bank loans taken towards smooth business operation. The future of low-income transport workers looks grim due to the lack of subsidies in their income tax and the interest in loan payment. Kochi Metro, India cut fares to make the journeys affordable for the customers from 7 September 2020 onwards. Buses comprise of around 75% trips in public transportation in India and the government owned "State Transport Undertakings (STUs)" normally recovers 47% in urban areas and 81% in the rural areas (TheCityFix, 2020). Since more than 90% buses were out of business hours during COVID-19, the STUs faced huge financial loss and out of fear in public, there was increased booking cancellations and reduced intercity ticket booking. Karnataka STUs already asked for government's support and many would follow at the time when additional buses are being asked to meet social distancing demands in India in spite of 200,00 already existing buses (TheCityFix, 2020). According to the World Bank, the financial crisis due to the pandemic would lead to almost 20 billion dollars loss in the Indian public transportation sector. Chinese visitors spent more than £600 million in 2018 to visit one of its top destinations – the UK. Between January-February 2020, fee free refunds were provided to the Chinese customers for unused tickets in the UK rail journeys. On 27 March 2020, Malaysian Prime Minister announced RM 250 billion financial package called PRUHATIN Rakyat Economic Stimulus Package in which RM 100 billion was towards supporting businesses including small and medium sized businesses (Sakura Science, 2020).

3.7 Resilience and Recovery:

As countries in the Asia and Pacific are easing up travel restrictions amidst fearing for a second wave, public transportation will play a major role in economic revival and aiding healthcare professionals in treating patients. Citizens whose savings have taken a toll during the lockdown, will prefer low cost mobility. Hence, it is important that the public transportation be operational with improved services and at affordable cost. Leading Singaporean public transport provider called Go-Ahead Singapore is starting a 'Helping Hand' scheme to help commuters with physical disabilities or other unknown mobility difficulties from November 2020 onwards. As per the designed scheme, the passengers have to carry a pocket-sized card with special messages like "May I have a seat please?", "This is a wheelchair" and "Alert me when I am approaching my stop" etc. so that they can be lent a hand in need by the bus drivers. For sustainable practices, the Go-Ahead Group also uses a system called "SwitchOff" on the buses due to which the bus engines which are idle for more than five minutes get automatically turned off. Malaysia planned to increase public transportation in the urban areas by 40% by including light rail, metro and BRT (Bus Rapid Transit) systems and reducing private vehicles by 10% by the next decade (ISDB & SLOCAT, 2020). In an effort to tackle climate change

issues and human health, Seoul government has recently announced to build wind path forests with trees like pine and maple so that particle matter which causes pollution could be absorbed, urban heat island effect could be reduced and clean air can reach to commuters.

Some of the measures that Asian cities can pursue after the pandemic for stronger resilience are as below:

- Government can exempt the private and public sector buses from tax payments so that it can be used to improve fleet and hygiene practices
- Contactless payment should be encouraged, and dedicated bus priority lanes should be made to make bus fleet faster and contact free
- Analysing ridership data would help in identifying the emerging travel patterns to improve safety and efficiency
- Business plans should be included with long-term funding and urgent financial measures
- Emphasis on agile regulation, strong common vision and social justice
- Introducing Artificial Intelligence (AI) applications in the buses and trains for efficient use of vehicles and infrastructures. This would also optimise performances, contribute to traffic monitoring and management, pave ways for future mobility.
- Adopting intelligent technologies such as – automotive night vision, rain sensor, satellite navigation system, anti-lock braking system, collision warning, driver monitoring, blind spot detection, speed advice, parking assistance, traffic jam autopilot etc.

4. Conclusion

A crucial feature of public transportation is complete accessibility of vehicles and its infrastructure. To ensure fleet success, movement of all abilities (elderly, children, pregnant women, people with disabilities) should be included in transport planning. Level crossings, pedestrian bridges, elevators and sidewalks should be built, and electric fleet should be enhanced to combat climate change. In future, public transportation companies could opt for AI techniques, Light Detection and Ranging (LiDar) systems, digital maps and sensors to operate efficiently. Digital safety is another issue for transport companies to look upon in future since during lockdown, many organizations complained about data being hacked. Due to economic benefits, transport companies normally target the most profitable areas and hence, rural areas are often ignored. An integrated public transportation could change the particular region as a unified seamless system leading to developed and convenient mobility network for all.

Public transportation has been greatly affected due to COVID-19 with sharp reductions in ridership amidst the debate about the role of public transportation and shared mobility in the outbreak. Through the examples, individual behaviour, changes and impact on the operations are discussed which gives us a glimpse on how measures could help in controlling the long-term impacts on shared mobility. Since public transportation contributes to economy and depends primarily on riders, loss of revenue, drop in commuters and higher cost of regularly cleaning and disinfecting transportation vehicles and facilities could put additional financial burden on the Asian transport authorities. If the demand for required hygiene measures are met across transportation, riders' behaviour would be improved. The pandemic has tossed the economy in low-middle income countries and hence, action should be taken by governments and different stakeholders to minimize risk for commuters and transportation staffs. Affordable cost, tax reduction, promotional offers and special schemes for transport employees, students or senior citizens would improve share mobility efforts. During digitization movement, some of the drawbacks found in the mobile tracking apps are threat to personal digital security,

increased surveillance, exclusion of the marginalised or vulnerable people who do not have access to smartphones. Hence, data security and inclusion of vulnerable people in information distribution should be closely monitored so that no one is left behind. Coordinated responses from all the concerned authorities and implementing them should be the action plan to ensure safety of staff and commuters. Periodic impact assessments, difference between essential and non-essential services, fund and aids, environmental and social impacts should be considered.

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