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Responsively, and Efficiently Center

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Transit Industry Thought Leaders Interviews

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16. Abstract <p>Transit is at a pivotal moment. Even prior to the COVID-19 pandemic, transit ridership had been declining across the United States for several years. Although it decimated ridership, the pandemic also emphasized the essential role of transit and transit riders, underscoring the need for equity considerations. Simultaneously, advances in transit innovations ranging from new types of vehicles to fare policy changes to new public-private partnerships have the potential to fundamentally alter the types and delivery of transit services. Each of these factors individually, much less occurring concurrently, would be enough to warrant a methodical interrogation into the future of transit. For this research task, the authors conducted semi-structured interviews with 22 transit thought leaders with a wide range of expertise. During the interview, interviewees were asked to share their perspectives on the current and future state of the transit industry and how certain social and technological factors may affect that future. The interviews were then analyzed using the Nvivo software for themes of interest. The coded quotes were then exported and synthesized into a series of 6 thematic memos, including COVID-19, fare technology, metrics, micromobility, on-demand services, and public-private relationships. Given the challenges and rapidly changing environment of the transit landscape, informed perspectives of the broader vision for transit are essential to guide policies and practice.</p>			
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Although the interviewees are listed in alphabetical order, the comments of each interviewee in this report have been randomized to ensure privacy subject to our IRB protocol.

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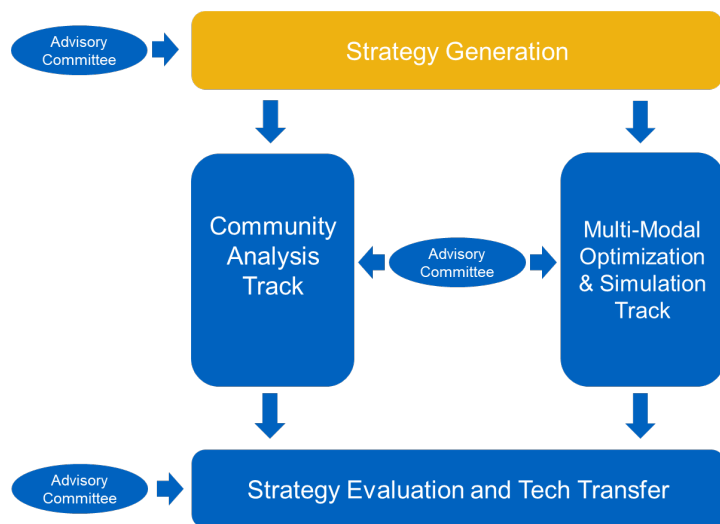
Introduction

The Tier 1 University Transportation Center known as Transit – Serving Communities Optimally Responsively and Efficiently (T-SCORE) was a consortium from 2020 to 2023 led by Georgia Tech (GT) that included research partners at University of Kentucky (UK), Brigham Young University (BYU) and University of Tennessee, Knoxville (UTK). The investigators from each university are:

- **Georgia Tech:** Dr. Kari Watkins (Center Director, now at University of California, Davis), Dr. Michael Hunter, Dr. Pascal Van Hentenryck, and Dr. Srinivas Peeta
- **University of Kentucky:** Dr. Gregory Erhardt
- **Brigham Young University:** Dr. Gregory Macfarlane
- **University of Tennessee, Knoxville:** Dr. Candace Brakewood, and Dr. Christopher Cherry

The overarching goal of the T-SCORE research center was to define a set strategic visions that will guide public transportation into a sustainable and resilient future, and to equip local planners with the tools needed to translate their chosen vision into their own community. The research approach for the T-SCORE center is shown below. The research began with a strategy generation stage, which generated qualitative descriptions of strategic directions that transit agencies and their partners can take for further evaluation. These strategic visions fed into a two-track research assessment that includes a Community Analysis Track (led by Dr. Candace Brakewood at University of Tennessee) and a Multi-Modal Optimization and Simulation

(MMOS) track (led by Dr. Greg Erhardt at University of Kentucky). Both of these tracks aimed to identify the potential feasibility, benefits, costs, and implications of each strategic vision, such as on-demand transit services or new fare policies. These tracks came together in the final strategy evaluation stage, shown below. More information about the various research activities conducted as part of the UTC Tier 1 center can be found on the T-SCORE website hosted by Georgia Tech:



<https://tscore.gatech.edu/>

The T-SCORE Center is committed to facilitating the implementation of tools and policies to shape the future of transit. Gaining perspectives from professionals and experts in the transit industry provides applied insights into the opportunities and challenges facing the industry and guides how the Center’s research can address these areas. One avenue to gain these expert perspectives is through semi-structured interviews. These interviews inform the "Strategy Generation" portion of the T-SCORE Center's broader research objectives to address trends in

declining transit ridership. The information collected from these interviews was used to develop 3-5 strategic directions that transit agencies and their partners can take for further evaluation. These strategic visions will feed into a two-track research assessment that includes a community analysis track and a multi-modal optimization and simulation (MMOS) track, which will come together in the final strategy evaluation stage. The end result is an assessment of the likely benefits and trade-offs involved with each strategic direction. Given the challenges and rapidly changing environment of the transit landscape, informed perspectives of the broader vision for transit are essential to guide policies and practice.

Context

Transit is at a pivotal moment. As noted in previous work from the T-SCORE Center, transit ridership has been declining across the United States for several years. The COVID-19 pandemic has exacerbated some of these trends as well as creating a variety of other concerns. The pandemic also emphasized the essential role of transit and transit riders, underscoring the need for equity considerations. Advances in transit innovations ranging from new types of vehicles to fare policy changes to new public-private partnerships have the potential to fundamentally alter the types and delivery of transit services. Each of these factors individually, much less occurring simultaneously, would be enough to warrant a methodical interrogation into the future of transit.

Methods

For this research task, the authors conducted semi-structured interviews with 22 transit thought leaders with a wide range of expertise. During the interview, interviewees were asked to share their perspectives on the current and future state of the transit industry and how certain social and technological factors may affect that future. Interviewees were selected based on their experience as people directly involved in transit agency operations, researchers within the transit industry, and/or those who seek to innovate or challenge the current industry norms. Interviewees had diverse backgrounds on topics such as emerging technologies, environment/sustainability, rural transportation, and transit agency operations. Of the 32 potential interviewees that were contacted, 22 interviews were conducted. The adequacy of the results that stemmed from this size of pool is based on the principle of data saturation given the breadth of knowledge already represented by the 22nd interview.

The process of conducting, processing, and analyzing the interviews was structured to respect interviewee confidentiality according to the Institutional Review Board (IRB) protocol. The 1-hour interviews were conducted using audio and video via Microsoft Teams. Interviews were recorded, the videos were removed, and a transcript of the audio was made. Names of interviewees were redacted, and both the recording and the transcript were stored in a de-identified file to ensure confidentiality. The interviews were then analyzed using the Nvivo software. Interviews were manually coded for themes of interest according to the questions asked during the interviews, topics of interest for the T-SCORE Center, and other relevant topics addressed across interviews. The coded quotes were then exported and synthesized into a series of 6 thematic memos, presented here. Topics include COVID-19, fare technology, metrics,

micromobility, on-demand services, and public-private relationships. Given the wide array of topics, each of the memos vary in structure, and the thoughts and opinions shared in the memos reflect those of the experts. This diversity in opinions emphasizes the value of many perspectives and highlights the need to engage in these discussions in order to reach a more holistic vision for the future of transit.

Topic 1 – COVID-19

The COVID-19 pandemic completely upended numerous aspects of society, and transit was no exception. Shutdowns and stay-at-home orders caused instantaneously sharp drops in transit ridership, particularly on rail and commuter lines. As the pandemic persisted, other trends such as concerns about sharing public spaces, increased car ownership, and a greater flexibility for work-from-home created increased uncertainty about who, if at all, would return to transit.

These interviews were conducted during Spring 2021, about a year into the pandemic. While enough time had passed to reflect on the early stages of the pandemic, there was still much uncertainty about how long the pandemic would last, how large of an impact these trends would have, and what steps, if any, the transit agency would need to take to respond to them.

Comfort levels

Experts attributed fears of crowded places as a deterrent to using transit during and in the short-term after the pandemic (5,13). Similarly, other experts commented that these concerns around sharing public spaces were particularly pronounced around transit, stating that people feel more comfortable engaging in riskier activities like eating indoors, going to the gym, and indoor parties than riding transit (8, 17). One expert did acknowledge that transit's ability to bring people together, which has operational and social benefits, has been stigmatized by some for a long time before the COVID-19 pandemic (8). In addition to ridership, one expert noted that fears of touching surfaces may boost interest in contactless services like app-based payments (7). Though these fears of public spaces will likely subside over time and there will be availability of vaccines or infection-induced immunity, these measures will not be enough to bring back all riders (5, 20).

Cars

Several experts discussed the relationship between COVID-19, car ownership, and resulting impacts to transit services. As one expert explained, car purchases have been going up, particularly used cars, among people who don't want to use shared modes of transportation. This was not necessarily a trend before COVID, and while it might be easier to go back to shared modes than switching from teleworking or online shopping, cars are a major sunk cost. In other words, "if you're not using the car, you're paying for it sitting there, it's a waste, so once you have a car, ... it's much harder to switch back to other modes" (1). Beyond the ridership impacts, experts noted the larger land use and lifestyle implications of more cars.

One expert described a scenario where "if fewer people are taking transit..., you get more people buying cars, more people living further away because they don't have to commute five days a week, which makes the whole mobility as a service thing less appealing if you already

own a car” (4). Similarly, people may live in less dense areas or farther away from where they work, so they might be willing to make a longer commute less often or move to exurban places for affordable housing (7, 18). At that point, it’s much harder to draw that person back to the city and therefore back on to transit. Additionally, there may be an increase in the demand for residential property in cities, but people will now organize based on cultural or political considerations as opposed to economic reasons like job centers. While these different uses may shift transportation demand, this would not necessarily spell the end of transit as transit service may be able to pivot to meet these new usage patterns. A much more alarming consideration is that in certain places, “if poverty rates go down and asset accumulation continues, that you see a lot more acquisition of private vehicles” (3). Another expert commented that in Europe, car owners were driving more, leading to greater congestion. While this may subside with the normalization of work-from-home, congestion from more cars will likely be an issue for at least the next three or four years (19).

Telecommuting

With regard to telecommuting, many experts expressed skepticism about an all-remote future. Rather, many suggested that hybrid schedules of 2 or 3 days at home were more popular (11, 17, 20). Though this will certainly vary, one expert suggested looking at large companies like Google, who not only employ large numbers of people themselves but may also set the cadence for other companies and set new norms for work-from-home. Although employees may have variable opinions on hybrid scheduling, it’s really a decision for the employers (11). Another expert also remarked that geographic and industry considerations should also be noted as this may provide more insight into the overall impact on transit ridership. In their words, “it’s not just how many people continue to telework. It’s which people and which geographies and what does that mean for public transportation?”(20). Regardless of the exact details, there will undoubtedly be impacts as a result of such major changes in lifestyle patterns, including changes in travel behavior resulting in service implications.

According to several experts, more flexible work environments mean that commuting patterns will change, likely becoming more sporadic and event driven (6). People may spend less time on the “not fun stuff” like commuting, rush hour, and errands. Instead, people will travel for social and recreation, which has different profiles and destinations (18, 20). Though still trips, these trips can’t be rationalized in terms of economic benefits and are dispersed destinations at variable times. As a result, this may create challenges for structuring consistent transit service (20). Following that line of thought, one expert posited people may even be drawn to different fare media as a result of different travel patterns. For example, less consistent travel patterns may make passes for a given number of rides that don’t expire more popular than an unlimited monthly pass for large segments of the populations transit agencies want to attract (6).

Experts agreed that while there will be some bounce back from all-remote work, transit will still have to work hard to incentivize people as regular or even once-in-a-while commuters (5, 13). For one expert, they could see this “dystopian future where we end up with massive service cuts. And maybe the quality of the service for the core riders could be brought up, but transit in its old state of serving both those transit-dependent populations and those commuters, choice

riders may not recover” (21). Other experts echoed the sentiment that lost white-collar commuters will be hard to get back (8, 20)

Service Impacts

Numerous experts discussed the impact of telecommuting and work-from-home on transit service planning, particularly around commuting and peak services. Several experts were excited by the idea of less extreme peaks. In the words of one expert, “the possibility that peaking may not be so extreme in the future... has some very powerful benefits for transit if it would allow us to shift some resources from rush hour to the all-day, all-week pattern that more people find useful and especially more people in the bottom 80% [of income earners] find useful” (15). Agencies wouldn’t have to make such intense capital and labor investments for the peaks, which might allow better service planning (17). For some, hybrid schedules create problems with office space coordination and could exacerbate peaking problems, which is already something transit has been struggling with (3).

A few experts expressed real concerns about the ability for transit operators to meaningfully predict and plan for such service fluctuations (20, 21). Additionally, if the flattening of peaks means that “travel just becomes much more dispersed in time and space, that’s much harder for transit to solve”(17). Another expert went one step further theorizing that if telecommuting takes “5% or 10% of trips out of the peak, the typical work commute trips, that changes congestion, that changes parking availability, and hence the competitiveness of transit” (20). Additionally, even if agencies want to make service changes away from the peaks, there is significant infrastructure built around commuting and peak periods, so even if we wanted to do away with it, it would be a decade before we could make change (8).

Beyond general service planning, several experts highlighted differential impacts for bus versus rail. Buses have recovered much more than rail partly because of density and partly because buses serve essential workers (11). Conversely, although rail is often fun, prestigious, and most people enjoy using it, it works best for commutes, particularly for white collar workers, which not only took the biggest hit in terms of ridership but introduce the greatest uncertainty with their return to work (7). One expert is expecting, in the long term, there is a 1/3, 2/3 rule where we’ve recovered by 1/3 already, will at best recover another 1/3, but the remaining third will remain to recompute. This ratio will likely remain true going forward for new hires as well (11).

Equity

Between COVID-19 and the Black Lives Matter protests, “there’s been more openness to thinking about that redistributive social service role for public transit and embracing that more full-on” (3, 5). Relating equity conversations to other aspects impacted by COVID, one expert commented that, as office work patterns change, public transit will have “less emphasis on the central business district and more emphasis on social justice and equity, which ... are important issues that public transportation has always dodged but are now at the forefront”(4). For one expert, the role of transit to move large numbers of people may have taken “an enormous beating,” but the importance of that “social service role of mobility for people ... without” many

other options or resources has been highlighted (3). In the words of another expert, “What we do best is we move essential workers around. We get them to work. And the pandemic has showed us that essential workers really are essential, and transit is essential to those folks getting to their jobs” (7). Indeed, transit rebounded so quickly because it is so essential and once people started to need to move around again, they needed transit (9). These core riders should be the priority (21). When considering the role of transit, particularly in light of COVID-19, transit “could do a better job of equity, inclusion of all people, but right now we are almost like the stopgap just to keep people from destitution [and to connect them to] jobs or basic health care” (16). We rely on those who rely on transit to help society function (16).

In terms of transit riders themselves during COVID, “the [average] riders on transit have become poorer ... And they're even more concentrated among people of color than before” (3). As the same expert continued, this “doesn't mean that they've gotten poorer, [but] it just means that the more affluent riders have left and have been very slow to return” since it was mainly more educated and affluent workers who were able to transition to remote work (3, 18). People who were riding transit during COVID-19 were those without any other options and were typically much lower income (5). Many of these people also overlapped with “essential workers,” including restaurant staff, lab workers, and other service industries which society depends on (6). This was especially the case with bus services, which even in the height of the pandemic, still maintained relatively high ridership rates, indicating that transit is needed and here to stay (6, 7). This may also help explain why telecommuting did not have as profound an impact on overall service (16, 18). Transit was and is a critical lifeline for many people, and society as a whole. As one expert noted, “During the pandemic, we were all transit-dependent” (6).

Beyond emphasizing the values of transit systems, equity considerations in light of COVID-19 have had profound service implications. On one hand, post-COVID “budgets are tighter in the public sector” and might shrink services to core, high volume routes and get rid of lower density areas, which might have equity concerns and might lead to “some pressures to outsource more to the private sector” (1). However, others have seen a real opportunity for some agencies, which have been able to make service changes that would normally have been difficult and unpopular. Often, when there are service changes, there are winners and losers, but COVID has somewhat changed that by showing people the essential social service role of public transportation to the essential workers (3). That being said, making these changes could have significant impacts on relative services and funding levels for different transit service. For example, one expert noted that if there is a shift away from thinking of transit as just getting people to jobs downtown toward more equity, then commuter rail systems may run up large deficits while local bus systems may not be able to adequately serve their communities. To address these service shifts, there may be unpopular funding and service changes (4).

A longer-term impact of COVID-19 may be a more critical “re-examination of what is the purpose of transit and what is the right tools for the job” (4). For another expert, while they echo that the present circumstances have called for a re-evaluation of transit priorities and values, they are concerned that people will forget about the priorities made clear with COVID-

19 and may challenge service choices such as cutting express services (7). As the same expert continued, services like express buses or commute routes, which are expensive and cause scheduling problems, have long been used to attract choice riders, but many of these services were cut during the pandemic. Despite almost no evidence that commuting is returning, many agencies are now experiencing pressures to bring back these services from commuters, who “know how to get the [transit] board’s attention” (7). For this expert, from the COVID-19 pandemic, “we did learn who our riders, our riders who really need us, are. And putting resources into serving them would be much more effective, in my book, than bringing back these express routes” (7).

Long-term Trends

In broad terms, one expert commented that the overall impact of COVID-19 will be “the acceleration of long-term trends that were already underway” (1). This includes activities like work-from-home and online shopping, which were already increasing before the pandemic. Another expert also cited the rising popularity of telehealth services, which have become increasingly important to rural communities as clinics leave for cities (12). COVID-19 may have dramatically increased these rates of adoptions, which may decline again as the situation settles, but the overall trajectory will go on and likely be of a higher magnitude (1).

Speaking specifically to transit ridership, a few experts were optimistic. According to one expert, there may be some declines in ridership in the short- to medium-term as people also enjoy more active modes of transport like e-bikes. In the longer term, as people are vaccinated and COVID-19 waves are less dramatic, ridership will return (10). One expert theorized that in 10 years, ridership will return to or even exceed current levels, and transit agencies will survive, but the service models and modes will fundamentally shift (e.g. more on-demand services, smaller vehicles) (14). Similarly, another expert noted that transit operators have been fairly nimble in terms of adjusting service and that this dynamic responsiveness will be especially important as we consider the future of transit (21).

Topic 2 – Fare Technology

Fares are an essential feature of transit and are an important equity check on the system. In the United States, there is no agency that brings in enough fare box revenues to make public transit a profitable enterprise. As a result, transit is and will likely remain heavily publicly subsidized. However, fares are thought to capture the value of transit and help off-set some of the costs, making them an important financial stream. Despite the social and financial importance of fares, they still serve as a barrier for some, raising concerns about equity and accessibility. Innovations in fare policy and technology can reduce some of these barriers and may even improve connectivity across transit systems and modes.

Opportunities with Improved Fare Technology

For many of the experts that were interviewed, fare technology and policy present exciting opportunities to make transit easier to use and operate and to shape the behavior of users.

Ease of Transit Use and Operation

Several experts commented that advancements in fare technology would improve the customer experience and make using transit more convenient (1, 7, 14, 19). In many agencies, the current fare systems are complicated and disjointed, making them a hassle for existing users and deterring potential riders (6). On a related note, one expert explained that it can be quite difficult to acquire physical fare media, but everyone has a phone, even if they don't have a car. This technological accessibility makes the case for not only innovations in fare payment systems but also provides justification for providing services like Wifi on buses to increase accessibility for people who might not have internet at home (16). One expert commented that simplifying fare media "is about democratizing the experience and meeting people exactly where they want to be [met] to make it as seamless as possible for them to get around" (14).

Some experts noted that improved fare technology could also improve transit operations. If people could buy their tickets ahead of time, it would decrease dwell times for the buses and speed up boarding (7, 9). Additionally, the current fare systems are relatively expensive, so innovations in fare media could minimize some of the costs associated with maintaining fare systems (1).

Incentivizing Behavior

In addition to simplifying the use of existing transit service, several experts noted that innovation in fare pricing and policy could be used to shape future transit use and decision-making behaviors. For example, fare pricing incentives like discounts or other offers could shift behavior to avoid rush hour peaks (6). This could include changing routes as well as modal shifts, like incentivizing bus instead rail (19). While there could be scheduling advantages for agencies, users may also benefit from potentially shorter travel times during peak hours or additional incentives and offers. Such behavior shifts could be further facilitated through Mobility-as-a-Service (MaaS), which is discussed in more detail later, because the incentives could be for other modes outside of transit services (5).

Fare Capping and Pricing

Fare capping and pricing was often discussed in the context of ease of use and equity considerations. More specifically, several experts debated the merits of monthly passes. As one expert explained, "all-you-can eat" or flat fares provide a reliable revenue stream for agencies and drive demand because consumers will be incentivized to use their passes to recoup their investment (10). Another expert commented that psychologically, monthly passes are easier to use because the user doesn't have to think about what the trip costs, if they have the money, or a way to buy the appropriate ticket (1). However, one expert proposed that given the shifts in working and commuting, monthly passes may not be as useful since people may not have as consistent of travels patterns. As a result, systems based on the number of rides that don't expire as opposed to unlimited travel in a fixed period of time may be more attractive for riders (6).

Regarding more flexible fare capping systems, experts noted benefits for users as well as agencies. Two experts noted that agencies have the technology to do automatic fare capping, which eliminates the need for many types of fare products. Once the user hits the pre-defined usage rate, there is an automatic cap comparable to the old systems of a daily, weekly, or monthly pass. This removes the need for agencies to maintain various fare products, and it is a simpler and more transparent system for users (5, 19). From an equity consideration, one expert explained that “especially if you're someone that does live paycheck to paycheck, you're sort of penalized because you can't pay out front for a monthly pass, and with fare capping, that levels that playing field” (16).

In the context of fare pricing, none of the experts advocated for free fares for all. Rather, several were supportive of free or subsidized fares for certain people or even along certain routes (5, 9, 12, 19, 20). However, while supportive of differential fare payments, a handful of experts explicitly noted that it is not the responsibility of the transit agency to determine reduced fare eligibility but should instead be tied in with other forms of public assistance like food stamps (4, 5, 20). Similarly, one expert noted that traditional criteria for reduced fares such as age are not as equitable as initially thought, and the criteria for reduced fares must be more intentional (2). Additionally, another thought-leader referenced a previous study looking at rent-burdened households, where transportation is one of many expenses, and commented that many of those participants were “very intrigued by the idea of a fare-less transit, and they thought that that provided a lifeline to them” (21).

Mobility-as-a-Service (MaaS)

“The hero case for transit agencies spending a ridiculous amount of money on fare systems is because it allows them to be at the center of everything ... in terms of bringing all of these things together” (7)

Whether referred to as Mobility-as-a-Service, or by other parallel names, many of the experts were supportive of or at least curious about an integrated system of fare products, fare pricing, and other shared transportation services (1, 4, 6, 7, 9, 10, 19, 21). At a higher level, “the idea of being able to pay for all your mobility needs except for private cars with a single wallet or a single fare structure” is an acknowledgement of “the idea that the mobility system as a whole, again, minus private cars, can work together to service people's needs” (4). In terms of empowering the agency as a regulator, account-based systems “change us back towards a thing which is more controllable and can form the basis from which you can regulate essentially all of these other services” (7).

Speaking to the deployment of a MaaS system, many experts had suggestions for the services and structure of implementing an integrated fare and service system. At a minimum, experts indicated that we should take opportunities to connect regional transit operators because different transit systems often have different fare media for different services. Connecting regional operators would not only save time and hassle but would also be the “quickest way to expand the reach of the existing networks” (6, 16). Thinking about connecting transit to other transportation services, some experts offered scenarios beyond subsidizing the fare of only

transit and offering a number of rides for on-demand services, bikes, and scooters to complete a user's mobility package (4). To this point, other experts noted the benefits of being able to plan and pay for an entire journey, rather than just one leg of a longer trip (6, 10). By linking various modes and services as one journey through a centralized system, transit agencies may be able to leverage different revenues to cross-subsidize services across modes (1).

The cross-subsidization opportunities with a MaaS model could create opportunities to meaningfully change the role that transit plays in society. As one expert explained, transit fares are fundamentally a subsidy from the government to incentivize people to use a service for the public good. By extending this rider-side subsidy to services that transit does not operate like bikes, scooters, and ride hailing, transit agencies "can exert a similar amount of influence on rider behavior and operator behavior through the fare engine" (8). The same expert described in one scenario how transit agencies, rather than running services between 11:00 PM and 3:00 AM, could subsidize a comparable Uber or Lyft trip. In a different scenario, price-induced incentives could shift riders between services or modes to reduce peak congestion and improve the overall experience for everyone (8). Such a system centralizes the transit agency at the core of transportation services and, perhaps most compelling, transportation funding. Beyond the immediate changes to services, revenues, and scheduling, a symbiotic relationship between agencies and private operators could create new avenues for standardized data collection, strategic regulation, and public-private cooperation.

Thinking outside of the transportation space, one expert envisioned a system based on MaaS that could have lifestyle implications for users. They noted that the benefits of MaaS are "not just that seamless fare payment, but being able to see what your choices are and how they are different in terms of different commodities" (21). Going one step further, the expert explained that by looking at the transportation system as a whole, riders can make decision based on "not just price, but your travel time, or your level of calories that you're going to burn because part of your choice might be to take a bike to do first mile/last mile, or if you care about reduction in vehicle miles traveled, maybe a conversion of that or greenhouse gas emissions" (21). By creating an integrated mobility system, MaaS could allow riders to understand the interactions between and implications of transportation choices.

When discussing obstacles to MaaS or payment integration, one expert stated that the barriers are "almost purely institutional and commercial," and that "the technical part of it is totally, reasonably solvable if you solve those other challenges" (17). This sentiment was echoed by a different expert who commented that "the automatic real time financial infrastructure for MaaS is less important than people think" and is often overstated as an obstacle (18).

Challenges

Though excited about the advantages of fare innovation, several experts acknowledged challenges and barriers to fare innovations. One area of discussion was access to technology like smartphones or formal banking systems, which are often critical components of proposed fare innovations. As one expert noted, many transit operators operate off the assumption that they serve an unbanked clientele and therefore cannot move away from cash. If transit

operators do embrace more convenient payment options like paying via credit card or phones, these may seem like differential benefits for choice travelers (20). Despite this acknowledgement of these concerns, experts ultimately recognized that unequal technological access is a barrier that can be worked around (7, 13).

Other experts noted that the cost of fare technologies is a deterrent to implementation. One thought-leader explained that agencies resisted making changes because of the cost of processing systems and middlemen (13). These financial barriers are further reinforced by the current funding opportunities available to agencies. Fare collection services are comparatively cheap within the scope of transit infrastructure, but it isn't seen as essentially in the same way as other infrastructure, so there is limited federal funding opportunities (7).

Topic 3 – Performance Metrics

Performance metrics are used for a range of critical functions such as determining funding, design of the transit system, assessment of performance over time, and many other aspects of transit service. Performance metrics are therefore an essential component to the functioning of transit agencies and the transit systems they run. As such, the future of transit will guide, and is guided by, metrics. This section discusses the importance of metrics, outlines a few key measures that are of value, and highlights challenges to selecting and deploying performance measures.

Importance of Metrics

What an agency chooses to measure or not is often a reflection of the agency's values. As such, different metrics may drive different outcomes. For example, one expert stated that "the metrics that public transit operators are typically evaluated on are taking us down a road that's different than one in which we're promoting social equity" and that "metrics are causing the industry to do something different than if the metrics measured a very different outcome than ridership or farebox levels." (21). Several experts suggested that agencies should define their goals first, understand why they selected those goals, and then pick metrics that align to measure how they are meeting their goals (4, 20).

On-time Performance Measure

With the exception of on-time performance, experts were not very interested in the "standard" performance metrics and noted that outside of limited contexts like basic information for consultants or internal uses, the majority of current performance metrics had limited applications.

Regarding on-time performance metrics, experts thought it could be a useful measure for the reliability of service. Maintaining on-time service improves ease of use by limiting the amount of times people will need to look at a schedule (6).

User Experience Metrics

According to one expert, there is sometimes tension between traditional operations Key Performance Indicators (KPIs) and customer service. While an agency may be meeting many of

their operational KPI goals, customer service and experiences are not being measured (1). Another expert suggested asking questions with a more customer focus: what do they think of the agency, why are they using your service, and what do they want you to do better? (13).

Beyond collecting more information on customer experience, other experts challenged agencies to frame their operational KPIs as more “passenger-facing.” For example, rather than measuring on-time performance, agencies should measure how long someone was waiting (7). Similarly, another expert proposed that there are three primary metrics that affect user experience: how much time to wait, how much time riding on transit, and how much time to access transit? These three aspects are what ultimately matter most to the rider, and each could be as readily assessed as operational KPIs, but agencies measure none of them (8).

Ridership

For some experts, ridership is a fundamental metric. As one expert noted, “whatever we’re trying to accomplish, you’ve got to have people on the vehicles to do it” (20). Ridership can be used as an implicit capture of accessibility, an indicator of transit’s usefulness, and as a gauge for transit’s popularity over time (20, 15, 9).

Despite the value of ridership, many experts agree it is an imperfect metric or should not be the sole indicator. As noted by several experts, fluxes in ridership are often due to forces outside the operator’s control, making it difficult to tie ridership changes to agency changes (3, 15). Additionally, traditional ridership counts often do not factor in rider demographics, which is becoming an increasingly important consideration when looking at the relative impacts of transit (5, 14, 16, 19).

Accessibility

Accessibility was a focal point for many of experts. As defined by one expert, accessibility is “access to opportunity for each residential location in the metro area” with a travel radius of less than 45 minutes each way (15). Several other experts also noted that the amount of opportunity is not defined by total land area but rather useful, essential, and desirable destination (3, 15, 6, 5). Accessibility was an important consideration when looking at the equity of a transit system, with one expert noting that different groups or geographic areas often have different level of accessibility (15). Similarly, another expert noted that the importance and value of a transit trip may not be equal for all people (3). While these different values may justify more equitable access, equity may look different in different communities, which is a challenge for measuring across areas (16).

Other experts also associated accessibility with the coverage of a system and the presence (or lack thereof) of transit in given communities (5, 9, 11). However, coverage should not come at the expense of quality, with the “the implicit assumption ... that a reasonably high quality of service is part of the definition of success in terms of providing access to everybody” (17).

Innovation

Experts noted several potential areas where innovation could be measured including adoption of electronic fares and ticketing, use of smartphone capabilities, Google Maps integration, amount of deployed sensing technology, and even innovative public-private partnerships (1, 21). However, despite these suggestions, most experts noted the challenges in creating innovation metrics.

Several experts discussed the challenges with innovation metrics, ranging from issues quantifying level of integration to instances where innovations occur outside of what the metrics seek to quantify (1, 21). Other experts cautioned against measuring innovation for the sake of innovation (7, 14). One expert asked to following of innovation metrics: "Is the innovation making people happier with transit? Is the innovation leading to more ridership and more returns or revenues? ... I want you to hook that innovation measure to something else" (21). Other challenges include limited transit agency ability to drive innovation, difficulties in accurate measurement, and challenges in comparing metrics across agencies (13, 21). Lastly, one expert commented on the rate of innovation, noting that "it's tough to quantify innovation just because by the time you finally quantify it, you probably should be changing it anyways" (16).

Interagency Considerations

In addition to intra-agency considerations for metrics, a few experts also discussed the challenges of interagency measurements. One area of note is the role of the Federal Transit Administration, which requires agencies to report on certain KPIs. Because transit agencies are compared based on other transit agencies, they tend to adhere to metrics like those from the FTA that are easy to compare across agencies (11). This does not encourage agencies to seek out more specialized metrics, and those agencies that do define their own metrics often vary widely in what they seek to measure and how (1). To correct for the wide variety of metrics, one expert recommends to "define those metrics collectively so that everyone understands the value of them and how to calculate them, and what you're going to do with that metric once you've done it" (18). Lastly, while FTA metrics are standardized across agencies, they are often used for federal money and grants and are not necessarily focused on optimizing the system (18).

Other Considerations

Experts also addressed metrics related to a variety of other areas of transit service. For example, some were concerned about the environmental impact of buses, looking at public health impacts of pollution in certain neighborhoods or opportunities for overall CO2 emissions reductions (5, 10). Others were interested in maintenance metrics about number of breakdowns (9), debt ratio of the agency for long-term financial investments (17), and assessments of competency and transit usage for senior leaders of transit agencies (17).

Challenges with Performance Metrics

Numerous experts noted the challenges with identifying, collecting data for, and comparing performance metrics. Speaking to the overall value of transit, "the most meaningful measures

of what transportation systems do [such as organize central business districts and bring economic benefits] are actually quite hard to measure” (3). As a result, the impacts transit does measure are often imperfect proxies. For example, Vehicle Miles Travelled (VMT) is correlated with rising incomes, “positively correlated with economic booms, ... associated with emissions, ... fuel consumption. But it’s a direct measure of none of those things” (3). The value of metrics is further complicated as different routes and types of service have different standards, making it hard to compare the system as a whole (7). Speaking specifically to innovation and equity metrics, because these activities may look differently in different regions, these metrics will have to be dynamic and community based, which is another challenge to standardizing these metrics across regions (16).

Topic 4 – Micromobility

In recent years, micromobility services, most often in the form of electric scooters and bikes, have become increasingly prominent features in the transportation landscape. Much of this explosive rise is due in part to advances in technology, which have made them more affordable and convenient to use. Despite their popularity, micromobility services have also created a number of challenges such as concerns about competition with transit and sharing road or sidewalk space.

Regarding definitions and conceptions of micromobility, experts expressed a variety of potential configurations. In the words of one expert, “micromobility, as I understand it, means a person-sized vehicle piloted by the person who is traveling. So a bicycle, a scooter, some sort of golf cart that you rent, all of those things” (15). Another expert described “micromobility as a niche for light electric vehicles, regardless of form factor” for both people and goods movement (1). In terms of the actual vehicles used, one expert theorized that “scooters will mature and find a place [along with] electric bikes, but I think there's going to be two and three-wheel electric vehicles and pod cars and all kinds of stuff that'll come out over the next decade or so that'll serve some of those urban [center] trips” (20). Another expert expanded the list, noting that “there's not only scooters, there's electric skateboards, and there's one wheels, and there's all the other ways that are even before that, that have been around forever, like regular bicycle and skateboards and roller skates and all those sorts of things that people use in the urban environment. And then you've got electrification of those devices” (18). Definition and form aside, experts shared their thoughts on the relationships of micromobility and transit as well as opportunities and challenges.

Relationship to Transit

Micromobility is not unlike transit in many ways. For example, both are “a capital investment. Service quality is extremely important. It does much better with density to serve more people [than] in less dense areas, [which] costs more” (17). As such, micromobility may run into similar problems as transit, though the fact that micromobility services are almost entirely run by the private sector means that may have slightly different priorities such as working toward economic stability by operating where volumes would be highest (17). Regardless of who

operates micromobility service, there are other considerations for how micromobility interacts with existing transit service.

Experts had mixed opinions on whether or not micromobility competes with or complements transit. According to one expert, “micromobility ... is a fundamental complement to public transit in cities because it is the other way, apart from transit, that large numbers of people can move through very little space. They do that by using vehicles that don't take up that much more room than their body could” (15). Other experts claim that scooters and bikes are “long run, core competition” with transit trips (8). Another expert supported this claim citing that in some locations, bike trips are replacing transit trips (12). Another expert claimed that their data suggests that micromobility has historically competed with transit, but they see a future where micromobility could complement transit services, but private companies won't necessarily do this without regulation (21).

Some experts were skeptical of the level of competition, with one expert claiming that micromobility will likely both compete with and complement transit trips; the most important considerations are the relative proportion and purpose of the trips. The expert continued that some micromobility trips mainly compete with walking, “which just sort of seems sort of like a waste of time and energy” (17). Similarly, another expert noted that micromobility makes up a “limited number of trips,” and “people probably should be walking if they can. And if they can't walk, they certainly can't ride a bicycle, and they certainly can't stand on the [scooter]” (2). Another expert noted that micromobility may take some trips, but it can't compete over long distances (19). A different expert provided an example in New York City, noting that Citi Bike had a record breaking 118,000 trips in one day, which is impressive, but still pales in comparison to the 5,000,000 daily trips on MTA, suggesting that the impact of micromobility in terms of number of trips may not be main priority for agencies (17).

Opportunities for Micromobility

Several experts expressed excitement about the idea of micromobility acting a feeder into fixed transit services or supporting first mile-last mile connectivity (1, 7, 12). This connectivity is especially valuable in dense and congested areas, like Manhattan, where it may be faster to use a scooter than another mode of transportation (19). Several experts expressed support for micromobility services, namely bike share (7, 12). They cited the benefits of a healthy lifestyle from biking, which is a more active lifestyle than taking the bus (12). Additionally, technological advancements such as e-bikes have “enabled a larger percentage of the population to use those services because they're electrified and easier to manage. You remove some of the barriers that people had to use in those before, like they don't want to get as sweaty or something like that, or the trip takes too long or it's too early” (18). Another expert was excited about opportunities to more fully integrate micromobility into a package of services through mobility-as-a-service platforms (16). In the words of one expert, “[micromobility is convenient and flexible and very responsive to folks' needs” and, consequently, will likely remain and become embedded in the transportation system (20).

Challenges with and for micromobility

Experts highlighted a number of challenges with existing micromobility service as well as challenges for the future of micromobility. For example, several experts noted that sharing sidewalk space, particularly for pedestrians and scooters, has become a safety concern for a number of cities (2, 7). Similarly, another expert noted that the lack of appropriate infrastructure to organize these services makes the transportation network less legible and more of a hassle for companies and agencies (9). Improved infrastructure like designated corrals or parking would also improve the safety of these services (12, 20). This will be especially important for dockless services, which are overwhelmingly scooters over bikes (21). In addition to safety, people may not feel comfortable using these services, especially in areas where there is not adequate infrastructure (17).

Regarding challenges for micromobility, experts expressed mainly concerns with the financial feasibility. Regarding first-last mile connectivity, “most of the companies in microtransit say that that market's not big enough for them to survive. They'd need more riders” (7). Additionally, “sometimes the service area is so small, we really don't know at the end of the line, what people's issues and challenges,” making providing service a potentially risky investment (1). Another expert explained that at low densities, providing micromobility services may be inefficient because it's essentially just providing personal use for individuals. People will use a bike or scooter to get close enough to their homes to make it worthwhile but who will use the bike or scooter next? Then, someone will have to drive around to collect these bikes or scooters. At some point, there is a usage curve where providing micromobility services at such a fine grain is not efficient (17). Other challenges for micromobility include potential location-specific challenges such as land use and weather because “what works in Southern California does not necessarily work in Chicago in the winter” (11). This is especially the case with use relative to car alternatives. For example, while people may use bike share to connect to buses, it must work within other options for transportation because “if the alternative is you have plenty of space to park, you're never going to get people not to drive and park” (7).

Other concerns related to the fact that while most micromobility services may be zero local emissions, there are other environmental impacts, namely from the scooters. Beyond concerns about people having to drive around to pick them up, two experts noted that the incredibly short life span of scooters is troublesome (10, 19). As one expert explained, the average lifespan of a scooter is 28 days in some places like China, New York, and some parts of Europe because they are getting scrapped once the batteries run out, thrown into rivers, and are just generally not well cared for. This is less so the case with e-bikes, potentially because they are larger, seem more expensive, and their batteries can be reused (10). Regardless, constant production and poor maintenance may offset the potential environmental benefits of micromobility.

Topic 5 – On-demand Transit

On-demand or demand-responsive services are not necessarily new features of the transportation network, but innovations in those spaces have repositioned the role these

services play in relationship to transit. The rise of transportation network companies (TNCs) and microtransit technology have introduced new service providers and vehicles. Complex and sometimes contentious relationships between on-demand services and transit, regulators, and labor unions have created challenges envisioning a sustainable and supportive transportation system. However, on-demand services have the potential to complement transit and improve mobility for customers.

Opportunities

For many experts, one of the biggest benefits of on-demand services is the opportunity to dramatically increase the coverage and accessibility of the system (1, 2, 4, 7, 12, 16, 17). One expert described on-demand services as replacing “underperforming” fixed routes, which are those with “low ridership, and expensive circulator routes in low density areas” (1). Another expert took this concept one step further and envisioned opportunities for connecting people who are 20 miles out of the city and still providing them some level of access to the town (12). In addition to going places where transit doesn’t serve people, on-demand services can also operate when transit doesn’t, namely late at night and early in the morning. In this way, on-demand and ride hailing services can be incredibly valuable for the community (2, 12). Similarly, several experts expressed the opinion that paratransit services would benefit immensely from an on-demand model (2, 4, 8, 16). Demand responsive paratransit service would make scheduling and using rides easier and more dignified. From the agency perspective, operating expenses are likely to be lower while providing a major service boost.

Some experts see on-demand services not as replacements or additions to transit service but rather as a tool to improve the overall efficiency of the system. To one expert, this translates into “feeding into services that [transit agencies] are already running more so than replacing anything that [they] might be running currently”. The same expert also acknowledged that new technology provides flexibility and removes some of the operational barriers that were deterrents to previously attempted systems like deviated fixed routes (16). Another potential efficiency is the ability to more intentionally meet people where they are with stops and pick-ups. One expert explained that with on-demand service, there are more places to pick-up, it is easier to change or add pick-up locations without huge capital outlays, and there are opportunities use data to aggregate rides and more quickly change routes (14). Furthermore, TNC companies have impressive ability to scale and are able to apply lessons from around the world “to transition over technologies to the US very quickly in meaningful ways” (14).

Speaking specifically to the impacts on equity, experts considered the increased coverage from on-demand services an opportunity to serve more people. This could be especially important post-COVID as some agencies have had to cut service and routes because of budget constraints. As such, on-demand service could “spread your budget further if you have a lower cost and you can arguably serve more people” (1). In other scenarios, on-demand services might be more expensive than transit offerings, but it may provide better service or service where there wasn’t any. In these cases, higher costs for more or better service could be a good trade off, but it would be up to the community to decide if it’s worth the cost (4).

Despite these potential opportunities with innovation, experts expressed reservations about the benefits of on-demand (17). For example, one expert noted that while on-demand could access places or markets that transit doesn't serve, they didn't necessarily see an increase in ridership (7). Another expert commented that while on demand may be "able to expand the overall footprint of the service," they still believed that most of their routes should remain fixed routes (16). As one expert said of on-demand vehicles, "they don't solve everything, they're not a cure-all," but they allow agencies to concentrate high-capacity service along high-capacity corridors, which increases frequency, while allowing smaller vehicles to cover lower-capacity corridors and provide at least some level of service, namely coverage (8).

Relationship to Transit

A few of the experts acknowledged that TNCs and transit generally interact in both complementary and competitive ways (1, 7, 10, 16). The one expert emphasized the different impacts in different contexts. For example, in the Southeastern US, there are places where there is a need for transit service that is not currently being met, and TNCs are helping fill that gap, so there isn't as much competition (16). Others expert highlighted the different impacts on different demographic groups, stating that for some groups like the elderly or the disabled, on-demand service would be an improvement to current transit service whereas for the general public, ridehailing replaces activities and transit use (10). Other experts echoed these sentiments, noting that socioeconomic considerations might explain who uses publicly subsidized transit versus more expensive, private ridehailing (16). Segmenting into more demographically distinct groups can have important implications for the impact on TNCs on ridership.

Several experts suggested that the ability for TNCs to shift rides away from transit may be limited. According to one expert, TNCs are most disruptive when they enter a new market in a new city. However, after two or three years, their market share stabilized. People who were going to use these services used them, but once TNCs were embedded in a community, "they weren't stealing bigger market shares." Looking at the future, as prices continue to rise and pressures mount to improve compensation, TNCs will lose some of their appeal, further limiting their market (20). Two experts noted that users of ride hailing and TNC services are often of a higher income bracket and a younger age demographic than the majority of transit riders, indicating less of a rider overlap (7, 9). As such, while TNCs may take some of the higher income riders or the people who don't feel safe at night, private ridehailing efforts probably don't explain that much of the decline in transit ridership (7). One expert did note that the demographic impact of these systems depends on where they are deployed. While many transit agencies are hoping to incorporate on-demand service to attract choice riders, many of the core riders of these on-demand services have actually been "low-income, working class people" because of where the service is offered (14).

Operations

When considering the implementation of on-demand services, experts expressed a range of opinions on public versus private operators. A few experts felt relatively agnostic about

whether or not the transit agency or a private company should run on-demand services (1, 12). One expert wondered “what's the difference between a TNC that's shared like a Uber Pool or a Lyft and a microtransit? ... they're both on-demand, they're both shared” (1). Another expert even proposed allowing groups of volunteers to operate these services, if not for the whole trip, then at least to bring people to a more central location to link with transit service (12). While still neutral on the overall service delivery, one of these experts did acknowledge some benefits to private outsourcing such as the “potential to move along a little more quickly because there's a role for external players to come in and manage some of those problems that are difficult for the agency internally to manage” (1). Conversely, one expert advocated for private sector involvement, at least on some level because “to get to good on-demand quality service, you need a tremendous amount of R&D...: really good algorithms, really good customer experience, integrations with so many different techs,” and a level of investment that public transit agencies can't provide. There is value in public-private relationships where the private sector takes on risk (14). In the instances where some public agencies have experimented with running some of these services themselves “to co-opt the advantages of ride-hailing,” it has been a complicated process building these partnerships, structuring services around them, and regulating them to serve the public benefit (8).

Regardless of operations, numerous experts commented on the need for some level of public oversight (1, 8, 9, 16, 17). Speaking to the role of private operators and service allocations, one expert commented that transit agencies grapple with a “difficult triangle of ridership, equity, and budget,” and a private operator motivated by ridership and revenue won't necessarily solve that (17). Similarly, another expert advocated for “transit agencies playing a role in defining service areas, setting service parameters and fares in a way that ... the private market is just not going to” (1). The public sector should also help establish certain operational standards to ensure safety and certain minimum levels wages, though this oversight should still be relatively limited and should not go so far as to set prices (16).

Complementary Relationship with Transit

Many experts see an opportunity for TNCs and transit to have a complimentary relationship. Similar to transit, TNCs thrive in areas with low-car ownership, so if car ownership were to decrease and people were unhinged from their cars, there could be a huge opportunity to change the mobility landscape (4). Complimenting this viewpoint, another expert theorized that TNCs are kind of the future, especially with autonomous vehicles, and there is an opportunity for everyone to make a lot more money if TNCs and transit can work together (19).

Experts noted that the areas and times of services for on-demand services could be complementary to transit service. One expert explained the spatial relationship between TNCs and transit: “Uber and Lyft and taxis are big competition for public transit on the outskirts of the city, but that's also where public transit wants to operate less. So that's where the collaboration happens” (8). Another expert noted that it was a negative that transit did not embrace TNCs because beyond helping with first-last mile connectivity, these services help people get from where they are to where they want to go (2). In terms of offering services

when transit is not operating, one expert suggested that TNCs would be open to negotiating service contracts because “while there may be limits on the price for government-procured services, agencies could be “throwing them 100 times more customers than they already have between 11:00 PM and 4:00 AM, they're going to negotiate with you on the price” (8).

While experts acknowledge the potential synergies between on-demand and transit, several of them also expressed reservations or limitations. For example, one expert noted that there are some innovative partnerships where TNCs can be subsidized to operate where they do best (i.e. low-density areas) and bring riders to a more central location to transfer to a fixed route bus or rail (7). However, while this is interesting and could be useful, the same expert said the benefits have been oversold and doubted whether this is a sustainable model if the subsidy goes away. Part of this is because in many of these areas, there is not a larger enough market, which is the same issue transit faces(7). Similarly, another expert explained that in rural areas, TNCs have a hard time seeing the business case with so few people spread so far apart. As such, they will likely require some kind of financial support or subsidy from the agency, which further blurs the lines of a public or private operator (19). Lastly, one expert emphasized the need to coordinate scheduling between transit and on-demand services, especially those being used as feeders, to help people make connections. If there is not that level of integration, then on-demand services run into the same problems as other modes (16).

Competition with Transit

In general, experts were less concerned with competitive dimensions of relationship between TNCs and transit. One expert noted that TNCs are taking some of the transit trips, namely because there is a huge number of gig workers willing to work for substandard wages to provide these on-demand services (13). A different expert explained that while TNCs are replacing trips in the urban core, “there's a natural limit to how many they can replace based upon the road capacity” (8). As such, the impact of the competition will be mitigated by space, congestion, and pricing so there is a certain self-limiting, self-correcting element (8).

Challenges to implementation

Experts noted a variety of challenges to implementing on-demand technology, including dynamics with transit agencies, cultural norms, and relationships among TNCs.

Regarding transit agencies, several experts noted both reluctance and inability to make the changes necessary to support on-demand services. As one expert pointed out, some agencies may be slow or unwilling to relinquish control over services, especially to companies they aren't used to contracting out to (4). A different expert explained that “transit boards are not businesses, [and] transit is created mostly by governments, joint powers, or state or local” authorities, so they are bound by certain restrictions like not carrying parcels and regulated fares that make adapting difficult. This not only limits the types of services that agencies may be able to offer, but within these changes, transit agencies must still serve existing customers (13). Such constraints make changing service offerings and structures politically challenging for agencies as well. Additionally, transit agencies often have relationships with labor unions, which often have a vested interest in maintaining certain levels and types of services. While

concerns with labor unions often come up in terms of autonomous vehicles, experts stressed here that labor constraints may limit the possibilities for on-demand services (2, 20).

A couple of experts discussed the cultural norms around sharing and the limits it may create for on-demand services. One expert explained that public transit wants to deploy on-demand services based on the experiences people have had with ridehailing and TNCs because it feels different than public transit, but there are also different standards. Smaller vehicles and preconceived notions of TNCs mean people have “culturally-embedded” expectations for TNCs. Consequently, while users may have spent less time waiting outside, there is more transparency, and the trip is shorter, customers may still be upset by certain on-demand experiences when they have to share the space or detour to pick up additional people (14). A different expert’s comments built off this sentiment, stating that “there’s a limit to what people are willing to share,” and while pooling rides will be a crucial role, “it won’t be the future.” It’s difficult to match people and trips in a way that makes sense, so there will still need to be a mix of single and shared rides for TNCs (4). Lastly, although there are certain norms around sharing, they are primarily cultural, meaning it is something people could get used to and can work around. While this may be the case, these cultural divides are more pronounced when trying to use TNCs to pursue choice riders, who aren’t used to sharing or taking detours. Despite transit agencies marketing their on-demand services as very comparable to the typical ridehailing experience, they are still distinctly different. With choice riders in particular, there may be more challenges overcoming these expectations of sharing than with other transit users (14).

The TNCs themselves may also be a challenge to implementing certain on-demand models. Many of the TNC’s have “baggage” that is hard to overcome, making entering into some of these agreements politically complicated (4). One expert even went to far as to say that TNCs need transit more than transit needs them because of the bad press for some of these TNCs (7). Industry competition can also create complications for industry-level cooperation in a region. For example, one expert noted that for agencies to incorporate one type of ridehailing service on their app, other service providers may not be willing to share their data, cooperate on sharing software, or enter into other agreements because the companies won’t “play in the sandbox” (5). For transit agencies looking to integrate on-demand or ridehailing services into a more comprehensive mobility system, limited company cooperation may be a deterrent to deploying new agreements and services.

Labor Costs and Automation

As noted above, several experts commented on the impact of labor in terms of challenges with implementation, but other authors noted the need for automation if on-demand services are to be truly viable. According to one expert, the current system for ridehailing is built off not paying drivers a living wage (7). As such, these ridehailing services won’t be able to survive or be profitable without some level of automation in the future (2, 7). This incentive to one day be profitable is part of what pushes some TNCs to innovate because automated vehicles will be their breakthrough (6). Shifting from cost to service implications, one expert noted that if people don’t have to worry about when ridehailing drivers want to work, which would affect

scheduling and the availability of services, then ridehailing can be truly demand responsive to consumers. The same expert continued, noting that with automated services, there is “a gizmo that's doing the driving, it doesn't have a family to feed, it doesn't have a kid to send to Princeton, and it doesn't care when it works” (2).

Concerns with Microtransit and Ridehailing

Some experts are wary of microtransit or other on-demand services as “innovations” and argue that they are just more recent iterations of existing or previously offered services (7, 15). As explained by one expert, more technology has made some of these services a bit more efficient, namely by streamlining communication, but they are not nearly “a tenth as efficient as a fixed-route network can be in most places, except when you're doing coverage to the most transit hostile landscapes” (15). For a different expert, they theorized that many of the benefits of on-demand services such as less delays and shorter walks for first-last mile connections could be achieved with more frequent service (9).

Regardless of the novelty of on-demand services, several experts expressed criticism relating to the parallels of on-demand, namely ridehailing, services to private vehicles. According to one expert, “ride-hail is just purchasing an automobile trip one trip at a time ... What we've done with ride-hail is offer yet another way to get a private vehicle trip, which has done more to pull people away from public transit.” The expert continues that “it's not about regulating ride-hail or regulating automated vehicles ... if things are exacerbated by automated vehicles, if they're exacerbated by ride-hail, it's focusing on the wrong part of it” (3). In this way, many of the concerns about ride hailing, whether that relates to taking trips from transit or additional carbon emissions, are less about the specific type of service but the underlying landscape of the private automobile. One expert even went so far as to claim that “the fact that [on-demand services] are circular, and they move around is worse than a parked car” (10). Furthering the connection between TNCs and private automobiles, one expert noted that “by virtue of the market being rigged to the advantage of a private car, it's also rigged to the advantage of other kinds of tools that operate like private cars such as Uber and Lyft,” and the real issue with TNCs is not taking market shares but congestion (15).

Concerns about congestion were shared by several experts. A few experts commented that more, smaller vehicles with less capacity on the road would increase roadway congestion, potentially even slowing down buses (7, 9). One of these experts also commented on issues with curb space, especially in larger cities where ride hailing vehicles may be waiting when a bus pulls up, impacting traffic (7).

Experts also noted several other areas of concerns, namely around vehicle accessibility, safety, the environmental impacts, and funding. Several experts commented on the supply of handicap accessible vehicles, both for paratransit as well as general service (4, 13, 16). Other experts noted issues of safety, namely looking at rider safety as well as driver trainer, driver insurance, and regular vehicle inspections (13). As explained by a different expert, “there's certain liabilities and risks which no one ever thinks about when they take transit,” but that TNCs and other private companies are not necessarily beholden to the same standards (16). In terms of

sustainability concerns, on-demand services may be burning more emissions because multiple, smaller vehicles are serving what used to be served by two buses (4, 10).

When considering the broader impact of TNCs on urban mobility, one expert expressed that their “only view about the future of transit is that geometrically, there isn’t an alternative to it in major cities,” and people are “going to keep chasing techno gizmos and everything else to try to avoid just solving the problems of cities with the only tools that actually work for the defining problem in cities, which is the need to share space effectively” (15). Another expert echoed that while ridehailing can be a useful service, it should not be a replacement. In their opinion, “if people are willing to pay more to get in a taxi, I guess that that should be their prerogative,” but an on-demand option shouldn’t mean that transit is allowed to deteriorate or be less competitive. The goal should still be “that everyone believes that they can get where they need to go on the transit system” (9).

Topic 6 – Public-Private Partnerships

Between government regulation and oversight, public funding, and being seen as a public good, it naturally follows that for decades, transit has been closely, perhaps almost exclusively, tied to the public sector. However, investments and innovations from the private sector have begun to unpack many of the core features of transit and have called into question the role and need for public sector involvement. Many experts suggest opportunities to leverage the strengths of both the public and private sector to create a mutually-beneficial relationship that ultimately improves services for the end users.

Innovation role of the private sector

Many experts acknowledged that technical innovations can, and should, come from the private sector (1, 11). Part of this rationale is based off of simple business principles. Many private operators are operating at losses or are unsustainably funded, so many of these companies have the incentive to innovate to one day get their operations out of the red (6). However, many technological innovations require lots of research and development and high levels of investment, and transit is now a space benefitting from these venture-capital level investments. Leveraging these private dollars creates opportunities to innovate and support the public sector in ways that public agencies aren’t capable of doing (14). External innovation is also important for pushing government entities forward (16). In many instances, the public sector is understaffed, has set ways of doing things, and has strong labor unions which makes them resistant to changes and unable to respond to and integrate in new technologies (1). This makes generating innovations from within the public sector particularly challenging. Another expert also noted that “[TNCs] need transit now because of some of the bad press they get,” suggesting that public sector applications of private sector innovations is mutually beneficial (7).

According to some thought leaders, there is no need for the public sector to be directly generating innovations in the first place. Transit agencies don’t need to develop the infrastructure or technology when they can get it from other sources and use those tools to deliver services the way they want to (17). However, the commercial side of innovation often

moves faster than regulatory frameworks, which sparks the need for a more nuanced conversation about the need and degree of regulations (14).

Regulatory role of transit agencies

Nearly every expert spoke about the need for regulation (1,2,4,6,8, 9, 12, 13, 14, 16, 17, 19). As stated by one expert, “regulation is necessary because transportation is a public good and therefore requires public oversight to oversee private [interest]” (2). Another expert acknowledged the need for some level of public oversight because there are tensions between ridership, equity, and budget, and “you wouldn't necessarily solve on that triangle purely from the perspective of a private operator whose sole goal is basically ridership and revenue or profit” (17). While agreeing on a need for regulation, the thought leaders differed on how much regulation and in what areas.

For some experts, they strongly advocated for more public regulations. Speaking to a broader philosophy of the government role in transportation regulation, one expert commented that “everyone in our business knows that what government should really do is level the playing field between transit and other modes and impose appropriate disincentives to driving such that an individual's decision about whether to drive is influenced by price signals and other signals that represent the harm that they're doing to both society and the planet by driving” (15). A different expert generally wanted more regulation over less with the transit agency at the center (9). This sentiment was shared by others, who see transit agencies as regulators but also as managers of the mobility, who can regulate for the public benefit by, for example, tackling the huge amount of traffic congestion at peak periods (8). Another expert championed “broader-based regulations like congestion pricing for high space, high energy vehicles, and allocating street space a certain way, and having ... the full cost of roads be borne by... their users, at least in proportion to how the cost of transit is borne by the users” (17). There is also a need to hold private sector companies accountable, particularly around transparency, regulations, and privacy (18). With regard to more of the specifics of regulations, experts proposed a variety of different potential areas and mechanisms for regulation.

The most common area that needed regulation was safety (6, 12, 13, 16, 19). This includes everything from rider safety, accessibility and ADA compliance, driver training, vehicle maintenance and inspection, and insurance (6, 13,16). Other experts advocated for regulations in “defining the rules how that game is going to play out from a city or from a state perspective” (19) and “setting a few ground rules, like you need to serve everybody” (4). This may include defining service areas, setting service parameters in areas, and controlling fares” (1, 4). Another potential “Part of the transit agency’s regulatory role is ensuring that the private sector is at the table” (12).

In addition to suggesting areas that need regulation, experts also offered some way transit agencies could regulate. For example, one expert noted that transit agencies can regulate by providing infrastructure and making the networks more legible (9). This may include parking places for scooters (12). Another potential opportunity could be through more integrated service platforms like a single app, which is easier for users but also consolidates services and is

thus easier to regulate (9). Another expert expressed a related sentiment, noting that while regulating across many services, industries, and business is complicated, the public sector is ultimately responsible for establishing standards and regulating currency, which can be applied across the industry to regulate (8). Despite recognizing the need for regulation, several experts expressed apprehensions about over-regulating.

For many experts, there is a need to find the right amount and type of regulation. Commenting broadly on the role of transit agencies as regulators, one expert expressed the following reservations:

“I’m a little nervous about the way transit agencies are being encouraged to take on other responsibilities. I think that's partly a reflection of the fact that our elites don't care enough about transit and therefore won't respect transit agencies unless they're doing something they care about. ...We urgently need transit agencies to design and run really good transit systems and to have the funding to do that however that works out jurisdictionally, bureaucratically” (15).

However, accepting that transit agencies will likely inevitably be asked to play some kind of regulatory role, other experts offered a few potential limitations for a variety of reasons. As stated by one expert, “all governance frameworks are about walking that line of too many regulations versus not... we have to be really thoughtful about it as we go forward, we can't take old regulations and just say, ‘This makes sense for this because it's what we do for everything else’ because it's not that’ (14). Different experts shared these feelings commenting on the need “to keep [regulations] as minimal as possible to really regulate what must be regulated and not trying to generate an advantage for the public transport” (19) and making sure not to stifle innovation (6). To the point about prices, two experts wanted regulation so that private operators “don’t get greedy” but shouldn’t go as far as setting prices (2, 16). In order to keep some of these areas more clearly delineated, one expert recommended that regulation should be at the federal level and separate from operators (6).

Summarizing the importance of regulations, one expert described the potential of regulatory networks to delineate “a lot of things that empower agencies to work with partners and not be in a place where they're dependent on partners but also have to create space for innovation” (14). For another expert, “the public sector has to take the responsibility of representing its constituents and being responsible for the overall design of a transportation system, a public transportation system, [and] the private sector's role is enabling the public sector's mission and creating the tools and technology such that the public sector can execute on its vision” (4). According to many experts, the best way for the private sector to support the public sector is through technological innovation.

Models for Partnerships

Many experts discussed a number of considerations and proposed models for creating efficient and effective public-private relationships. For some experts, innovative models for partnerships create the opportunity for transit agencies to act “as the integrator of mobility as a service but the degree of coordination can vary” (11). Stated differently by another expert, the real

opportunity for transit lies in “looking at transit as the backbone of this innovation. It's more on the institutional and the partnership side of things and a lot less about the technology, [so] the innovations need to be in building the institutional environment and the partnership environment, [which are] the relationships between other mobility services that can complement transit” (5). Connections across modes are especially important because modes have been very siloed in the past (1). Regardless of whether agencies play a central coordinating role or not, many experts expressed support for agencies advocating for themselves in these relationships.

Numerous experts had useful advice and considerations for agencies looking to build productive and empowering relationships. As one expert explained:

“it's going to be really important for agencies to advocate for themselves and own their data, and own everything that's happening. What you don't want to happen is that agencies are coming in and piggybacking with private companies and private companies are providing a service at a cost and locking in agencies as they deprecate former business models. What you want to do is be locking in with partners who have a lot of competition that are replaceable and you have a lot of ownership over the data, over the service” (14).

This includes creating a competitive space where there are many options, creating the right kinds of partnerships that give “agencies the type of data that they need in the way that they need it at a way that their level of security can handle”, and “making sure that agencies are contracting in a way that doesn't create massive amounts of lock-in where not necessary” (14). This intentionally flexible relationship is critical “to fit the needs of agencies because every agency is very different as well as every ridership base is different and it's going to require private sector partners that can meet the demands of what public sector agencies are seeing on the ground because they know it better than anybody from the outside in” (14). The beauty of an agile and dynamic system is that it creates a close, collaborative effort that can delegate responsibilities but also shift them as needs and wants change, which is essential in a rapidly changing and innovating space (19). However, while agencies should be empowered to decide the model they want to use, there are a number of considerations such as whether the private company provides some combination of software, vehicles, and drivers for given routes at given times that makes creating partnerships a dynamic process itself (4).

In the current landscape, the relationships of the private sector to the public sector can be highly variable based on a number of factors to meet agency needs. For example, transit agencies may continue to operate services while the private sector provides backend support (21). Some experts see the private sector building equipment and vehicles and even serving as contract operators in some situations (20). Other experts envision some cases where the private sector may provide software, vehicles, staff, or a combination of these services. In each of these instances, there is not necessarily a one-size-fits-all partnership, but while there may be little difference operationally, there could be a financial difference (1). In fact, some experts envision a future where there is little distinction between public and private because for the

end-user, they will just see it as all part of the transportation system (5). This blurring between public and private may have broader societal impacts as well.

The public-private sector partnership has the potential to be mutually beneficial. A more integrated system allows “transit to capitalize on those private sector services to elevate itself and you want the private sector to succeed as well because it's going to be for the good of everybody in that region, not just that private company is going to make some money” (5). The same expert continues “that partnership has to be for the good of both the public and private sectors, and the intersection between those has to be focused on what the community needs in terms of mobility” (5). Despite the opportunities and benefits for public-private partnerships, there are a number of challenges as well.

Challenges

There is certainly an eagerness and enthusiasm on the private sector side to work with agencies, but there are a number of institutional and financial barriers (1,2). At the most basic level of even opening the conversations, one expert noted that “transit agencies are almost impossible to bring to the table for anything so they kind of have to initiate that conversation” (17). Even if there is political and institutional support for innovations, transit agencies face a number of technical challenges to building and implementing new technologies (1, 17). In addition to the limited capacity of transit agencies, the private sector has their own goals and challenges that must be met.

For the private sector, one of the biggest challenges surrounds the financial sustainability and viability of innovations. Unlike the public sector which is deeply subsidized and often operates at a loss, the private sector must maintain certain requirements for operating such as covering expenses and generating a certain profit margin (1). Currently, many of these private-sector transit innovations are still operating at a loss, and the private industry is currently subsidized from private source like venture capital, which is unsustainable. As such, if there a desire for the private sector to provide service, there will need to be some kind of public sector financial support such as subsidies or a minimum contract value (1, 2).

Experts cited a number of diverse reasons why there should be some level of subsidy for private operators. The first is the fact that public transit is subsidized to keep it affordable, but it operates at a loss. Since private operators can't operate at similar losses, they must either charge higher rates, which does not keep in line with equity goals, or they must receive some kind of subsidy (1). A different expert proposed a different model where the private sector should be allowed to operate according to the market, but “if the public agency wants to direct these private services to work with public transit or behave in ways the market would not otherwise dictate, they may have to subsidize some of these efforts to manage the system” (4). In any case, there is a need to be open to publicly subsidizing private service, most likely at the federal level, as part of the broader transportation system (6, 15).

There are also some political obstacles to building better public-private sector relationships. The first is within the private sector, where competition among companies may make or break partnerships with the public sector (5). Additionally, one expert cautioned against giving the

private sector too much sway, noting that strong lobbies and interests can be powerful forces in shaping policy (21).

Conclusion

Innovative public-private relationships present a variety of opportunities for both sectors to improve the transportation system overall. For transit agencies, private-sector partners can provide much needed research and development investments to generate important advances in transportation technologies. The private sector benefits from increased legitimacy and potentially larger financial gains. In any case, dynamic partnerships are key, allowing for appropriate regulations, financial incentives, and flexible arrangements to meet the changing wants and needs to consumers and improve their mobility.

Cross-topic Conclusions

Experts discussed a wide range of topics and shared a variety of opinions. However, across the interviews, there were several common themes. Perhaps the most important one is the emphasis on cooperation and complementary solutions. Whether through integrating new modes, creating mutually beneficial public-private relationships, or restructuring user interfaces and fares to build more cohesion, collaborative solutions that work with transit and other modes are the best way to build a more efficient and effective transportation system. Similarly, experts shared the sentiment that transit is and should remain a central feature of the transportation system, although the exact role of transit agencies as regulators, service providers, or mobility managers may be less certain. Lastly, experts shared sentiments on transit as a critical mobility lifeline and the importance of taking equity into account. For many experts, the COVID-19 pandemic and movements for racial justice refocused their priorities on the importance of transit and transit riders. Thought leader opinions on how to maintain or create more equitable systems varied wildly but all centered equity as a core pillar in the future of transit.

Appendix A - Recruitment E-mail

Hi [name],

We are working on a research project for the Transit-Serving Communities Optimally, Responsively, and Efficiently (T-SCORE) Center, which is a US Department of Transportation funded University Transit Center, which aims to address declining transit ridership trends.

For the upcoming phase in our project, we are interviewing experts and thought leaders across the industry to get their perspectives on the current and future state of the transit and how certain social and technological factors may affect that future. We will use the information collected from these interviews to develop 3-5 strategic directions that transit agencies and their partners can take for further evaluation. We are engaging those who are directly involved in transit agency operations, researchers of the transit industry, and/or those who seek to innovate or challenge the current industry norms.

We're very interested in speaking with you to help inform our strategic directions. The interview will take no more than 1 hour. Participation in this interview is voluntary. A list of all interview participants and their professional association may be included in the final report; however, your responses will not be associated with your name.

Do you have availability for an interview via Microsoft Teams sometime in the next several weeks? Please contact Bianca Mers at bmers3@gatech.edu to schedule an interview time. If you have any questions, feel free to contact Dr. Kari Watkins at kari.watkins@ce.gatech.edu.

Best,

Dr. Kari Watkins, T-SCORE Center Director
Dr. Michael Hunter, T-SCORE Associate Director
Bianca Mers, Graduate Research Assistant

Appendix B – Consent Form

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Georgia Institute of Technology

Project Title: T-SCORE Key Informant Interviews with Thought Leaders in the Transit Industry

Investigator: Kari Watkins, Michael Hunter, and/or Bianca Mers

Principal Investigator: Kari Watkins, Ph.D.

You are being asked to be a volunteer in a research study.

Purpose: This project seeks to inform the "Strategy Generation" portion of the T-SCORE Center's broader research objectives to address trends in declining transit ridership. We will use the information collected from these interviews to develop 3-5 strategic directions that transit agencies and their partners can take for further evaluation. These strategic visions will feed into a two-track research assessment that includes a community analysis track and a multi-modal optimization and simulation (MMOS) track, which will come together in the final strategy evaluation stage. The end result is an assessment of the likely benefits and trade-offs involved with each strategic direction. The research anticipates that up to 30 individuals will participate in this research based on their professional experience in the transit industry.

Exclusion/Inclusion Criteria: Study participants must be 18 years of age or older with expertise in the transportation or autonomous vehicle field. Persons located in the European Union will be excluded.

Procedures: Participation will be in the form of a semi-structured interview. During the interview we will seek your perspectives on the current and future state of the transit industry and how certain social and technological factors may affect that future. The interview will be by phone and will last between 30 minutes to 1 hour of your time. This interview will be recorded and a transcript made for research purposes. Both the recording and the transcript will be stored in a de-identified file (i.e. the data of your interview will not be associated with your name to ensure confidentiality. With your consent, the research team will store and analyze your de-identified interview data.

Confidentiality: The following procedures will be followed to keep your personal information confidential in this study: The data collected about you will be kept private to the extent required by law. Your records will be kept in secure files and only study staff will be allowed to review them. A list of all interview participants and their professional association may be included in the final report; however, your responses will not be associated with your name. Your privacy will be protected to the extent allowed by law.

The Georgia Institute of Technology IRB, and the Office of Human Research Protections, may look over study records during required reviews.

Benefits: There is no immediate, direct benefit to the participants. There may be a social benefit from this project as the information may assist the transit industry in their ability to more effectively serve their communities and efficiently use resources.

Costs to you: There are no costs to you other than your time, for being in this study.

Risks or Discomforts: Participation in this study may carry the possibility of breach of confidentiality in the case of malicious external activity. The risks involved are no greater than those involved in daily activities such as email correspondence or user registration via a secure website.

Storing and Sharing Information: Your participation in this study is gratefully acknowledged. It is possible that your information/data will be enormously valuable for other research purposes. By signing below, you consent for your de-identified information/data to be stored by the researcher and to be shared with other researchers in future studies. If you agree to allow such future sharing and use, your identity will be completely separated from your information/data. Future researchers will not have a way to identify you. Any future research must be approved by an ethics committee before being undertaken.

Questions about Your Rights as a Research Participant:

- Your participation in this study is voluntary. You do not have to be in this study if you don't want to be.
- You have the right to change your mind and leave the study at any time without giving any reason and without penalty.
- Any new information that may make you change your mind about being in this study will be given to you.
- You will be given a copy of this consent form to keep.
- You do not waive any of your legal rights by signing this consent form.

If you have any questions about your rights as a research participant, you may contact:

Ms. Melanie Clark, Georgia Institute of Technology
Office of Research Integrity Assurance, at (404) 894-6942.

If you have questions about the focus group or the overall goals and objectives of the research project, then contact:

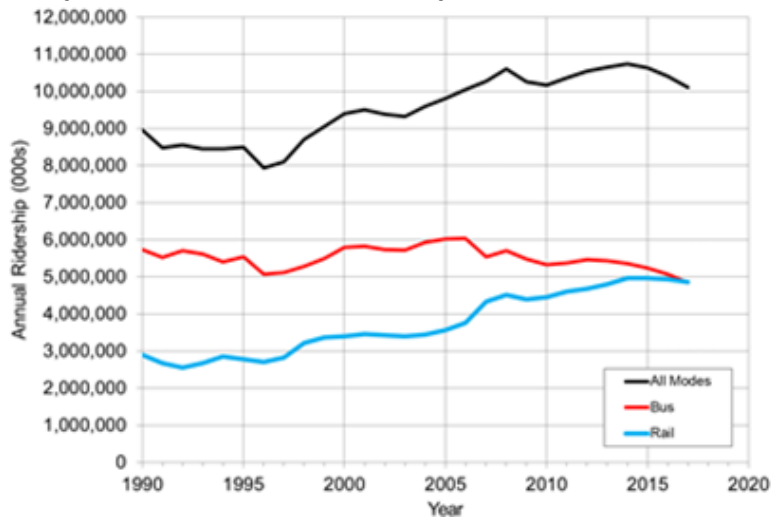
Dr. Kari Watkins
School of Civil and Environmental Engineering
Georgia Institute of Technology at (206) 250-4415

If you participate in the interview, it means that you have read -- or have had read to you -- the information contained in this letter and would like to be a volunteer in this research study. By continuing with this interview, you indicate your consent to be in the study. Thank you.

Appendix C - Pre-Interview E-mailed Text

The subject of this interview is to **explore existing opportunities and challenges, perceptions of how emerging technologies** will impact the future of transit, and **reflections on how transit can innovate** to meet the rapidly evolving conditions. We are attempting to develop a synthesis of agency, transit expert, and technology developers and implementers **views on the needs and direction** of the transit industry, and for their **vision of what the future of transit could be**. To begin, we wanted to provide you with a snapshot of our own findings on transit ridership.

Pre-pandemic Transit Ridership



Even before the COVID-19 pandemic, transit ridership in the United States declined for the fifth consecutive year in 2019. Buses were the most affected with the lowest transit ridership levels since the 1970's. Even rail declined the last few years following an upward trend since 2009. As transit ridership declines, agencies lose fare revenue and often reduce service to meet budget constraints, resulting in further ridership losses.

While these trends are remarkably consistent across U.S. cities, transit ridership in numerous other countries has increased in the last several years. Canadian transit agencies have experienced a steady rise in transit ridership, which has closely followed increases in service since the mid-1990s. Among 39 countries tracked by the International Association for Public Transport, 24 “experienced an increase or at least maintained a stable rate of public transport use (journeys per capita) over the past 15 years”. The US is not alone in their transit ridership losses, but most countries with similar losses have poor economic conditions or substantial changes in demographics.

The recent decline in transit ridership is particularly worrisome because traditional factors of transit ridership do not seem to be involved. Although U.S. transit agencies experienced drastic service cuts following the recession, overall vehicle revenue miles rebounded to their 2010-level by 2015 and have kept growing ever since. Meanwhile, urban population and employment rates, which are both typically associated with high transit ridership, have risen substantially in the same period.

Explaining Transit Ridership Declines

The most comprehensive effort to understand transit ridership change within the industry has been the Transit Cooperative Research Program (TCRP) A-43: Recent Decline in Public Transportation Ridership: Analysis, Causes, Responses. From this project, it is clear that a mix of factors are contributing to recent transit ridership trends, pushing transit ridership in competing directions. To separate the effect of each of these factors, the team conducted statistical analyses that correlate these factors with changes in transit ridership. In a system-level, multi-city analysis, longitudinal models of total bus and rail ridership were estimated for 215 Metropolitan Statistical Areas (MSAs) in the US between 2012 through 2018, to establish the sensitivity of transit ridership to changes in the descriptive variables (service miles, fares,

population, etc.). Results were grouped into three clusters of MSAs based on transit operating expenses: High (greater than \$300 million), Medium (between \$30 to \$300 million), and Low (below \$30 million). Major data sources include the National Transit Database, Census American Community Survey, Bureau of Labor Statistics, Energy Information Administration, Bureau of Transportation Statistics, and Uber.

Overall, two sets of factors push to increase transit ridership from 2012 to 2018:

- **More service.** Across all clusters, transit operators are providing more bus and rail service. These service additions result in a net bus ridership increase ranging from 2.5% (high operating expense cities) to 4.7% (mid operating expense cities). Rail service increases are associated with ridership gains of 10% (high operating expense) to 18% (mid operating expense).
- **Land use.** Land use affects transit ridership in terms of total population and employment growth, and how centralized that growth is. By cluster, metro areas grow between 5.8% and 7.9% in population and employment, pushing up ridership. However, in most clusters, that growth is becoming less centralized, pushing ridership down, so that the combined effect of land use changes is less than 2% increase in ridership.

The causes of net transit ridership decline between 2012 and 2018 come from a combination of four main sources that more than offset the factors above that push ridership up over this period. They include:

- **Income and household characteristics.** Higher incomes, higher car ownership, and an increase in the percent of people working at home contribute a net ridership decline of about 2% for bus and rail, which is relatively consistent across clusters.
- **Bus and rail travel becomes more expensive.** Average bus fares go up in two of the three clusters. Average rail fares in all clusters increased, with that increase ranging from 7% to 13%. The result is net ridership declines of 0% to 4%.
- **Driving becomes less expensive.** Average gas prices decreased by about 30% over this period, contributing to about a 4% reduction in bus and rail ridership.
- **New modes compete with bus and rail.** The model results suggest that ride-hailing is the biggest contributor to lower bus ridership between 2012 and 2018, resulting in net decreases of between 10% and 12%. The effect of ride-hailing on rail ridership in larger metro areas (high operating expenses) is much smaller, but the effect in the mid operating expense group is similar to bus. Bike share and e-scooters have a much smaller impact, less than or about 1%.

Future Transit Ridership Impacts

Over the past year, the transit industry has been hit by what may be its biggest challenge to date, a global pandemic that uniformly discouraged the close proximity between people on which transit depends to be the most spatially efficient mode. Across cities, we have seen significant declines in rail ridership, as rail modes are often used by workers that are more likely to have work-from-home options. We have also seen declines in bus ridership, although much of the lower-income and critical workforce populations that buses often serve are still riding transit out of necessity. As we move forward in 2021, researchers are still trying to understand the longer-term impacts that the pandemic might have on mobility and public transit in particular. Will telecommute impacts on transit continue? Will population density continue to decline? How will the cost of auto ownership impact transit? What will the impact of new modes be on transit? More importantly though, we must think beyond just the recovery from the pandemic. This is where you come in, and we are eager to hear your thoughts.

Appendix D – Interview Questions

Goal: Across interview participants, we will **explore existing opportunities and challenges, perceptions of how emerging technologies** will impact the future of transit, and **reflections on how transit can innovate** to meet the rapidly evolving conditions.

Method: Through a series of **interviews**, we will develop a synthesis of agency, transit expert, and technology developers and implementers **views on the needs and direction** of the transit industry assuming current trends continue, and for their **vision of what the future of transit could be**. For each interview, we will provide a short hand-out summarizing our recent findings on the causes of transit ridership decline and our initial assessment of interventions. Using a program such as NVivo, transcribed interviews will be analyzed for themes and trends to compile a qualitative description of possible strategic directions.

Target Interviewees: We believe the input of all **three groups** will be critical to the development of transit strategies – 1. the view from “in the trenches” providing transit services; 2. those that research methods to improve transit and guide agencies; and 3. the potentially innovative or disruptive forces.

Across all participants, we will also seek to understand their sources of information to shed light on the filters each uses in their visioning, understanding their self-imposed constraints and information prioritization. Interviewees across all three groups will be asked the same set of questions.

Questions:

- Existing Opportunities and Challenges
 - What is the role of transit?
 - What aspects of this role does transit do well?
 - What aspects of this role could be improved?
 - What should be the values/priorities of transit systems?
 - *Prompts: coverage (serve everyone, even if it's not very well) vs frequency (concentrated corridors)*
 - How will COVID-19 affect transit longer term?
 - telecommuting/car purchases?
- Role of Equity
 - Who does transit currently serve? Who should it serve?
 - What is the relationship of transit to social equity?
- Reflections on How Transit can Innovate
 - What do you see as being the biggest opportunity for transit? Biggest obstacles?
 - What do you see as being the emerging technologies that will most affect transit?
 - *On-demand services, Micromobility (bike share, scooters), driverless vehicles, electrification/alternative fuels, fare media? Boxes? Etc*

- What is the role of emerging technologies and what is the relationship to transit?
- What is the position of transit within larger conversations about mobility?
 - *thinking about mobility as a service* (some kind of definition – either in the questions about fares/pricing or just opening line)
- What is the role of the private sector and what is the responsibility of the public sector? What is the relationship to innovators – should the industry regulate them, price them, etc?
- How do you think the mobility industry can be more creative about fare policies and media?
- How can transit remain sustainable in terms of funding in the longer term?
- Performance Measures
 - What should be the performance metrics for transit agencies?
 - What is the mark of “success”?
 - *Prompt: how does this align with perception of current state/equity/innovation?*
- Information Sources
 - What information/sources of information are you using to inform your perspective?