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Slowing the spread of COVID-19: Review of "Social distancing" interventions deployed by public transit in the United States and Canada

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ABSTRACT

This paper presents a review of social distancing measures deployed by transit agencies in the United States and Canada during the COVID-19 pandemic and discusses how specific operators across the two countries have implemented changes. Challenges and impacts on their operations are also provided.

Social distancing is one of the community mitigation measures traditionally implemented during influenza pandemics and the novel coronavirus pandemic. Research has shown that social distancing is effective in containing the spread of disease. This is applicable to the current situation with the novel coronavirus, given the lack of effective vaccines and treatments in the United States and Canada in the first eight months of the pandemic. Moreover, social distancing is particularly useful in settings where community transmission is substantial.

Directives for social distancing were issued in several states and public transit operators were charged with how to provide for physical distance of six feet between passengers on their property including physical infrastructure such as station buildings and rolling infrastructure (rolling stock) including trains, subway cars and buses. Operational changes were also required due to physical distancing, e.g. adding train cars to provide for opportunities to physically distance on the train. Examples of some measures discussed in this research includes taping off every other seat on buses, increasing the total length of trains by adding cars, separating bus drivers from passengers with plastic sheeting, rear door boarding, etc. This research also analyzes long-term impacts for transit operators and challenges to encourage passengers to return to public transit after lockdown requirements ordered by government officials are lifted. A section on the policies that are being explored by government to continue to sustain public transportation is also included.

1. Introduction

Since the first case of COVID-19 infection was reported in the United States (U.S.) on January 20, 2020, cases of the novel coronavirus (2019-nCoV) have been confirmed in multiple countries around the world (Holshue et al., 2020). On March 11, 2020, this viral and deadly disease was declared a pandemic by the World Health Organization. After a large outbreak of the novel coronavirus in their states, the governors of Washington State and New York announced new regulations to limit large gatherings and closures of schools and non-essential businesses. These measures were followed by the U.S. President's Coronavirus Guidance for America announcement on March 16, 2020 for 15 Days *to Slow the Spread* guidelines, which was revised shortly after to 30 Days *to Slow the Spread*. This guidance recommended avoiding gatherings of more than 10 People and discretional travel to facilitate social distancing measures (The Whitehouse 2020). On March 16, 2020, Canada closed its borders to all foreign nationals except for U.S. citizens, unveiled restrictive measures, and urged people to stay at home to contain the coronavirus outbreak (Cecco 2020). The U.S. Centers for Disease Control and Prevention (CDC) defines social distancing as "a public health practice that aims to prevent sick people from coming in close contact with healthy people in order to reduce opportunities for disease transmission" (Pearce 2020). During the month of March 2020, most states in the U.S. and provinces in Canada have reported some community spread of COVID-19 and "stay-at-home" orders have been issued to slow this spread. To reduce the transmission of COVID-19 through communities, CDC and health officials in Canada have encouraged residents to practice "social distancing" measures. Throughout the two nations, transit agencies have implemented multiple measures to obey social distancing policy. Given the environment in

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which the transit system is operating, maintaining "physical distances" on their systems comes with many challenges. This paper presents a review of social distancing measures deployed by transit agencies in the U.S. and Canada during the COVID-19 pandemic and discusses how specific operators across the two countries have implemented changes. Challenges and impacts on their operations are also provided.

2. Background

A pandemic is commonly described as a disease that affects a large number of people within a community, population, or region and that spreads over multiple countries or continents. The disease may spread easily with causing a high rate of infections, illnesses, and deaths to people. What makes it challenging, is the fact that there are no specific therapeutics or vaccines readily available. Past pandemics include the Spanish flu known as the 1918 influenza pandemic which was considered the most severe pandemic in recent history (CDC 2020a). According to the U.S. Centers for Disease Control and Prevention (CDC), it is estimated that about 500 million people became infected with this virus worldwide (CDC 2020a). There have been many other pandemics and most recently, the novel coronavirus (COVID-19) pandemic, which is believed to have originated in Wuhan, China (Cotton 2020) and is considered the greatest public health threat since the 1918 influenza pandemic (Greenstone and Nigam 2020).

Unlike many other disasters that humans may encounter such as hurricanes and earthquakes that are mostly localized in a geographic area and cause damages to infrastructure, pandemics are global and do not damage infrastructure (Fletcher et al., 2014). Given the fact that pandemics affect multiple communities at the same time, resources may not be able to be shifted between communities to effectively respond to the pandemics. Responses to pandemics may cause major impact on the general public, such as travel restrictions and school or business closings, which may potentially trigger severe disruptions on domestic and world economies.

Viruses causing diseases in a pandemic, like the 2009 H1N1 and COVID-19 outbreaks, can be highly contagious and transmit from human-to-human through physical contact. In the absence of specific medications or vaccines, governments around the world are relying on classical public health measures by implementing various forms of non-pharmaceutical containment measures as the principal means for mitigating the progression and impact of the viruses (Valdez et al., 2013; Faass et al., 2013; Wilder-Smith and Freedman, 2020) . The aim of such public health measures is to prevent person-to-person spread of disease by physically separating people to interrupt transmission. The non-pharmaceutical measures used to slow the spread of the disease may include engineering controls, administrative controls, isolation, quarantine, social distancing and community containment, personal protective equipment, environmental hygiene, and ventilation (Fletcher et al., 2014; Wilder-Smith and Freedman, 2020).

As described in Fletcher et al. (2014), 'engineering' controls are measures that aim to physically separate people from the contamination; 'administrative' controls include training, plans, policies, and procedures that articulate and enforce means to reduce infection; 'isolation' is the separation of infected persons with contagious diseases from non-infected persons to prevent the transmission of the disease; and 'quarantine' —one of the oldest and most effective tools of controlling communicable disease outbreaks (Valdez et al., 2013; Wilder-Smith and Freedman, 2020)—is the restriction of movement of persons who have been exposed to a communicable disease for a period of time in such manner as to prevent effective contact with those not exposed (Fletcher et al., 2014). Quarantine and full isolation measures are difficult to implement in a large population and can have a negative impact on the economy of a region (Valdez et al., 2013). Therefore, public health officials promote other non-pharmaceutical interventions.

Social distancing is one of the community mitigation measures implemented during influenza pandemics and the novel coronavirus pandemic and falls within the 'engineering" controls. Patterson-Lomba (2020) indicated that social distancing is effective in containing the spread of disease, "particularly when facing a novel pathogen and no pharmacological interventions are available". This is quite applicable to the current situation with the novel coronavirus, given the lack of effective vaccines and treatments in the United States and Canada in the first eight months of the pandemic. Moreover, social distancing is particularly useful in settings where community transmission is substantial (Wilder-Smith and Freedman, 2020).

The objective of social distancing is to limit interactions between people to reduce the transmission of the virus by increasing physical distance or reducing frequency of congregation in socially dense community settings (Greenstone and Nigam 2020; Valdez et al., 2013; Wilder-Smith and Freedman, 2020; Ahmed et al., 2018; Fong et al., 2020). Examples of social distancing controls include "stay-at-home", closure of schools and non-essential workplaces, cancellation of gatherings, cough etiquette, and travel restrictions. While these non-pharmaceutical controls could be easily implemented by organizations such as hospitals and schools, they are providing real challenges to apply in public transit settings, where large numbers of people remain in close quarters (Faass et al., 2013). The very nature of transit stations and vehicles compounded by limited opportunities to clean, lends itself to easy transmission of droplets known to spread diseases such as influenza and COVID-19 (Faass et al., 2013).

Transit agencies have faced difficulties in implementing social distancing measures to offer adequate protection from infection to their employees and customers. Social distancing is practically deployed by maintaining a reasonable physical distance between persons. The literature is very limited on providing practical measures that can be implemented in the transit setting. Faass et al. (2013) have developed a preparedness training course for the transit industry for the H1N1 pandemic and recognized that transit remains vulnerable to the effects of infectious disease. For example, small transportation organizations can be impacted by absenteeism, which can negatively affect their operations and sustainability (Fletcher et al., 2014). This precarious vulnerability justifies the need for planning ahead of time by transportation organizations of any size so that they can be ready to address issues that arise. The American Public Transportation Association (APTA) developed a guidebook that provided recommendations for reducing the risk of spreading COVID-19 among transit agency staff and riders during a pandemic (APTA 2020). The guidebook indicates that the choice of implementation would depend on the "agency's size, modes of operation, geography, and available resources" (APTA 2020).

Gupta and Abramson (2007) compared urban transit responses to pandemic influenza and found that social distancing, though mentioned in local public health department pandemic plans, is only incorporated in a marginal number of municipal transit plans. Of seven large American cities surveyed regarding their transit preparedness for pandemics, the authors found only three that listed social distancing as a measure and they were included in plans for all hazards and not specifically geared to pandemic influenza (Gupta and Abramson 2007). APTA referenced four fact sheets issued by the CDC specifically regarding how public transit operators can follow CDC guidelines for operating during pandemic outbreaks (CDC 2020b). The fact sheets provided suggestions for bus and transit managers, including how to protect maintenance and station workers. In addition to several other remedies such as sanitizing protocols, it recommended limiting "close contact with others by maintaining a distance of at least 6 feet, when possible" (CDC 2020b). Actual social distancing in transit facilities and on rolling stock must be continuously monitored because service utilization will fluctuate during a pandemic (Fletcher et al., 2014). However, by analyzing transit demand during the COVID-19 pandemic, Liu et al. (2020) found that there is a very limited research investigating the impact of the pandemic on transit demand. Wang (2014) established that the Taipei underground system lost close to 50% of daily ridership during the peak of the 2003 SARS pandemic. Kim et al. (2015) revealed that there was a sharp

decline in trip frequencies across different public transit modes, social groups, and neighborhoods during the 2015 MERS outbreak in Seoul. Therefore, frequent analysis of changing ridership needs and employee availability is desired in that these can impact ridership demand, equipment, and worker availability.

3. Methodology

To accomplish the objectives of this research, the authors conducted a systematic and comprehensive review of literature to explore for information regarding social distancing in general and gather available evidence on specific measures deployed by the public transportation industry. This review involved a search of sources that included both general information about social distancing and specific to transit during viral pandemics. The authors reviewed available sources such as news articles, content from virtual presentations and agency's websites, to identify the measures that transit agencies are taking to facilitate physical distancing.

The authors reviewed available evidence beginning in March 2020 to assess what specific measures have been applied by public transit operators to implement physical separation (generally, of at least six feet) while riding and in all facilities. Also reviewed were the websites of the transit agencies in states and provinces to gather information related to COVID-19. The deployed interventions were grouped into two separate categories: infrastructure (stationary and rolling) and operations. Transit's infrastructure includes stationary facilities such as station buildings and rolling stock. The authors reviewed social distance measures that were deployed in stationary infrastructure and in moving infrastructure such as trains, subway cars, and buses.

The authors explored operational changes recommended to facilitate physical distancing such as frequency of bus and train services, route modifications, and changes in labor availability. Recommendations for procedural changes such as rear-door entry and having operators relieve each other in route to minimize the number of people returning to the depot were also reviewed. The authors also looked at factors related to ridership as they tried to learn more about mode shifts that occurred. This would also reflect on decreases in ridership due to the large numbers of people who were no longer making the work trips at all as government enacted stay-at-home orders and restrictions to non-essential travel.

4. Discussion of measures taken by transit operators in the United States and Canada

As states in the U.S. and provinces in Canada enacted stay-at-home orders, public health officials have recommended a physical separation of six feet between people to reduce the risk of transmission of the virus. Public transit services were considered necessary to serve essential trips and to transport essential service staff. Therefore, public transit was not exempted from the social distancing orders. Transit operators have designed and deployed measures needed to control for social distancing given the necessity of transporting essential workers and riders requiring access to essential services such as groceries and pharmacies. Transit operators across the U.S. and Canada encouraged physical distancing in a variety of ways. The following sections are a review of measures taken in stations, on rolling stock, and operationally to provide for social distancing by public transit operators in the early weeks of the COVID-19 pandemic. It is important to note that as time progresses and needs change, operators will have to be ready to adapt to changing needs and requirements as they arise.

4.1. Transit stationary infrastructure

Transit stationary infrastructure includes facilities such as transit vehicle stops, station buildings and the indoor space, furniture and equipment inside them. This infrastructure can include the lobby, ticket vending machines (TVM), ticket and information booths, waiting area with seats, restrooms, etc. Subway stations, commuter rail station buildings, intercity passenger rail stations (e.g. AMTRAK), bus station buildings and bus stops fall into this group. Express bus, Bus Rapid Transit (BRT), or light rail stops might include ticket machines and waiting seats as well.

A lot of activities take place in bus and train stations. People move, wait, transfer between lines and sometimes shop in the stations (Loukaitou-Sideris et al., 2015). Passengers often transfer to and from track platforms, line up at ticketing booths or TVMs, take stairways and ride elevators leading to adjacent streets or upper/lower level platforms. The challenge with maintaining social distancing at stations and stops is how to keep people at a safe distance apart in locations primarily built for gatherings. Also, another concern is keeping workers safe, including ticket agents and information booth staff.

4.1.1. Preventing crowding and limiting number of people in stations

To meet social distancing recommendations, one action taken by public transit operators was to try to prevent crowding at transit stations. Transit operators have rolled out public awareness and education campaigns by posting flyers encouraging and reminding passengers to keep a reasonable physical distance with other passengers (e.g., Winnipeg Transit in Manitoba and TransLink in Vancouver, Canada). They are preventing passengers from sitting on tightly-spaced seats by roping benches off. Operators have been marking six feet of distance along platforms and advising customers to stand accordingly. Some agencies are guiding passengers with tape on sidewalks at bus stops to encourage six feet separation when on line to board vehicles. In the case of outdoor service, some operators are closing waiting areas and lobbies to eliminate crowding and requesting that passengers congregate outside. In employee-only facilities such as shops and yards, APTA recommends "closing gathering places such as locker rooms, blocking off non-essential seating, seating call center employees with six feet between them, transitioning to virtual bulletin boards and choosing electronic communications (e.g., email) for notifications whenever possible instead of posting on a centrally located board (APTA 2020) .

The need is to physically separate people by six feet in spaces primarily built to allow for gathering and that can be sometimes crowded, while allowing activities to continue such as purchasing tickets, waiting on platforms, and boarding a bus or train. Purchasing tickets at a ticket booth in a station poses significant difficulty in adhering to social distancing recommendations because customers need to stand on line and often, close to each other. This is also a concern for ticket agents due to the need to interact with customers while performing transactions such as to exchange cash and sell fare cards. Operators have taken varying approaches to meet this need while minimizing the potential harm. Some providers continued selling tickets in-person, but made some adjustments to avoid interactions with passengers. Operators with available TVMs at stations or mobile ticketing system have directed customers to utilize these systems to eliminate interactions between passengers and their employees at ticketing booths. Some operators have reduced the hours of operations of the customer service at their facilities and limited access to customer service counters. MATA in Memphis, for example, reduced hours of operations at their Transit Center and instructed security officers to allow only three people to enter or exit the building at one time (WMC 2020). Customer service booths also underwent changes that can be illustrated by Tacoma's Pierce Transit, which has closed the Bus Shop at Tacoma Dome Station, but the assistance remained by redirecting all customer needs to phone service (Pierce Transit 2020a). The Dallas Area Rapid Transit (DART) has also closed the transit center waiting areas and direct bus passengers to wait outdoors to board vehicles (Jones 2020). As the largest subway operator with five million average weekday riders in 2019, the Metropolitan Transportation Authority (MTA)'s New York City Transit (NYCT), canceled all cash ticket sales at station booths and issued a directive to perform all transactions through MetroCard vending

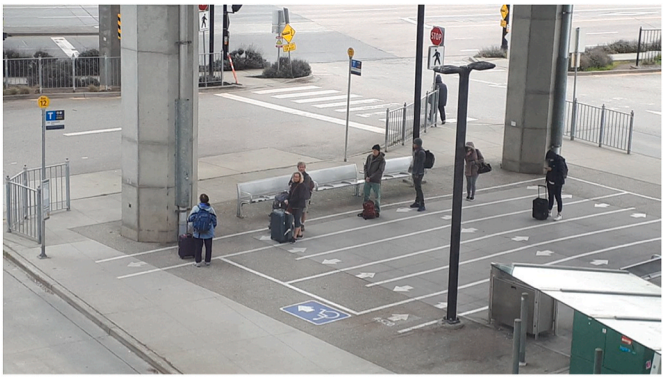
machines (MTA 2020a). MTA commuter railroads, Metro-North and the Long Island Railroad, also closed their ticket counters and directed customers to purchase by TVM or the *MTA eTix* app. These options were possible because of technology initiatives undertaken in prior years to automate ticket sales. To further minimize viral transmission, Sound Transit in Seattle chose to suspend all fare requirements on buses and trains. Therefore, they have eliminated the need for employees and customers to exchange cash or transit fare cards at stations. To prevent large public gatherings at stations, the Regional Transportation District (RTD) in Denver, Colorado instructed on its website that customers waiting at their Civic Center Station and the Union Station bus concourse board the first available bus to their destination and limit the time spent at stations to no more than 10 min prior to the departure of their bus (RTD 2020a). This was a modification to an existing policy that allowed passengers to wait up to 2 h for their bus.

4.1.2. *Mark platforms and rope off benches to physically distance when waiting to board*

The platform is the queuing area on which passengers wait prior to bus and train arrivals. Amenities such as bench seating are also found near platforms, which further limit standing room, though many operators have roped off the benches to enforce physical distancing. Platform areas can also be constricted by structural elements such as stairways and columns particularly those with older architecture such as some NYC subway stations, originally dating back to the early 1900s. These elements further minimize available standing room. Increases in customer queuing can be hard to regulate in that it is temporally sensitive as well, particularly during regular peak periods. It is also sensitive to service disruption or reduction. Nevertheless, it is still essential during the COVID-19 outbreak that passengers physically distance while standing or sitting on benches as they are waiting for train and bus arrivals.

To remind and encourage passengers to practice social distancing, several operators tried to urge the customers to physically distance while standing on the platform and have added decals six feet apart to guide passengers as to where to stand while waiting on train platforms or bus stations for the arrival of vehicles. Some operators, such as in Dallas and Toronto, urged six feet of distance even while waiting outdoors for buses or light rail and promoted it through communication and/or the placing of highly visible decals showing where to stand.

The photos below demonstrate an example of decal placement.



Physical distancing at outdoor bus stop in Vancouver, Canada (Shepert 2020).

Outdoor Decal at Vancouver (Shepert 2020).

4.1.3. *Employee protection*

Operators also implemented measures at stations in order to protect their employees from being in too close of a proximity to customers. Interventions such as closing of customer services, lobbies, and bathrooms at stations to limit where employees could be exposed are measures that have been applied at many transit properties. The Washington Metropolitan Area Transit Authority (WMATA) closed several stations located less than one mile from another station (WMATA 2020). Directives have been issued to help employees stay safe. RTD at Denver, Colorado have asked its employees, to continue to limit close social interaction with others and required them to wear masks at all times while on the job (RTD 2020a).

Some transit operators have looked to maintain physical distance between employees and customers at their facilities with threats of levying fines on customers for violations. In New York City, the NYCT used decals, but also subjected their customers to a possible fine of $500, which was imposed by the mayor's office (McCarthy and Meyer 2020). Enforcement of physical distancing on the platform was made more difficult due to operational issues. Unintended reduction of employees due to illness and reduced ridership caused by the closing of non-essential businesses and stay-at-home orders, have resulted in reduced service. This, in turn, caused more crowding, particularly at stations where essential riders boarded in high numbers. Police were also stationed along the subway platform to direct passengers if necessary.

4.2. *Rolling infrastructure*

Rolling infrastructure or rolling stock operated by transit properties includes trains, buses, subway cars, and light rail vehicles. This section involves the social distancing measures taken to protect customers and employees on rolling stock while boarding, sitting, alighting, and riding inside vehicles. Transit agencies have implemented rear door boarding, rear door exiting, limiting the number of passengers per vehicle, separating drivers from passengers with a partition, roping or taping off seats in the first few rows near the driver to free them from passengers, and

requiring passengers to sit further away from each other by taping off seats throughout the vehicle. Many agencies were very concerned with the safety of their employees and passengers. To provide services, the drivers and operators must be able to feel safe in order to operate the vehicles and passengers must be safe to ride inside the vehicles. Following are some measures agencies took in this regard.

4.2.1. Rear door boarding and egress

New boarding procedures on rolling stock, particularly on buses, are one of the most widely implemented social distancing measures. The purpose of this procedure is to protect the driver from continuous contact with boarding customers. For this reason, almost all agencies have implemented "Rear Door Only" boarding. Bus passengers board and exit only through the rear doors of buses, as a way to keep proper reasonable distance from bus drivers. The elimination of front-door boarding negatively impacted the revenue collection, because the farebox system is primarily located next to the driver in the front of most buses. Some agencies however, added personnel to continue the enforcement of fare payment by inspecting fare cards in the rear part of the vehicle. Phoenix, for example continued to require fares, but by visual inspection only, not in the farebox due to rear boarding (Nañez 2020). Swiping fare cards in stations through turnstiles to either validate or pay for fare was often maintained at stations.

There were exceptions to rear-door boarding as it was not required for passengers in need of accessibility. Passengers requiring a ramp to be loaded for boarding or priority seating were exempt from the rear-door boarding policy. This was because the lift is only available at the front door and the convertible seats are in the first few front rows in most vehicles. In these cases, drivers without partitions remained unprotected. Another concern raised by drivers was their role to fasten the wheelchairs in place at the seats that convert for wheelchair use. Driver safety could be a concern due to this activity in which they are in very close proximity of the wheelchair bound passenger.

4.2.2. Partition the driver's cabin

To physically separate drivers from the passengers, some agencies used a partition to close off the driver cabin. For vehicles without partitions, some transit operators have initially installed temporary plexiglass or plastic sheeting, but quality was not as effective as permanent partitions. A few months into the pandemic, the MTA in New York began installing plastic sheeting with the possibility of installing more permanent solutions in the future (TWU 2020). Some operators accelerated plans to install them and others already had partitions, at least on some of their fleet. Light rail vehicles used in Pittsburgh have full plastic enclosures surrounding the drivers and therefore, the riders continued to pay fares with cash or *ConnectCard* onboard or off-board fareboxes when traveling by light rail (Deto 2020). Their buses did not have partitions, so bus passengers were instructed to board from the rear door (Deto 2020). NYCT also maintained front door entry on express buses because payment is made prior to boarding. However, these passengers were instructed to avoid sitting in the first three rows so as to offer protection to the driver. In buses in Houston, Texas, transparent protective barriers were placed on buses to protect both passengers and bus operators (Metro 2020). The Coast Mountain Bus Company, which is the contract operator for bus transit services in Metro Vancouver, has accelerated installation of operator protection barriers on all of their buses (Translink 2020).

Rear door entry resulted in less fares collected and can have significant implications to the financial health of the transit agencies, both in the near and long term. Loss of fare revenue is a serious problem for public transit agencies, particularly those that depend most heavily on fare collection to meet operating expenses. These expenses include all costs associated with running the bus or train such as fuel costs, maintenance, operator salaries, etc.

4.2.3. Tape a line behind the driver

In addition to requiring all passengers (except people with disabilities) to use rear doors when boarding and exiting the transit vehicles, further measures were implemented inside the vehicle to provide reasonable distance between the driver and the passengers. Some agencies have used caution tape to block areas near the front of buses to maintain the safety of drivers in the midst of the coronavirus pandemic. As examples, buses in Houston, Utah, and Phoenix have moved the yellow passenger line back on buses so that there is 6 feet between operators and riders to support social distancing guidelines (WMC 2020; UTA 2020; Nañez 2020). Other properties like Broome County in New York added a red line for passengers to stay behind (Crighton 2020). Light rail trains in the Valley region of Phoenix have blocked the driver's area to establish the social distancing space recommended by the U.S. Centers for Disease Control and Prevention (Nañez 2020).

4.2.4. Social distancing with cleaning/ventilation

As research shows, implementation of two or more remedies working together can result in improved health outcomes since they complement each other (Ahmed et al., 2018). Combined cleaning practices and physical distancing measures reinforce each other to provide for better safety. This combination is essential on public transit since social distancing potential is limited by the size of the vehicle and number of passengers on board. In addition, many surfaces can be touched during a run and therefore passenger safety depends on cleaning priorities as well. It is important that agencies add new cleaning regimens to their daily requirements to further protect customers and employees in stations and on rolling stock. Demonstrating the importance of cleaning, all DART station concierge personnel were reassigned to assist with *enhanced cleaning protocols* after their booths were closed (Jones 2020). NYCT hired contractors to help implement recently enhanced cleaning measures to meet COVID-19 issues (MTA 2020b). Pierce Transit and MATA are performing a daily fleet and bus shelter cleanings which include comprehensive disinfecting and sanitizing measures with a focus on "high touch" areas such as handrails and grab bars (Pierce Transit 2020b; Moon 2020). Capital Transit in Juneau, Alaska, has implemented more robust cleaning/disinfecting procedures on its vehicles (Capital Transit 2020). BART has increased cleaning and disinfecting in stations and trains (BART 2020a). Cedar Rapids Transit as the primary provider of mass transportation in Linn County, Iowa, is providing hand sanitizer for riders, along with regular cleanings of the buses (Cedar Rapids 2020a).

Maintaining a reasonable distance between the driver and passengers is not the only concern for driver protection. Some drivers have raised issues with the circulated air in the bus and have recommended that future changes seek to separate circulated air in the driver cabin from the air of the passengers. Improved ventilation on buses was recommended during a TransitCenter sponsored webinar (TransitCenter 2020). The speaker indicated that it would be preferable to install ventilation that would enable airflow from the outside. Air that flows from back to front, as is the case in most buses, may cause viral loads to go past the bus operator, who is on the same bus for several hours per day. The Amalgamated Transit Union (ATU) website recommends air control settings with properly designed barriers that brings fresh air in and expels it through the rear of the bus. If this would not be possible due to expense or other reasons, an alternate recommendation was to install electro static filters (ATU 2020).

Many transit operators are focusing on enhanced cleaning methods. Though, this had been part of their regimen for safety prior to the pandemic, many additional procedures and increased frequency for cleaning and disinfecting are being implemented. New cleaning and disinfecting products have been and are continuing to be evaluated for effectiveness at this time. On April 30, 2020, APTA sponsored a webinar titled *Effective Methods to Clean and Disinfect Transit Vehicles*. During the webinar, it was reported that NYCT is focusing on enhanced cleaning practices on subways and buses. Modifications in the cleaning process,

frequency, and products used were already being tested in the past year. Contractors were brought back in to study effective methods in light of the Covid-19 pandemic. The NYCT pre-existing cleaning process involved three steps: (1) End of Run Cleaning (Terminal Cleaning); (2) Daily Cleaning Overnight in the yards (Lay-up Cleaning); and (3) Deep Cleaning Every 72 h. Due to enhanced cleaning, an additional procedure was added on March 2, 2020 to include the disinfecting of all touch surfaces on all subway cars every 72 h. In addition to thorough cleaning of interiors, disinfectant was applied to all surfaces, and an anti-microbial shield was also applied. Another change was announced on April 30, 2020 by the Governor of New York that subways would be taken out of service every night from 1 a.m. to 5 a.m. for enhanced cleaning to minimize viral infection due to Coronavirus during the pandemic (TransitCenter 2020). More on this is written in the operational impacts section of this paper.

4.2.5. *Maintain six feet of distance while sitting on the vehicle*

Passenger capacity in buses, subway cars, light rail cars, train cars, and paratransit vehicles is based on the vehicle floor area and the number of seats. Capacity in paratransit vehicles is also set by policy. Depending on the type of services, vehicle capacity may be limited to the number of seats, as passengers must be seated during the ride. Other services allow standees during the ride. The number of riders also plays an important role to the passenger load of the vehicle. To adhere to the recommendation of public health professionals to maintain six feet of separation between passengers inside the vehicle, operators have deployed some procedures.

Several operators have reduced seating availability for passengers inside vehicles. Seats have been taped or roped off to foster physical distancing while on board. Examples include, Houston METRO that tagged some seats as unavailable on their buses and MATA in Memphis that used caution tape to indicate that every other seat on a bus or trolley could be used (Metro 2020; Downes 2020). Signage was also used to encourage passengers to maintain social distance and sit apart. Many operators used this method, at least at first, rather than implement capacity limits on the bus. With the rapid reduction of ridership following the stay-at-home order, maintaining reasonable distance between passengers was sometimes easily facilitated. If not, other measures were taken. In Houston, Texas, seats on buses and MetroRail were tagged as unavailable (Metro 2020). Also, when a Houston bus reaches 50 percent capacity, digital signs warn waiting passengers to wait for the next bus (Metro 2020). On board vehicles operated by most of transit agencies, customers are required to maintain six feet distance between themselves and the operator and stagger seating as much as possible to maintain the recommended physical distance. However, trying to maintain distancing in vehicles has raised some issues. One of these issues is whether bus drivers should be charged with enforcement responsibility of these measures.

Controlling the number of passengers in vehicles is necessary in meeting requirements of reasonable physical distance among passengers. Many of the systems have experienced a severe reduction in ridership across their system and, as a result, passengers were able to engage in physical distancing with little effort. There were systems that also experienced decreases in ridership and corresponding reductions in service levels, but received reports of overcrowding on buses and subways at a few locations, creating difficulty in maintaining physical distance requirements. Stops that served large numbers of essential workers were especially problematic. For example, commuters raised concerns with social distancing on some New Jersey Transit bus after schedule reductions went into effect (Wilson 2020). In Chicago, some Chicago Transit Authority (CTA) drivers complained about packed buses when those buses ventured into South Side communities (Terry 2020).

To adjust for this, several operators decided to limit the number of passengers on board. Many transit properties have limited the number of passengers on board buses to half (e.g., Houston Metro (2020), 15 passengers (e.g., Metro in Madison, Wisconsin (Metro Capital Transit, 2020a), CTA, Chicago (CTA 2020), Minneapolis and St. Paul (Metro Transit 2020b), Cedar Rapids Transit, Iowa (Cedar Rapids 2020b)), and 10 passengers (e.g., The Capital Area Transit System CATS (CATS 2020)).

At locations with large ridership demand, some agencies had immediate plans in place to call for additional vehicles to come and pick up the remaining passengers or to be available nearby busy stops. Others requested calling for backup or for the waiting customers to wait for the next available bus. In Denver, for example, RTD chose to “limit the number of passengers to 15 per bus and 20 on larger buses” (RTD 2020a). They utilized additional buses on most popular routes and staged buses in those areas if they were available (RTD 2020a). Operators have recommended commuters who use busier routes to consider additional travel time and their need to travel, particularly during rush hours to maintain the limited number of passengers in vehicles. However, the problem with passenger crowding was not a major concern for many systems as the ridership had decreased sufficiently.

For paratransit operations, some agencies maintained regular services without modifications, but others limited the number of passengers to a maximum of two.

On RTD trains, passengers were limited to approximately 30 on railcars and additional train cars were added on popular lines (RTD 2020a).

4.2.6. *Enforcement of compliance*

With transit properties implementing a limit on the maximum number of passengers on board of vehicles to maintain social distancing guidelines, issues have been raised on enforcement of these measures. Limiting the number of riders presents an issue as to whether the driver should be the one responsible for enforcing compliance. The RTD operators in Denver were authorized to bypass stops, but given some personal discretion (RTD 2020a). They were told to request a backup bus if they did not feel six feet spacing could be maintained (RTD 2020a).

Some enforcement of compliance procedures were implemented in gradual steps. In Illinois, for example, social distancing rules forbid groups of ten or more (CBS 2020a). Initially, CTA bus drivers were not supposed to bypass passengers even if there were more than ten people on a bus (CBS 2020a). The CTA later indicated that bus operators were authorized to run as ‘drop-off only’ and bypass certain stops (CBS 2020a). A similar policy was in effect in Kings County in the State of Washington. Here, enforcement of compliance was accomplished through skipping stops when the capacity limit was reached, but a bus driver could allow additional passengers to board if they stopped to let a passenger off. In NYC, subway cars continued to be crowded as services were reduced due to rising absenteeism of employees. NYCT has used NYC police officers at subway platforms to enforce the directives for social distancing in subway cars by moving passengers from crowded cars to less crowded cars (Mocker and Solomon 2020).

4.3. *Measures on operations*

Transit operations involve the operational requirements of running the system, which takes into account the ability to run the trains and buses. These requirements depend on factors such as the number and size of vehicles, scheduling issues, system ridership, ridership per station, demand by time of day, length of route, expected congestion on route, headways, maintenance and cleaning requirements, etc. It can also be impacted by ill employees as has been the case during the COVID-19 pandemic.

Measures to facilitate social distancing can require operational adjustments to meet demand and enforce six feet of physical separation at the stations and on the vehicles. The measures can include switching to larger vehicles (such as utilizing an articulated bus), adding cars to trains to spread passengers out more, and adding vehicles on demand when stops are too crowded to safely social distance on one vehicle. Operational changes need to be flexible and operators are compelled to

observe the situation on a continuous basis and make changes as needed. The Toronto Transit Commission (TTC) is monitoring passenger loads through ridership data and field observations, and is encouraging its drivers to report busy routes and stops (Spurr 2020).

Almost all operators across the two countries have been impacted with significant reductions in ridership due to shelter-in-place orders and restrictions on non-essential travel to reduce the spread of the COVID-19 virus. Nevertheless, they need to provide safe and adequate service to transport passengers for essential trips. To maintain a properly social distancing at stations and on board of vehicles can be complicated because cutting train length or limiting number of riders on a vehicle can either result in more packed vehicles or crowding at stations. To meet these requirements, transit operators have deployed as solutions to add cars to trains, call for additional buses, switch to articulated buses or make route changes to only serve specific bus and train stop locations.

Following are examples of operational measures put in place across the two countries to meet social distancing requirements and issues associated with this.

4.3.1. Utilizing longer trains

Some operators have relied on large capacity vehicles to serve the sporadic demand and meet the social distance guidelines. BART announced in May 2020, that their ridership had decreased sufficiently to enable social distancing and that they continued to run long trains to enable this as well (BART 2020b). BART ridership has decreased by 93% when compared to the May budget projections (BART 2020b).

4.3.2. Public outreach

Websites are used to communicate to customers about any changes in service. In communicating their requirements for opening up, BART posted information on its website regarding the use of large decals and semi-permanent signs and banners to be placed system-wide and on-board trains for the purpose of communicating safety measures and procedures as they returned to work from prior stay at home orders. Websites of most of transit operators reflect a significant list of service changes that are continually being adjusted during the pandemic.

4.3.3. Modified service

The impacts of pandemics on public transit demand have not been widely explored in the literature. Transit agencies have been making operational adjustments due to significant decreases in ridership. Since the start of the outbreak, transit operators across the two countries have lost significant ridership, some suffering as great as a 93 percent reduction in riders by April or May. Examples of modified service includes:

- Due to coronavirus closures, Pittsburgh Port Authority saw a 50% drop in ridership in March 2020. This resulted in a service cut by 25 percent (Lynn 2020).
- The system in Denver is another example of significantly decreased ridership, with a 70% decrease in the early weeks of the pandemic as activity in Denver was curtailed. In April, the agency changed weekday service to weekend schedules. (CBS 2020b).
- Systemwide TTC ridership felt to roughly 70% below normal levels since the pandemic shut down in March 2020 (Spurr 2020).

Fig. 1 below illustrates public transportation systems' worst single-day declines in ridership at selected transit systems in the U.S. as of April 30, 2020 (Wilson 2020).

4.3.4. Switch equipment as needed

If some models of rolling stock were better suited for physical distancing, agencies employed these whenever possible. RTD, for example, indicated that they would move as many of the "MallRide" buses as possible to use on regular routes (RTD 2020b). These models were advantageous in two ways: they offered multiple-door boarding and exiting and drivers on MallRide buses were enclosed and separated from passengers (RTD 2020b). Switching to larger articulated buses is an option as well, which are usually about 60 feet, compared with single buses between 35 and 45 feet (Ryczkowski 2020). In response to subways closing during late night hours when many essential workers still required transportation, MTA in NYC provided buses and compliant 'dollar vans' at no cost to an estimate of 10,000 essential workers in need of ride during those hours (Feuer et al., 2020).

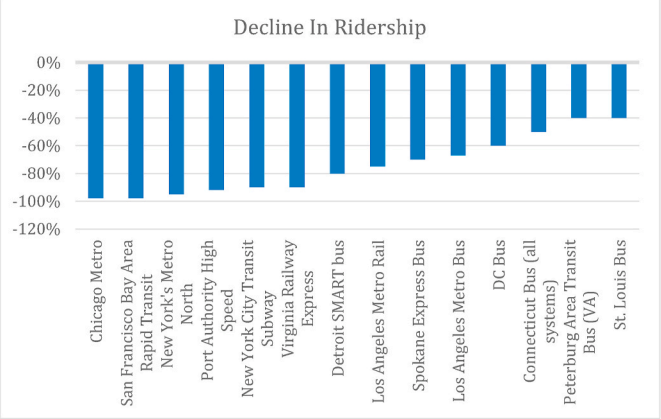


Fig. 1. Reduction in ridership in selected locations due to COVID-19 (Wilson 2020).

4.3.5. Route planning

Route planning during a pandemic is impacted by the need to transport essential workers. It is important to analyze the route to provide service where demand is warranted. For example, NYCT has used the bus service when the subway system was closed for cleaning during 1 a.m.–5 a.m. in order to accommodate essential workers during these hours. Nighttime bus service provided 61 routes, many serving hospitals throughout the city (Rivoli 2020).

5. Challenges and policy implications

The COVID-19 pandemic has affected many cities around the world and caused devastating impacts on different aspects of our society livelihood. The impact on the public transportation system has been unprecedented. In this section, the authors are laying out the challenges that public transportation agencies are currently facing while deploying social distance measures and are expected to continue to face in the long-term. This discussion includes policy implications generated by the rolling out of these measures in both short-term (during the pandemic) as the pandemic shows no signs of slowing down and long-term (post-pandemic) as there is optimism that the pandemic will eventually end.

5.1. During pandemic

As discussed in the prior sections of this paper, the basic challenge for providing transportation service during the height of the COVID-19 pandemic was how to provide the service while keeping passengers and employees safe using social distancing measures. It involved adapting current practices in ways that enabled sufficient space between people and minimal contact. Achieving this was difficult in that the number of passengers waiting for a given bus or train could be unpredictable and because employee shortages due to illness or absenteeism could limit the number of vehicles or trains in operation at any particular time. In addition, as the pandemic continued and less people traveled to work, ridership decreased sharply and many bus routes or rail lines saw a drop of more than 90%, compared to a similar period at the previous year.

The decline in transit demand has created some challenges in term of providing adequate transportation service in the areas served by the transit system. In terms of operations, transit providers must balance between the low demand while continuing to serve essential riders and communities that depend primarily on transit. Transit agencies and government leaders are faced with a social equity issue involving the continuation of service provision in communities that are transit dependent. In fact, by analyzing the transit demand data derived from a widely used transit navigation app in the U.S., Liu et al. (2020) found that the disparate declines in transit demand reveal different degrees of dependence across communities. One significant result of their analysis is that the demand for transit during this pandemic is very low for people who can easily work at home and it is almost intact for people whose occupation requires a physical presence at the job's location (Liu et al., 2020). While there is a need to modify the service given the decline in demand, transit providers must carefully weigh their decision to adjust (or reduce) service compared with the need to continue serving transit dependent communities. It is interesting to note that there may not even be a financial benefit to cutting service due to a reduced demand because additional resources (e.g. number of cars on a train, payroll for drivers, etc.) might still have to be expended to meet the social distance requirements.

As fewer people travel and less revenue is collected at the farebox, a ridership reduction presents a financial challenge both currently and, in the future, to transit agencies. The U.S. Federal Coronavirus Aid, Relief, and Economic Security (CARES) Act signed on march 27, 2020 allocated $25 billion for public transportation to recipients of urbanized and rural areas ($22.7 billion to large and small urban areas and $2.2 billion to rural areas) to cover all operating expenses incurred since January 20, 2020 as well as for administrative leave costs for transit workers due to reduced operations during the emergency (FTA 2020). However, most transit agencies say it is only enough to keep them afloat operationally through this calendar year. Deficits could continue next year as ridership is expected to stay lower than pre-COVID ridership and increased expenditures will be needed to cover new cleaning protocols and other measures.

With the prolonged continuation of the pandemic, transit agencies are trying their best to provide a safe environment on the trains with increased cleaning and disinfecting regimens and the installation of special ultraviolet lighting. However, COVID-19 can have long-lasting and structural effects on travel behavior and people's mobility (Sharifi and Khavarian-Garmsir 2020). Although a study of transit systems world-wide commissioned by APTA suggests that transit riders are at low risk of infection from COVID-19 during their commutes, the authors found that, people are still concerned and therefore restrict their use of public transit (Schwartz 2020). Harris (2020) claimed that the subway is the principal transmission vehicle of the COVID-19 virus by superimposing the subway station turnstile entries upon zip code-level maps of reported cases of COVID-19 during the early days of the pandemic, which hit New York City in March 2020. This finding is further evidenced by Teixeira and Lopes (2020). They studied travel data for New York City during the COVID pandemic and noticed evidence that there was a modal shift from subway use to bike-sharing, with the average duration of the biking trips increasing from 13 to 19 min. They also reported that New York's bike-sharing network experienced a lower reduction in ridership compared to the subway. Transit providers have to continue to build rider confidence and trust to regain some ridership.

Just implementing some social distancing measures presented their own hurdles, sometimes impacting service in larger ways. Rear door boarding for example, resulted in reductions in wheelchair passengers. It also exacerbated financial loss as fare collection was either waived or difficult to enforce.

5.2. Post-pandemic

In some states in the U.S. and provinces in Canada, opening the economy and allowing the return to work (in phases) has been allowed at the time of the writing of this article in February 2021, but sufficient availability of the vaccine is still an issue and cases of COVID-19 are continuing. Therefore, physical distancing along with wearing face masks is likely to be a recommended protocol for quite some time. Several challenges will be faced by transit operators to maintain social distancing and to keep passengers and employees safe as transit services gradually return. In addition, there will be several unknowns at first and operators and passengers will have to be flexible while navigating in the post pandemic environment. Some of the key issues and challenges that public transit is expected to face when riders will return to work are highlighted below. This section also highlights some governmental policies likely to be considered.

5.2.1. Re-entering into service

As cities are reopened for business and people return to work, transit riders will need to feel confident in their personal health and safety prior to riding public transit again. As a result, transit operators may need to review service requirements on a day-to-day basis because it might be difficult to fully understand what the proper level of service should look like. Varying issues might arise and conditions and demand could be variable over time. One key factor will be how to re-enter and maintain physical distance as ridership increases.

In cities that are heavily reliant on public transit and/or commuter rail for their workers' daily commutes, (NYC, Toronto, Washington DC, Philadelphia, Boston, Vancouver, etc.) returning to the actual peak period pre-pandemic demand would negate the ability to maintain six feet of distance between every passenger. Therefore, alternatives are being assessed to minimize overcrowding. These options might include partnering with businesses to continue to have employees work virtually when possible or to stagger work hours throughout the day. It will take time to fully understand how the businesses will return to full employment - whether their employees will work in the office or virtually and if virtually, for how long? There are also implications regarding the layoffs and furloughs that were issued for economic reasons and whether employees will be brought back or these positions ultimately abolished. Moreover, a new culture that prefers and accepts virtual office work as the new normal might develop. This could, in turn, result in continued limited peak period inbound travel. Commuter railroads would have to adjust in some way, perhaps shifting to a heavier off-peak or outbound schedule.

Developing alternatives will require collaboration on many levels such as between employers, employees, government, and transit operators. New York City subways and buses are pondering the implementation of a reservation system post-pandemic to manage crowding (Guse 2020). A reservation system for buses and subways will work in a similar manner to those currently used by paratransit systems at many agencies in which riders will select a time slot and reserve a seat. However, officials are acknowledging that reservations could present complications and be hard to implement in a century-old system like NYCT. In May 2020, the CDC issued guidelines and a mass transit tool to assist mass transit administrators in making (re)opening decisions and to help transit agencies resume and ramp up service amid the coronavirus pandemic (CDC 2020c). The CDC recommends that riders wear cloth face coverings in public settings like transit systems where other social distancing measures are difficult to maintain (CDC 2020c). The CDC also recommends that transit systems should ensure passengers can wash hands in train and bus stations and have access to sanitizer, which is rarely the case currently (CDC 2020d).

Businesses are considering proactive options for how to physically distance and keep employees safe. Implementation of those measures could also help to reduce crowding on public transportation. During the pandemic, some employers offered their own transportation and might consider continuing this option to protect their employees from crowded conditions on public transit or to cover for reductions in such service. For example, New York Presbyterian, one of New York's largest private

health-care systems, provided their own transportation with private coach buses for its essential medical workers at its hospitals (Cutter 2020). They capped capacity at 50 percent and cleaned after every trip (Cutter 2020).

Operators working with businesses to stagger work hours and in effect, change the concept of peak period travel, is another preemptive step that can be taken to minimize crowding (Mezghani 2020). estimated that to ensure physical distance, capacity on public transportation could be only about 23%–35% compared to what it had been during the most heavily traveled times before the pandemic. The article warned that this could lead to increased auto use, which would have negative implications on CO2 levels and sustainable living (Mezghani 2020).

Another issue is that some employers may consider leasing smaller office space in suburban locations in addition to maintaining their main urban space, to accommodate their employees that reside in the suburbs. In fact, it was observed that the pandemic has led to a movement of residents in urban areas to their second homes (Sharifi and Khavarian-Garmsir 2020). This shift to the second home real estate will likely increase reliance on private vehicles for the commute to employment locations (Kunzmann, 2020) In addition, some urban residents even without a second home might prefer to move out of the dense city location to less dense areas in the suburbs.

Though this could help with easing up space on the trains to the Central Business Districts (CBD and so make it easier to incorporate physical distancing on that commute, it could have a negative impact on suburban roads and CO2 emissions. However, as mentioned previously. transit providers might be able to adjust or increase some of their reverse trip schedules as well as partner with employers to encourage some of these employees to continue to commute by transit to their suburban offices.

5.2.2. Regaining confidence of riders

Transit operators are aware that in order to bring customers back after the multi-month stay-at-home experience, they will have to be diligent in their efforts to maintain the safety of their customers. As previously mentioned in this paper, social distancing is crucial, but so is maintaining the cleanliness of the vehicles and stations. In addition, agencies will have to be capable of making operational adjustments such as varying schedules as needed to minimize potential crowding likely to occur due to the same issues as before: ill employees, sporadic delays, and greater than expected ridership at any given station.

To gain the confidence of riders, some transit operators are laying out plans that they will be taking to maintain social distancing and mitigate the spread of COVID-19 as more riders return to the transit system. These steps include actions such as using hospital-grade disinfectant in stations and on-board buses and trains, piloting new configuration of seats to make it easier for riders to spread out and harder to transmit the virus, to offering personal hand straps for riders to use and take home for cleaning after each trip. Many transit agencies are also exploring new technologies to use and evaluating a variety of new cleaning procedures and disinfecting in response to COVID-19. The use of ultraviolet-c (UVC) for disinfecting the agency's vehicle fleet from viruses such as COVID-19 are currently piloted or studied by NYCT, BART, and NJT to determine if ultraviolet disinfecting methods are safe, will not cause damage, and are more effective and efficient than current practice. NYCT has initiated a pilot program using ultraviolet light as a remedy to kill coronavirus on surfaces in the train cars, buses, stations, and employee facilities (Queens Gazette 2020). BART is also assessing HEPA and MERV 14 filters for cars and testing the use of ultraviolet light in HVAC duct work. Exploring new methods for cleaning and disinfecting is another significant step in keeping customers and employees safe (BART 2020b).

5.2.3. App development for crowd control

There has been discussion regarding new apps that would assess how crowded a train is at a given time and communicate other options to riders such as taking a bus, ride sharing or available micro-mobility. It is also possible to advise subway commuters already on the platform as to which cars are less crowded and recommend appropriate platform queue locations.

In June, the MTA LIRR launched an update to their mobile app that allows passengers to choose less crowded cars even while waiting on the platform prior to the train's arrival (Castillo 2020). It uses "load--weight-sensors" and color coding to advise passengers how crowded a train car is (Castillo 2020). In May 2020, MTA NYCT launched an app called "Essential Connector", which assists essential workers to find alternate late-night transportation as a result of curtailing subway service from 1 a.m.–5 a.m. for thorough cleaning (Hawkins 2020).

5.2.4. Encouraging new mobility

It seems clear that providing for six feet of distance between passengers on all modes of public transit would be almost impossible if ridership were to return to pre-COVID levels in cities, particularly the locations with very high reliance on public transit. However, public transit use is crucial for minimizing road congestion and meeting environmental goals. Increased congestion also contributes to longer daily commutes, which impacts quality of life. However, promoting innovation in mobility has begun by several cities during the pandemic and might help in relieving transit in this regard.

Some measures were taken during the pandemic to provide increased road space for additional and safer travel by alternate modes such as bicycling, walking, and electric scooter. De Vos (2020) suggested that one of the outcomes of the pandemic is the reduction of demand for travel and an expectation that people will travel less by public transit. This seems to be a positive outcome of the pandemic as policymakers might want to further encourage active transport modes by promoting investment in walking and cycling infrastructure. Several cities in the U. S. including NYC, Oakland, Minneapolis, and Boston created open streets, which were intended as temporary street closures to accommodate safer pedestrian, bike, and micro-mobility traffic. Many sidewalks are too narrow to practice social distancing and so increased street availability addressed this problem. Providing for open streets was a practical decision in that public transit was experiencing significantly reduced operations, especially in the early phases of the COVID-19 outbreak. Open streets were an alternative way for essential workers to travel to work. The challenge here is to follow-up with similar physical distancing policies and incentives to minimize auto congestion after the pandemic has past.

The University Transportation Research Center (UTRC) report on the mobility trends in NYC during COVID-19 pandemic (Kamga et al., 2020) revealed evidence of increased use of bicycles as the pandemic progressed and as NYC made streets more available for such use. UTRC researchers examined mobility trends in New York City by mode comparing 2019 and 2020 ridership on subways, buses, and bicycles, taxis, etc. For April 17, 2020, the UTRC report indicates that there was a 93 percent decrease in subway ridership and a 97 percent decrease in bus ridership compared to similar days in April 2019 (Kamga et al., 2020). By contrast, they found a 21 percent increase in bicycle ridership on February 2020, before the stay-at-home order was enacted compared to monthly ridership in February 2019 (Kamga et al., 2020). It should be noted that the report did not specifically determine what percent of transit ridership *switched* to bicycling, but clearly bicycle ridership increased and transit ridership decreased at the outset of the pandemic.

Supporting new forms of mobility is an international issue as well. Heineke et al. (2020) in the McKinsey Center for Future Mobility Report referenced several cities and their goals for installing new infrastructure to support these new forms of mobility:

- "Milan will convert 35 km of streets previously used by cars to transition to walking and cycling lanes after the lockdown is lifted.
- Paris will convert 50 km of lanes usually reserved for cars to bicycle lanes. It also plans to invest $325 million to update its bicycle network.

- Brussels is turning 40 km of car lanes into cycle paths.
- Seattle permanently closed 30 km of streets to most vehicles, providing more space for people to walk and bike following the lockdown.

Montreal announced the creation of more than 320 km of new pedestrian and bicycle paths across the city."

5.2.5. Policy implications

One challenge would therefore be whether cities can develop programs and policies to continue to facilitate the use of micromobility on a regular basis as a possible alternative to public transit. A webinar hosted by the Institute of Transportation Studies at the University of California at Davis on April 27, 2020 titled "*How COVID-19 is Changing Transportation Worldwide*" presented how transportation behavior changed during the pandemic's stay-at-home orders in the Los Angeles area and how future policy could use these lessons to provide better service, particularly to locations currently not well-served (Blosch 2020). The discussion included talks on how the pandemic has influenced the public's attitude towards traveling on various modes including car sharing, buses, planes and micromobility (Blosch 2020). Emphasis was on how public policy could influence trends in transportation after the pandemic. The Los Angeles Department of Transportation provided buses to the Los Angeles Fire Department to set up test centers in lower income areas not currently well served by public transit. The speakers acknowledged that not everyone, especially due to age or disability, would be able to take advantage of new micromobility options (Blosch 2020). Recommendations that could help with better travel and access to jobs, included the potential for policy that could better serve minority communities due to low income or disability who are currently not served well by public transit in Los Angeles (Blosch 2020).

5.2.5.1. Equity. Looking into the future, there is recent evidence that equity issues will be in the forefront of most new policy in the US, particularly transportation. The need for this in transportation is reinforced by the need for equity considerations in other facets as well including health care, access to affordable and nutritious foods, environmental justice issues, etc. Social scientists, transportation planners, and government officials will need to think through the current situation to recommend the best way to move forward. This assessment will undoubtedly result in new policies that address the health-related and demographic issues that have come to the forefront during the pandemic. Preparedness would be essential should a similar situation arise again in the future. This continued effort is underway already at some areas. For example, New York City is clearly planning to continue its efforts in enhancing access for all by proposing to extend micromobility options into the outer boroughs with the goal of protecting the environment and building a "fair, safe, and equitable recovery for all of us." (NYC 2021).

However, age is an issue with using micromobility. According to Heineke et al. (2020) at the McKinsey Center for Mobility 2020, "about half of all shared-micro-mobility users are younger than 34, with the fewest users older than 55." Therefore, policies to increase access for all will require a multi-modal approach. This could include increased public transit service in these locations, but other potential arrangements are already being explored.

5.2.5.2. Modal partnerships. Reliance on a variety of modes can also help control for physical distancing by spreading the riding public out over increased public transit options including car-sharing, new bus routes to outer areas, more on-demand service that can control the number of passengers per vehicle, including one passenger at a time if necessary. There is potential to use new mobility options to connect people who are not connected well during this COVID-19 pandemic.

Several pilots are underway in the US to explore other modes and examine potential partnerships between public transit and TNC operators. These partnerships may provide a viable alternative for service to late night workers and to locations that are currently inaccessible by public transit. Some of the pilot locations include Miami Dade Transit-Uber and Lyft, Pinellas Suncoast Transit Authority with Uber, United Taxi and Care Ride, MARTA with UBER and St. Louis with Via (APTA 2020b).

5.2.5.3. Increased funding for transit. The financial damage from the pandemic has been profound to public transportation and there have been calls for new funds to financially stabilize the transit providers. In the U.S., a federal infrastructure bill is expected during the next year that includes transportation projects. A bill, (Moving Forward Act) had been recorded by the U.S. House of Representatives in July 2020, but was never acted upon in the Senate. Instead, projects in the Fixing America's Transportation Act (FAST Act) were granted a one-year extension at the same funding levels. Therefore, a new proposed bill is expected during the upcoming year with calls for significant investment in infrastructure (to repair aging infrastructure and economic development) and projects for safer and more equitable connections are likely to be proposed including urban and rural solutions (Govtrack 2020).

Additional sources of funds that were contemplated by municipalities to increase funding for public transit prior to COVID-19 have been called into question. Prior to COVID-19, New York City had proposed a congestion pricing measure for Manhattan as a means for raising additional funds to support public transit, which almost always operates at a deficit prior to COVID-19. However, with COVID-19, the number of driving commuters significantly decreased from the suburbs due to the transition to virtual work, the number of drivers fell right along with public transit commuters. Although by early 2021, the number of car commuters driving into Manhattan returned to about 90% of pre-pandemic counts (Walker 2021), some policy makers felt that it was inappropriate at the time to levy this charge on users who began driving to avoid infection from Covid-19 and also those that needed to drive to make a living, mostly lower income drivers.

Now, however, that there is an increasing emphasis on equity, congestion pricing could be viewed as a policy that also contributes to environmental justice. This is because reduced car traffic also reduces the negative environmental impacts on surrounding neighborhoods, several of which are of lower income.

6. Conclusion

This paper highlighted the measures that have been undertaken by transit operators in cities across the United States and Canada to facilitate physical distancing on public transit. It demonstrated that there were many changes in mode choice with significant decreases in ridership on subways and buses. The case was made regarding how transit operators will have to adjust transit after stay-at-home orders are lifted and the economy begins to reopen. There could be changes in commute patterns due to location decisions by employers or significant increases in permanent work at home practices. Public transit and policy makers will have to rise to these challenges. Additional research will be needed as these changes slowly become apparent. Agencies must be ready. The development of pandemic plans are necessary as future pandemics are likely to occur. Plans should be in place that show flexibility and adaptability as specifics change either because phases of a particular pandemic bring new needs or as new events happen over time. Research should be continued to study what changes do occur over time and what adjustments may be appropriate.

Author statement

Camille Kamga: Conceptualization, methodology, literature, writing, reviewing and final editing, Penny Eickemeyer: Investigation, writing-

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