Technical Report

TAKE-UP CHALLENGES IN LOS ANGELES PUBLIC TRANSIT

Perception and Experience: Addressing Frictions in the LA Metro

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CENTER FOR ADVANCED HINDSIGHT®

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Executive Summary

Introduction

Traffic congestion is a problem many cities are familiar with, especially the City of Los Angeles in which 75% of Angelinos choose to solo drive for their commutes. Traffic congestion imposes societal costs ranging from lost productivity to increased respiratory infection. To decrease traffic congestions, the City tries to encourage commuters to opt for the LA public transit system: the LA Metro. However, commuters often choose not to take the metro, hence the 75% solo drive rate. The perceived and experienced difficulties of using the public transit system pose a significant challenge for take-up by the public .

The Center for Advanced Hindsight is an organization dedicated to solving problems through applied behavioral science. In late 2020, the Federal Transit Administration awarded the Los Angeles County Metropolitan Transportation Authority (LA Metro) a $700,000 grant to develop a pilot program based on travel rewards. The LA Metro's Office of Extraordinary Innovation partnered with the Center for Advanced Hindsight, Harvard Business School, and a few technology and mobility companies to create the rewards-based system for this project. This report serves to provide additional evidence-based ideas and research for the project.

One way to mitigate traffic congestion is to get people to drive less overall. Public transit shows potential to decrease traffic congestion and get people where they need to go. However, despite the availability of public transit, majority of commuters choose to not take it. A factor that influences a commuter's choice to not take the Metro is the perceived and experienced difficulty associated with taking public transit. As the commuters may have suboptimal experiences in public transit or just see the trip as too cumbersome, many choose to drive instead. To mitigate this perception problem, public transit systems need to look at the rider experience. Partnering with the Center for Advanced Hindsight, which in turn partnered with the LA Metro's Office of Extraordinary Innovation, this applied policy project (APP) seeks to look at this problem and come up with solutions for possible piloting.

Background

LA's car-centric culture and sprawl has created an environment that heavily incentivizes driving a car over other modes of transportation. The consequences of this are heavy traffic congestion and a historical lack of public transportation investment. In recent years, public support and investment in public transit has increased. However, take up remains an issue.

The fresh start effect is the phenomenon of perceiving a clean slate to pursue new goals or behavior change. The City of Los Angeles is beginning to open back up from the pandemic shutdowns, potentially creating an area-wide fresh start. People will be looking to establish a sense of normalcy in their lives, including in their commutes. When people are faced with a sense of a new beginning, they are more open to trying new activities and behaviors. Given this context, the LA Metro is presented with an enormous window of opportunity to make a first

impression to commuters. Should commuters have a poor experience in riding the Metro for the first time (post-pandemic), they may form a norm of driving for their commute. However, if the LA Metro provides an experience that commuters find positive, commuters may be more likely to set a norm of using public transit for their commutes. With the opportunity to form new commuting norms and habits, the LA Metro may be a decisive variable in the traffic congestion equation.

Literature Review and Interviews

Upon reviewing a broad selection of scientific literature, covering bikeshare through tactical urbanism interventions, it is apparent that researchers and policy practitioners have only recently begun to think about this topic. Some research from other fields, such as the field of user experience, provide insights that may transfer to the field of public transportation. To gain additional perspectives and insights, experts from multiple fields were interviewed. The fields represented included behavioral economics, transportation economics, transportation planning, and transportation design.

Alternatives

Many Metro riders indicated that they felt uncomfortable or uninformed in navigating the Metro system and that the system was too slow. To remedy this, three alternatives were looked at: off-board fare collection, an augmented reality guidance application, and the utilization of loading screens in waiting areas. An off-board fare collection would move the fare collection process off the bus. This would allow for faster boarding and decrease the bus's idle time. The use of loading screens would create a labor illusion that could make the waiting experience more pleasant. Research in user experience has shown the effectiveness of loading screens in decreasing the pain of waiting for a screen to load. The AR guide mobile app would utilize the phone camera and overlay the video image with a virtual direction, allowing the user to see where exactly they should go. An AR guide would be like having an experienced rider guide the user. The alternatives were evaluated against five criteria: impact, equity, cost, novelty, and scalability.

Recommendation

Upon evaluation, two solutions were recommended: implementation of loading screens and the creation of an augmented reality guide. The augmented reality app would directly address the commuter concerns regarding the ease of use of the LA Metro. These solutions address the experience of time and the knowledge gaps indicated by the riders.

Problem Statement

Los Angeles (LA) is a city full of traffic congestion with 75% of LA commuters choosing to drive alone to work (United States Census Bureau, 2018). Despite the availability of public transit and carpooling services, most commuters still opt to drive alone, as evidenced by the commuting statistic. One factor that prevents commuters from using public transit is the difficulty or hassle associated with taking public transit. **The perceived and experienced difficulties of using the public transit system pose a significant challenge for take-up by the public.**

Client Overview

The Center for Advanced Hindsight (CAH) is an organization dedicated to solving problems through applied behavioral science (Center for Advanced Hindsight, 2020). As commuting trends are based on individual choices and perceptions, the issue of mass solo commuting can be approached from the behavioral angle. CAH has a history of working on government and transportation policy issues through carrying out and publishing case studies of behavioral interventions in the transportation realm. The difficulties of LA's public transit system is an area that can be tackled with a mix of policy and behavioral perspectives, falling into CAH's practice.

In the wake of Covid-19, the city of Los Angeles shut down. With most people staying at home, the city experienced the cleanest air in a while due to the absence of vehicle traffic (Kann, 2020). People were given an example of what is possible if driving patterns changed. The global pandemic has created a potential window of opportunity to change social norms and habits. Commuting behavior is a prime target. Seeking to reduce the number of cars on the road, the City of Los Angeles has begun to look for ways to incentivize the public to opt for communal alternatives for commuting (LA Metro, 2020). One such effort to find a solution was a forum called the "Think You Can Solve Traffic?" forum by the Los Angeles County Metropolitan Transportation Authority (LA Metro) Office of Extraordinary Innovation (OEI) (Hymon, 2018). A pilot program focused on human decision making was the result. The LA Metro partnered with CAH, Harvard Business School (HBS), and a few private sector technology and mobility companies to test and develop a system to incentivize people to opt for solo driving alternatives. Before any intervention is scaled the entire metropolitan area, a pilot program will first be run. If the results are promising, scaling may occur. CAH's expertise in behavioral economics offers the project a crucial perspective in creating a behaviorally informed intervention.

Where this report comes in is in examining the behavioral and physical aspects of public transit that can influence commuter decisions or experiences. CAH is interested in this report, as it adds an additional perspective in their project with the LA Metro and other potential

projects. As the topic of usage difficulty can create friction in a public transit system and thus influence take up, the topic examined is as much of a behavioral issue as it is a policy issue.

Background

The System

LA is an environment built to accommodate car usage. Businesses were built around the assumption of car usage. Many businesses built drive-in accommodations to play into the car-based culture. LA witnessed mass adoption of cars in the early twentieth century. Part of the adoption was catalyzed by the limitation of public transit options. Various rail companies were bought out by the car companies and subsequently dismantled to incentivize people to opt for car-based transportation (Novak, 2023). As such, LA's urban sprawl and car culture came to be.

Today, LA's notorious traffic congestion is a product of the system built to incentivize car ownership and usage. For example, the 405 Freeway, one of LA's main highways, averages approximately 379,000 vehicles per day (Sprague and Scauzillo, 2013). As illustrated in Figure 1 and mentioned above, around three quarters of commuters choose to solo drive. When it comes to creating and promoting driving alternatives, significant challenges are faced. From the perspective of public transit, LA's urban sprawl presents a challenge of reach and LA's cultural history presents a challenge of the status quo.[1]

As the car-culture of LA helped form the city, the downstream consequences resulted in an overall status of low walkability and bikeability. Though LA has its walkable neighborhoods and streets, where safety may not be a concern, distance from urban sprawl can decrease a willingness to walk or bike for a commute (A. Shavit, Personal Communication, November 23, 2020). When it comes to biking, safety is a large concern in any city. LA (proper) ranks only 57th when it comes to total cycling fatalities by city (Carinsurance.org, 2021). However, the low death count may be deceptive as many accidents do1 not result in death. The prevailing perception of cycling in LA is that cycling is one of caution. However, to facilitate more active transportation, changing the environment may be more effective than changing perceptions (Panter and Ogilvie, 2015). In recent past, support and movements for increased public transit options and shared roads have increased.

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[1] Efforts in the early twentieth century to build monorail infrastructure were turned down due to LA's low density and high geographic spread (Novak, 2023).
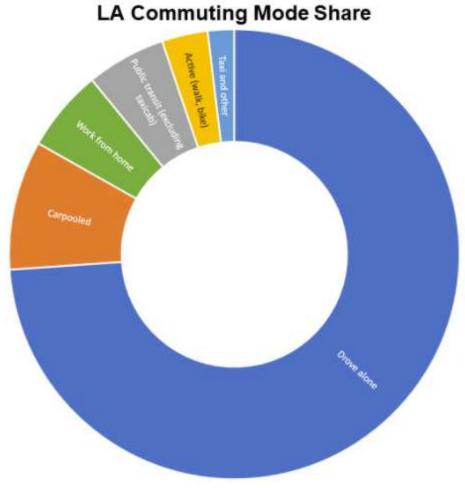
LA Commuting Mode Share

Figure 1
Source: LA County Open Data

When it comes to people moving into LA, many people who move to assume they will need a car. Car ownership is the largest predictor of transit take-up, with an inverse relationship (Manville, Taylor, and Blumenberg, 2018). With a new start, people are more willing to accept change and try new habits and behaviors (Price et al, 2017). However, the assumption of the necessity of the car hinders the willingness for new movers to try new commuting habits. The trend of mass solo driving is rooted in human judgment and decision making. CAH's expertise in applying a behavioral perspective to systemic trends, such as commuting behavior, is invaluable when it comes to tackling the problem of creating interventions that may go against the cultural currents.

First Mile-Last Mile in Public Transit

The distance between the commuter end destinations and transit stops is known as the first mile and last mile, or first mile last mile (FMLM). The FMLM can be viewed as the difficulty that the commuter will experience in getting to and from their public transit stations. For

example, a commuter may be willing to take public transit but ends up having to walk a mile in the rain and cross many busy roads; the act of physically getting to the station is a hassle. From a distance and planning standpoint, a New York Regional Plan Association study found that commuters are much more likely to take public transit if there is a transit stop within a quarter mile of the commuter's home and end destination (New York Regional Plan Association, 1997). Distance matters because many potential commuters are unwilling to walk long distances just to get to the start point of their commute when they have access to a car. The FMLM is not solely about distance, difficulties, such as trip safety, may play into FMLM as well.

Car Ownership

With the number of cars on the road causing traffic congestion and car ownership being the largest predictor of public transit take-up, one may look at ways to make car ownership more difficult. This approach is not without its unintended consequences. Car ownership is also associated with economic advancement. This is because cars allow commuters to take routes outside public transit limitations (Manville, Taylor, and Blumenberg, 2018). For instance, if a worker gets a job outside any traditional public transit route, they would have little way in getting to work. However, with a car, a worker can reach more work locations and thus be available to work in more geographical areas. With a car, those of lower-income status (under $29,436 in 2020) can experience more economic mobility through increased work availability.[2] As such, making cars more expensive to own or more difficult to own would have negative equity implications without any special income-related exemptions. Any intervention to discourage car ownership should target demographics that tend to be of higher incomes that can afford to handle or give up car ownership.

Car ownership is not necessarily the enemy of public transit.[3] Owning a car can give a commuter more flexibility in choice and schedule. For instance, a commuter could opt to drive for certain commutes and take public transit for other commutes, based on personal schedules and other factors (J, Brooks de Camarillo, personal communication, 2020). As the current culture, urban setup, and commuting system stands, commuters are heavily incentivized to drive solo. Car ownership cannot be properly viewed without the system that surrounds it.

Political Climate

The political climate surrounding public transportation in LA is generally friendly. This is evident in the voting outcomes of various ballot measures supporting public transit. LA

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[2] Per research by Taylor and Morris, the definition for low-income public transit riders is anyone under $26,335 in 2013 dollars (Taylor and Morris, 2014). In 2020 dollars, the amount would be approximately $29,436.

[3] Per conversation with Jacquilyne Brooks de Camarillo, a manager at the LA Metro, a promising approach to public transit is asking the commuter "what is the best way to get to your destination today?" (J. Brooks de Camarillo Personal Communication, November 20, 2020)

County's Measure M that was on the ballot in the November 2016 Election. Measure M was a sales tax, that would fund public transit, that was approved with a 71% majority. The measure would increase sales tax by 0.5% and passed with 71% of voters voting "Yes." Measure M also extended a previous 0.5% sales tax, also dedicated to public transportation funding, that was set to expire in 2039 (Ballotpedia, 2020). Given that Measure M passed with 71% voter support, it can be inferred that the public, or at least the voting public, overwhelmingly support public transit investment, to the point of raising taxes on themselves. Given the political support for public transit investment, the landscape for public investment in FMLM may be welcoming.

The Behavioral Side of Driving Costs

On an individual level, solo driving can be costly when compared to public transit alternatives. Since 1980, the percentage of people who drove alone increased from 64.4% to 76.4% in 2013 (US Census Bureau, 2013). Average gasoline prices have risen from $1.19 in 1980 to $3.53 in 2013 (Hallman, 2016). Even when counting for inflation, gas prices have risen. The average cost of auto insurance has also risen from $703 in 1998 to 795 in 2007 (III, 2020). In a 2015 study by AAA, the average annual cost of owning a car was found to be $8,698 (AAA, 2015). On the Metro, a 1-Day Pass costs $7. If a commuter bought one 1-Day Pass every day in a year, the total cost would be $2,555.[4] If we take the 2015 annual cost of car ownership cost of $8,698 and compare it to an annual Metro fare of $2,555, the cheaper option is the Metro. This ignores the fact that the Metro offers more cost-efficient options such as the 7-Day Pass and the 30-Day Pass. However, despite the higher costs of driving, most commuters still choose to drive.

From a behavioral perspective, the way the costs are presented to the commuter heavily favors driving over public transit. In behavioral economics, costs elicit negative feelings by the one who has to bear those costs. However, the presentation of the costs can influence how negative the feelings are. Costs that are combined into one big cost, hurt less than costs that are spread out (Anger, 2012). For example, if a customer wants to buy a four-course meal that costs $10 per course, the customer will feel better paying $40 once than paying $10 four separate times a course comes out.[5] Though the total cost is the same, the feeling is different. Likewise, a commuter will "feel" the costs more if they have to pay every time they make a trip. In other words, the costs are more salient (the costs are less in their face).

When a commuter takes public transit, typically, the commuter has to pay the trip fare every time he/she takes a trip. Conversely, a commuter who drives only has to pay once every week when they fill up their car's gas tank. From a cost perspective, the costs associated with

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[4] $7 * 365 days= $2,555

[5] To maximize an individual's value received, integrate the costs and segregate the benefits. In this example, to maximize the customer's enjoyment of the experience, integrate the costs by giving the customer one bill and separate the courses from each other by sending each course out at different times.

public transit are more salient to a commuter than the costs associated with driving. If a commuter has options that have lower cost saliency, the commuter would be more likely to take up the commuting option with lower cost saliency— other things equal. The difference in how a commuter feels the cost of each commuting option relates to the difficulties of public transit through influencing their willingness to take up each option. Though cost saliency is not exactly a difficulty, it is a potential pain point in the commuter experience. Interventions may be wise to confront cost saliency issues when dealing with the larger issue of public transit take up.

The Experience and Feeling of Time

One thing people dislike in any experience is waiting. Waiting often feels like a waste of time and makes time feel stretched. When it comes to experiences and waiting, Hornik and Zackay compiled past findings and studied the relationship between time and behavior. When a subject does not pay attention to the time passed and later estimates the time spent, time is perceived retrospectively. When a subject actively pays attention to time passed in real-time, time is perceived prospectively (Hornik & Zackay, 1996; Brown, 1985). The perception of time was broadly categorized into two categories: retrospective and prospective modes. The perceived duration, or feeling, of time is longer for subjects in a prospective mode. For example, waiting in line for an hour will feel longer than one hour of doing something you enjoy. Occupation decreases attention to time, with dull activities feeling longer than pleasant ones (Zakay, 1989). When waiting is inevitable, with little for people to do, giving a time expectation was found to increase satisfaction (Hornik & Zackay, 1996).

The Transit Cooperative Research Program (TCRP) compiled a number of studies, conducted between the 1960s and 1990s, on time perception and summarized their findings in Figure 2. The summary table and graph indicate that time spent waiting for public transit feels twice as long as time spent in a moving vehicle, on average for the examined samples. As the average was pulled from various cities around the US, the average may have a decent case for generalizability in the US. Assuming the findings are true on average, time spent waiting for initial boarding and transfers can make commuting time feel stretched.

	In-Vehicle Time	Walk Time	Initial Wait Time	Transfer Time
US Average	1.0	2.2	2.2	2.5
US Range	1.0	0.8 - 4.4	0.8 - 5.1	1.1 - 4.4

Figure 2
Source: TCRP Report 165, Chapter 4

These studies were conducted in an era before the wide adoption of mobile devices. When it comes to the context of public transportation in the 21st Century, the advent of smartphones and other mobile devices could influence the feeling of time spent waiting. Nevertheless, the lessons learned in these studies should be kept in mind when designing a commuting experience.

Covid-19

When Covid-19, shut the world down, public transit systems experienced decreased ridership. Many people attributed the decrease in public transit ridership to fears of public transit being hotbeds for the spread of Covid-19. A study by the American Public Transportation Association found no causal evidence between public transit and Covid-19 transmission. Given that commuters were likely following mask mandates and social distancing protocols on public transit lines, infection rates were not associated with transit ridership (Schwartz, 2020). It should be noted, however, that the American Public Transportation Association may have a vested interest in the promotion of public transit and increasing public transit ridership post-Covid-19. One shortcoming of the report was that the data relied on it also coincided with national shutdowns and social distancing protocols. As such, when transportation systems return to full operation and capacity, Covid-19 safety measures will remain a concern.

Covid-19 also presents a potential window of opportunity to help people establish new commuting habits. As the people of LA come out of lockdowns and begin to reestablish their normalcy in their lives, they may feel a sense of a new beginning, a fresh start. When it comes to commuting habits and a nation-wide fresh start, public transit systems have a one-in-a-lifetime opportunity to capitalize on setting new behaviors. Most LA Metro riders will essentially be new riders. Thus, it is imperative that the LA Metro provides a high-quality commuting experience for their riders, as many will be riding the LA Metro for the first time in over a year. Not only is this an opportunity to reduce traffic congestion, but a new start is an opportunity to help create a more equitable society.

2028 Summer Olympics

Looking ahead, the LA Metro has a reckoning coming: the 2028 Summer Olympics. As the city will be hosting guests from all over the world, LA has an opportunity to impress by providing a good transportation experience. On the other hand, LA needs to ensure its transit system can efficiently handle the massive influx of visitors without significant increase in traffic congestion. One crucial element to LA's success in people-moving is the LA Metro.

Cost to Society

Emissions and Health

  LA's car-based environment is not without its costs to society. In 2019, car commuters in LA spent an average of 103 hours in traffic congestion and lost an annual average of $1,524 in productivity from traffic congestion (INRIX, 2020). From the environmental angle, the US transportation sector (all transportation modes) contributes to nearly 30% of the US greenhouse emissions, most of which is from cars (EPA, 2015).

  The high volume and concentration of cars on the road, especially during peak hours, contributes to the mass congestion. The consequences of traffic congestion will continue to prevail unless there is a change in commuting trends. According to local statistics the number of public transit trips from 2010 to 2017 went from 308,797 to 278,682, a decrease of 30,115 trips (LA Almanac, 2020). Much of this decrease is attributed to the local environment being built to accommodate car usage. A logical jump may be made that a poor first mile last mile (FMLM) is a result of an environment meant for car-based commuting. As such, a good FMLM will make for an environment more friendly to public transit and help decrease the costs of traffic congestion.

  The average car emits 404 grams of carbon dioxide per mile driven (EPA, 2016). The average commuting distance in LA is 8.8 miles each way, creating a total of 17.6 miles, the amount of carbon dioxide emitted per car trip is 7,110 grams (Kneebone and Holmes, 2016). If we assume the decrease in public transit trips (30,115 trips) were people who chose to drive, then the amount of carbon dioxide emitted as a result of the public transit decrease is 214,117,650 grams (30,115 * 7110) or 236 tons.

  The air pollution, from LA's traffic congestion, has downstream health consequences. One study by the Jama Network found that long-term exposure to air pollutants significantly increased risk of lung disease (Wang M, Aaron CP, Madrigano J, et al., 2019). Other studies have isolated the effect of traffic related air pollutants (TRAP). A literature review of emissions exposure found that air pollution increases people's risk of cardiovascular ailments and deaths, as evidenced by rates and types of illnesses and deaths of people living near highways (Health Effects Institute, 2010). Another study found that exposure to TRAP was found to be associated with increased hypertension among pregnant women, leading to pregnancy complications (US Department of Health and Human Services, 2019). The health consequences of air pollutants are largely spelled out and pose a significant health cost for populations exposed to air pollution. As cars make up a 17% of the US greenhouse gas emissions (28% US emissions from transportation sector * 59% of transportation sector emissions from light vehicles = 17%), a net reduction of the number of cars on the road would help in reducing the health costs to society (EPA, 2016).

  Real or perceived difficulties, such as a poor FMLM, can limit the number of people who opt to take public transit if other commuting alternatives seem easier. As a result, it can be

reasonably assumed that some people who opt not to take public transit may end up driving themselves in their commutes. As such, the number of vehicles on the road would increase. With more vehicles on the road, carbon emissions increase and cause downstream health consequences (Tox Town, 2020). The consequences of a system with significant friction points can have long-term implications, as commuter behavior is difficult to change without strong-handed interventions (Ariella and Whillans, 2019). Difficulties that implicitly incentivizes commuters toward any means of commuting may be pushing commuters into a fixed mindset and behavior.

Literature Review

Purpose

This literature review exists to review available research and case studies relevant to the structural and behavioral aspects of public transit that influence the transit rider experience and comment on the state of current knowledge. The literature review will focus on FMLM interventions in public transit, active mobility, and behavioral science interventions in the realm of commuting experience and behavior.

Mobility as a Service (MaaS)

Mobility as a Service (MaaS) is a centralized platform integration of trip planning, trip calling, and payment systems across public and private transportation. This means that a commuter can plan out and pay for a trip, from absolute start to finish and know which modes of transportation he/she will be using. On top of the planning component, the commuter will have organized the trip and made all necessary payments from one mobile application (Geotab, 2018). The significance of MaaS is that a commuter will only need the MaaS application on their phone, to have access to any mode of public or private sector transportation and to pay for it. (Transdev, 2020).

The most notable MaaS case study is in Helsinki. Whim, a Finnish MaaS system was created and made available as a phone app. This gave commuters access to all modes of transportation, active commute planning, and payment on one platform. However, the development and adoption of Whim was largely dependent on the buy-in from relevant authorities (Audouin and Finger, 2018). In one study, Whim users rode public transportation in 63% of trips whereas commuters who did not use Whim rode public transit only 48% of the time (Ramboll, 2019). Evidence on Whim's impact on the Helsinki traffic landscape is scant as the technology is new.

Other researchers studied the unintended equity implications of MaaS. First off, MaaS may not be able to address the needs of those in poverty, as the costs to utilize MaaS may prevent access to those who cannot afford to pay. The researchers also note that MaaS

adoption will need strong government oversight to subsidize poorer commuters and maintain private sector efficiency (Pangbourne et al, 2019).

The need for support by relevant authorities was found to be necessary in a preliminary feasibility study in London. Researchers from the University College London examined the feasibility of a MaaS system implementation in London and concluded that a MaaS system could be feasibly implemented. However, further inquiry is required to better understand private sector needs and perspective on MaaS before any partnerships can be established. Researchers concluded that the leading transportations authorities also need to be involved by leading the adoption efforts (Kamargianni, 2015).

MaaS shows great promise and potential. Given that MaaS is new, there are few case studies on it. Multiple companies are still working on developing a product that can capture all the transportation needs of the market (Boston Consulting Group, 2019). In summary, this technology, MaaS, is unproven but shows promise in increasing public transit take up.

Bikeshare

Bikeshare, a service where bicycles are made available for paid short-term use, has gained popularity in cities over the last decade. One prominent example of early bikeshare interventions is the creation of the Denver bike share system. Seeking to make Denver more bike-friendly, a temporary bike sharing program called "Freewheel!n" was created. Freewheel!n ended up lending out over 5,000 bikes with more than 26,000 miles traveled, with an average travel distance of 4 miles over the three days of the convention (Marshall, Duvall, and Main, 2016). The Freewheel!n program ended up generating much political support for bike-friendly changes to the City of Denver. This intervention is an example of tactical urbanism, using temporary interventions to see the potential impact on an environment. The tactical urbanism intervention of Freewheel!n ended up being the birth of one of the first modern bike sharing systems in the US. This example shows how tactical urbanism can generate political will for larger and longer-term changes.

Recent research has suggested that bike share programs can reduce car travel in five cities examined (Melbourne, Brisbane, Washington, D.C., London, and Minneapolis/St. Paul). The estimated reductions ranged between 90,000 kilometers and 766,341 kilometers for each year (Fishman et al, 2014). The estimated car travel reductions were reliant on survey that asked bikeshare users if they would have driven had they not used bikeshare for their trip. Given the methodological shortcomings, a more rigorous study on the impact of bikeshares may be useful. As most public transit commuters walk or bike to their station in the LA Metro system, bike share interventions show promise (A. Shavit, Personal Communication, November

23, 2020).[6] However, bikeshare started in 2010. More recent, large studies would be needed to tell if bike share interventions have lasting effects beyond the short-term novelty.

Tactical Urbanism

Tactical urbanism is a broad term for low-cost, short-term interventions that can be easily and cheaply scaled to facilitate long-term changes to a system (Street Plans Collaborative, 2016). Examples of tactical urbanism interventions include transformational road closures and tactical transit lanes (TTL). Figure 3 shows an example of a bike lane being created through tactical urbanism. Tactical urbanism interventions are used to draw government attention to local issues, increasing public engagement. A key benefit for tactical urbanism is not just in the quick and low-cost interventions but in the testing of interventions.

Figure 3
Source: The Street Plans Collaborative

Tactical urbanism can also exist to give a demonstration of what could be. CicLAvia is an organization that promotes public spaces and active transportation in LA County.[7] CicLAvia carries out its public space and active transportation promotion by partnering with the proper authorities to temporarily close down certain road segments to all motorized traffic. This event is referred to as a "CicLAvia" or a "CicLAvia event." A CicLAvia allows for road segments to be

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[6] The LA Metro has data showing this trend (A. Shavit, Personal Communication, November 23, 2020).
[7] CicLAvia is a play on the word "Ciclovia," which is the original term for this type of public space intervention.

turned into public spaces, active transportation paths, and other health-centered activities. These activities have attracted many to come and see the possibilities of a human-centered design in land use and transportation.

CicLAvia's benefits are mainly in the health realm. A study, by Cohen et al, of a 2014 CicLAvia event found that 36,000 - 54,000 people were active in the event, meaning they were using the public space for physical exercise. The researchers estimated that 45% of active participants would not have exercised had they not attended the event (Cohen et al, 2016). Another study of a CicLAvia event found that the event reduced air pollution in the direct vicinity (Shu et al, 2016). Further studies are needed to see if overall regional air quality is improved or if air pollution is merely more concentrated outside the direct vicinity of the CicLAvia events. The typical cost of a Ciclovia event depends on the geographic location and size of the event as well as the duration of the event. The events in LA are seen to be cost effective from a public health standpoint (Montes et al, 2011). Broadly speaking, CicLAvia events are popular among the public, which is important for public support for building infrastructure for active transportation.

TTLs are bus-only lane segments, embedded in high-congestion streets (i.e. city streets), that are designed to speed up traffic and reduce congestion. Bus Rapid Transit (BRT) is a dedicated bus lane. Unlike BRT, TTL only designates certain segments of lanes to be bus-only, rather than an entire lane (Gahbauer and Matute, 2019; Bliss, 2019).

TTL is easily and quickly adoptable by simply painting certain segments of road or utilizing traffic cones signal dedicated road space. Gahbauer and Matute conducted reviews of multiple case studies of TTL implementation and outcomes. They found that while BRT was often the goal of many transportation initiatives, TTL was found to be more politically and financially feasible due to the ease of implementation and reversal (Gahbauer and Matute, 2019).

Overall, many case studies found that dedicated segments yielded positive benefits to traffic congestion and safety (Gahbauer and Matute, 2019; Dickens, 2019). Some cases have even found an increase in transit ridership (Dickens, 2019). Research about TTL and BRT is relatively scarce. Though there is no comprehensive study on the effects of TTLs, pilot programs allow this intervention to be studied inside local systems and contexts — an important consideration analyzing alternatives.

Tactical urbanism shows potential and promise. Given the examples and case studies of CicLAvia and TTLs we see how temporary and low-cost changes have the potential to give the public a sample of future interventions. Tactical urbanism allows practitioners and governments to test to waters for cost, operational, and political efficacy of an intervention. However, the literature surrounding tactical urbanism interventions is limited. Most literature available are how-to manuals from tactical urbanism support organizations and case studies. More literature would be helpful in forming a stronger empirical research base. Of course, interventions all

operate in their individual contexts and the only comfortable way to guarantee if an intervention is effective is to measure the intervention in practice.

Initial Attempts with Nudging

Nudges are changes in the presentation of choices without the alteration of the availability of each choice (Thaler, 2003).[8] One example of a nudge is mentioning on tax compliance letters that most people pay their taxes on time. The letter recipient's choices are still the same, they are simply made aware of what most people are doing. Many nudge interventions have been piloted to change commuter behavior, whether it be increasing public transit take up or the rate of carpooling. However, nudges have their limits. Kristal and Whillans (2019) conducted an analysis of four field experiments that had a combined sample size of 68,915 participants. All the field experiments utilized nudging, none of which yielded any sustained behavior change. The researchers determined that habitual behaviors are unlikely to be changed by nudge interventions, as nudges are less effective against habits than against one-time decisions. Kristal and Whillans conclude that commuter behavior change needs to be facilitated by heavy-handed interventions, such as regulations, that combine traditional policy with behavioral insights. They also end with a call for more studies that focus on the timing of behavioral interventions, social norms, and cost saliency (Kristal and Whillans, 2019; Benartzi et al, 2017).

Interventions on Waiting

When taking public transit, waiting is almost a guaranteed activity for every rider. Past studies have shown that time spent waiting feels longer than time spent moving in transit or in a car (Transit Cooperative Research Program, 2017). One field that also requires its users to wait is the field of user experience. In a series of lab studies, researchers found that by providing users with a labor illusion, the user's perception of effort by the worker, users tend to be more satisfied and have higher rates of waiting out the loading time (Buell and Norton, 2011).[9] The researchers also found that the labor illusion only holds if the users already perceive value in the service they are waiting for.

Another study on waiting found that the design of the loading process (what the loading animation looks like) significantly influenced the user's perception of reasonableness of the waiting time (Kim and Xiong, 2017). Kim and Xiong found that linear loading bars were perceived to have a longer waiting time than power functions. However, this study on the effect of the type of loading screen was measured through surveys asking users about the

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[8] It is important to note that nudges fall under the umbrella of behavioral science and should not be used synonymously with the umbrella term.

[9] Users who had to wait 30 seconds for a service to load waited 62% of the time when presented with cues that indicated work was being done versus 42% for those not presented with nothing. For users waiting 60 seconds, 63% waited when presented with cues while 23% waited when presented with nothing in the waiting time.

reasonableness of the waiting experience. The findings of these studies suggest that the design of the waiting time can decrease the pain or acceptability of waiting, at least in the field of user experience.

Final Comments

The literature reviewed covers MaaS, bikeshare, tactical urbanism, nudging attempts at commuting choice, and loading screens. The transportation-centered literature examined suggests that many innovative processes and technologies show promise but lack substantive research, as most of the literature are case studies from the recent past. This trend provides limitations to causal claims to some of these interventions. More research is needed to formally establish and identify intervention effects and reveal influential nuances.

In the context of the perceived and experienced difficulties in public transit, this research shows a wide degree of ingenuity and recent willingness to improve public transit directly and indirectly. The state of literature reviewed suggests that interventions in public transportation should be pilot tested before any scaling or heavy investment is to occur. Though this may be common sense for most practitioners, those looking for a simple and definitive answer to solve a FMLM problem will not find one. The same goes for behavioral problems. In regard to CAH, the state of the field's literature presents an opportunity to run more studies. The need to test the efficacy of different interventions in different contexts may make policymakers more willing to partner with organizations like CAH in order to pilot potential solutions and reap the potential benefits.

Conclusion on Existing Literature

The perceived and experienced usage difficulties are important variables in the public transit take-up equation. Diverting potential commuters from public transit pushes more commuters into solo driving for their commute. Access to the public transit system and the time spent commuting in public transit must not exceed, or significantly exceed, the time and difficulty of driving a car. Should commuters see public transit as an option that is less convenient to driving, most commuters will opt to drive. Any alternative needs to work with the rest of the public transit system in mind. Insights about human behavior and perception are necessary in creating a sustainable and attractive transit system that people are willing to try and use.

Notes from the Field

Interviews with field experts were conducted alongside the literature review. The interviewees came from a variety of different fields, ranging from behavioral science to transportation planning. This broad approach was intentional as it provided many perspectives in thinking about potential problem framing and approaches for solutions. Below is a summary

of interviews by the expert field. Summaries of individual interviews can be found in Appendix II.

Behavioral Economics

Interviewees agreed that we need to look at the commuter journey and decision points that influence their perception and experiences of their prospective commuting modes. As the system stands, driving is heavily incentivized. Increasing the saliency of driving cost (such as paid parking) can incentivize other commuting modes. Other modes should have their incentives more salient or disincentives overcome. For instance, one hassle to taking public transit may be the planning required, as such, removing the pain of planning with a trip planning application may remove this disincentive. Incentives, attitudes, and perceptions all need to be considered when thinking about behavior change.

Transportation Economics

One interviewee noted that some strong predictors of mode choice in commuting are the number of vehicles owned and years of education of the individual. The more vehicles owned by the individual, the more likely they are to drive. Likewise, the more years of education an individual has, the more likely they will own a vehicle, due to increased likelihood of higher earnings. However, other factors can influence mode choice, such as walkability and ease of use for other modes.

Transportation Planning

Public transit faces a challenge of operating in an environment built for the car. With this can come a challenge to culture, as many people can take on a car-oriented identity in commuting. When designing for the future, a city's culture needs to be considered and potentially shifted to one more friendly to transportation modes alongside the car.

Another challenge is the clashing of interests for land use. As businesses, residents, and county transit authorities may fight for land use, parking, and lane use, there is sometimes a give and take relationship between parties. The political atmosphere can vary from city to city, but some cities, including LA, have become more politically supportive of public transportation. With many clean air regulations and subsidy programs available in the state and local level, the political landscape is beginning to shift in favor of public transit.

On the individual level, when people think about commuting, they tend to have an all-or-nothing mindset ("I only drive" versus "I only use public transportation"). What could help is changing those mindsets to a more relative view of commuting ("I drive on days when I need to pick up my kids from school and take the bus on the other days"). Asking people what commuting option is best for them can make them more friendly to trying other modes. Aside from mindset, another big challenge is addressing ease of use in the Metro system. Though

people may be open to using public transit, they may not know how to use it and feel uncomfortable trying. Working to make prospective riders more comfortable could have potential in increasing public transit take up.

Transportation Systems Design

Every design has a contribution to the environment in which it exists. In the case of public transit take up, contextual design factors play a big role. For example, designing a city to include mixed use areas can increase the walkability of a city, as people will tend to make shorter trips. Culture plays an important role as well. Employers have great potential to influence their employees' commuting choice by creating a culture that favors sustainable transportation modes. This can be done by changing the presentation of parking costs, creating incentive programs for active lifestyles, and committing to being a good neighbor to the community. The design of the built environment, paired with culture can go a long way to increasing the rate of non-SOV (single occupancy vehicle) commuting.

Noteworthy Policy Opportunities

Before alternatives, to address public transit usage, are examined, a couple policy opportunities should be brought to attention. These noteworthy policies may fall outside the scope of mission for the project between the LA Metro and CAH. Collaboration between transportation agencies and state and local governments is not an uncommon occurrence. The policy opportunities are policies that aim to ameliorate the root problems of driving defaults. The LA Metro should advocate for these policies to help create a transportation system that is more accommodating to public transit, active mobility, and micro mobility.

Complete Streets and Public Spaces

With any systemic problem, the best way to fix the problem is to go upstream and change the system when possible. LA's heavy car enthusiasm in the 20th century has led the city to develop roads with numerous traffic lanes. Wider roads induce demand, meaning traffic congestion increases with each lane. In recent history, transportation planners have cooperated with cities to trial and implement complete streets - streets that allow the safe use of multiple mobility modes.

This policy would advocate for the modification of LA's crowded streets to include dedicated bus and bike lanes. This would increase mobility of buses and improve service for bus riders. The streets will be redesigned with paint to mark the new transit lanes, rather than constructing a new street. This policy is a long term solution that will likely require high political will and cooperation between multiple organizations. Changing the design of a city's streets may require zoning changes, street closures, and public acceptance. Progress has been made in this policy already. Many of LA's main streets include bus lanes, such as Wilshire Boulevard.

One success story of creating a public space is the transformation of Times Square from a car-centric street to a public space. In her book *Streetfight*, Janette Sadik Kahn wrote about her project in transforming Times Square from a car traffic hub to a pedestrian hub. Sadik Kahn was able to get Mayor Bloomberg on board by proposing a pilot program instead of an immediate transformation. When the pilot was implemented using paint and temporary fixtures, surveys revealed a high degree of public acceptance. The streets around Times Square did not result in a gridlock and traffic was not significantly affected (Sadik Kahn, 2017, Ch. 6). An important lesson from this example is that complete streets and open spaces can be successfully integrated into a city once people are able to experience the benefits of such projects.

Employer Support via Business Regulations

Seattle is often seen as a success story when it comes to increasing uptake of public transit in a car-centric city. Though a number of initiatives played a role in Seattle's public transit innovations, the Commute Trip Reduction (CTR) law comes to the forefront. The CTR Law is a state law that requires employers, with more than 100 employees, to work with employees to reduce single occupancy vehicle (SOV) commutes. This is done by incentivizing other modes of transportation . Local employers who are in violation of CTR law may receive a financial penalty (City of Seattle, 2021). The purpose of this law is to reduce carbon emissions by reducing traffic congestion. California does have similar programs such as Rule 2202, an optional emission reduction target (ERT) program that applies to employers with over 250 employees.

By targeting employers instead of the individual commuters as the primary customer, public transit systems can work upstream in getting more commuters away from solo driving. Working with employers to create employee incentive programs, ridepool programs, and alternative work schedules, can open more opportunities to reduce traffic congestion. For example, working with employers to only require employees to come to the office a few days a week or in off-peak hours can smooth the demand for road space or public transportation.

Alternatives

Below are a few alternative courses of action to address the problem of perceived difficulty of using LA public transit. The alternatives will target rider groups established by the LA Metro's data center. Two groups are of interest: high-potential transit users (HPTU) and drivers who occasionally ride rail (DWORR). HPTUs tend to be driven by convenience, ease, and time. Most high potential users claim difficulty of access as the main reason they do not use rail services and travel time as the reasons they do not use bus services. DWORRs tend to be driven by reliability and traffic avoidance. Their main concerns tend to be safety, accessibility, and systems knowledge (LA Metro, 2017). These two groups are not fully converted to public transit

while also not shut off to public transit. As such, HPTUs and DWORRs are ideal targets for interventions.

Off-board Fare Collection

Instead of having bus riders pay as they board the bus, riders will pay before they enter the bus, allowing riders to have paid by the time the bus arrives, speeding up the boarding process. Riders of the LA Metro use a card called the TAP card. The fair collection systems will be TAP dials (the digital payment system of the LA Metro) and ticketing kiosks stationed at every stop. This alternative addresses concerns about long bus rides by speeding up the time-consuming boarding process.

To enforce the compliance in fare purchasing, ticket inspectors will be used to check proof of payment. An inspector would board the bus from a random stop and check the riders for proof of payment. If a rider is found to have skipped the payment, the inspector would give the rider a TAP card. This low-consequence enforcement is an equitable alternative to traditional punishment-based enforcements, as ticket skippers are often minorities or lower-income riders (Tinoco, 2018). Punishing low-income riders with fines is regressive and would not necessarily stop the skipping of payments. This system of enforcement is used by the King County Metro (M. Hansen, Personal Communication, March 19, 2021). Given that many fare evasions come from reduced-fare riders who qualify for reduced fares, the lost income from fare evasion may be trivial as some public transit systems are considering fare-free transit (Barry, 2020).

Augmented Reality Guide

Per conversation with Jacquilyne Brooks de Camarillo, Transportation Manager at the LA Metro, many potential riders do not ride the LA Metro because of a lack of knowledge in using and navigating the LA Metro system. The 2017 LA Metro Customer Satisfaction Survey also identifies a knowledge gap as a significant concern by HPTUs. Along with the knowledge gap, is the need for proper timing in utilizing the knowledge, information that appears just in time.

To address this, an augmented reality (AR) phone application could be offered to all users. See Figures 4 and 5 for illustrations of this alternative. As illustrated, the AR application would have the rider look at the world through their phone screens, as if in camera mode, and overlay a virtual path into the live video. The AR guide would lead the rider through the station step by step, as if someone were guiding the rider.

Figure 4
Photo Source: LA Metro

Figure 5
Photo Source: LA Metro

An AR app may seem ambitious and unrealistic at first. However, free AR-enabled or AR-based apps have been released in the past. Some companies have developed AR mobile apps for free download. Two prominent examples are Pokemon Go and IKEA Place.

Pokemon Go is a mobile game where a user goes around the real world to capture creatures called pokemon and battle with other users with their captured pokemon (The Pokemon Company, 2021). Figure 6 shows a screenshot of one of Pokemon Go's largest features: capturing pokemon in the augmented reality world. Pokemon Go was released in the third quarter of 2016 and was downloaded over 500 million times (Statista, 2021). This finding reveals that over 500 million users had the required technological specifications in their mobile devices.

Figure 6
Source: https://www.digitaltrends.com/virtual-reality/deloitte-survey-shows-augmented-reality-widespread/

The IKEA Place app is an AR-based application that helps people imagine how new IKEA furniture or fixtures would look in any given space. Figure 7 shows a demonstration of the app. The significance of IKEA Place is that it bridges the gap between information and imagination. For example, if a customer wants to buy a new chair for her study, she can look at pictures of IKEA chairs on the IKEA website or magazine and imagine the chair in her study. While she may know what her study and the IKEA chair both look like, she still must combine the two images in her mind. With the IKEA Place app, she can actually see what the IKEA chair would look like, making her shopping experience easier. This example shows how AR can help bridge

imagination gaps for people. In the context of public transit, an AR navigation app could do the exact same thing with knowledge gaps; AR can show a commuter how to navigate a transfer.
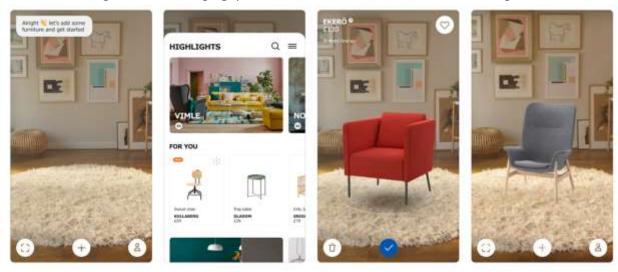

Figure 7
Source: https://www.chatelaine.com/home-decor/ikea-place-app/

Install Loading Visuals in Waiting Areas

Across our target demographics, both groups responded to their satisfaction with travel time on rail and bus. Some of the time in a Metro route is spent waiting for the bus or train to arrive. Waiting time is felt as a waste, and there can be a disconnect between actual time passed ("I don't like the Metro because it is slow") and the feeling of the time passed ("I don't like the Metro because it feels slow") (Hornik and Zakay, 1996). Much of our feeling toward an experience ("I don't like the Metro because it feels slow") is our memory of that experience ("I don't like the Metro because I remember it feeling slow") (Kahneman, 2010). By changing the feeling of waiting, we have an opportunity to change riders' memory of their Metro experience.

Research in user experience has shown the effectiveness of loading screens in decreasing the pain of waiting for a screen to load (Norton and Buell, 2011). In fact, some websites that show a labor illusion, a user's perception of effort by a service provider, increase the appeal of the website, even if another website gives similar results with less waiting time (Buell and Norton, 2011). The labor illusion is like operational transparency, showing the user the actual work being done, with the difference being the truthfulness of the labor. Buell and Norton found that feelings of reciprocity are elicited in the relationship between transparency and perceived value. In other words, users given a labor illusion associate the service they are waiting for as more valuable.

Companies have used loading screens or progress indicators to convey labor to users. Most loading screens are used for digital experiences, such as loading a streaming service. However, some companies are trying to use loading screens for real world goods and services.

One such company is Domino's Pizza with their Pizza Tracker.[10] As Figure 8 shows, the tracker segments the waiting time into labor stages. This can give the waiting user benchmarks to convey work by Domino's to deliver the user their pizza.
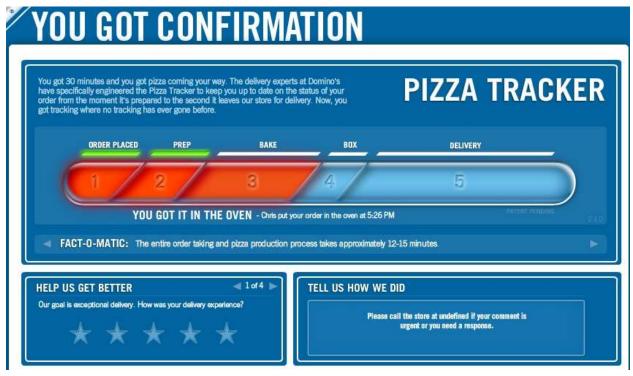
Using this finding, the LA Metro could apply this concept to waiting areas. This alternative is illustrated in Figure 9 with an example showing a loading screen for Metro riders waiting for an E Line train. In the illustration, the loading screen uses locational milestones to illustrate the train's progress. The example shows that the train is between the SMC and Bergamot stops. Similar loading visuals could be uploaded to station announcement screens to give waiting commuters a sense of their bus/train's work and progress through transparency (or well-concealed illusion). The bus or train's locational data can feed into the loading screens to help give an accurate reading of the vehicle's progress in arriving at the current stop. Though this intervention may not change the time spent in the LA Metro system, it can change the perception and memory of the user experience to one more positive and less painful.[11] With a more positive memory of their experience, the perceived difficulty of the LA Metro system may be lessened.

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[10] See more information from the patent: https://patents.google.com/patent/US10262281B1/en.

[11] A prerequisite for this alternative is the presence of a screen at a station or stop. As many bus stops, such as unsheltered stops, will not have screens or lack the ability to fit a screen, this alternative is limited by the design of the station/stop (Norton and Buell, 2010).
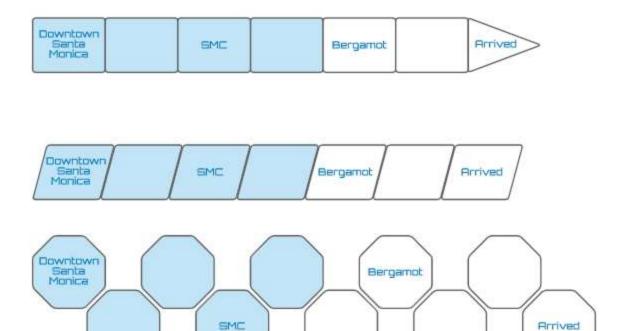
Figure 9

Criteria

CAH, values novelty, scalability, and equity. These values are manifest in CAH's research areas.[12] The LA Metro, CAH's client, values equity, and health, as manifest by fair pricing initiatives and a drive for a future of cleaner air. The criteria take the values of CAH and LA Metro into account. Each alternative will be evaluated against the criteria with a scale from 0 - 10, with 10 being the highest (best) score. The descriptions for each criterion state what an alternative would need to demonstrate to achieve a maximum score of 10. See Appendix II for detailed descriptions of scores between 5 and 10 for each criterion.

Some criteria (impact and novelty) will have an inclusion trigger, a cut-off score that automatically includes an alternative in the recommendation should the alternative meet the cutoff. The equity criterion will include an exclusion trigger, a cut-off score that automatically excludes an alternative from the recommendation if the alternative scores below the cut-off. Should an alternative trigger an exclusion trigger and an inclusion trigger, the exclusion trigger will override the inclusion trigger.

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[12] See more at https://advanced-hindsight.com/research/

Impact

A recommended solution should create a positive change. This criterion will evaluate how effective an alternative will likely be in increasing LA Metro bus and rail riders. Impact will be defined as increased likelihood of public transit take up. This answers the question "how much more likely would a person take public transportation if this intervention is implemented?"

To receive a maximum score of 10, a person's likelihood of taking public transit would be increased by at least twofold. A score of 5 would indicate that the intervention is unlikely to change a person's likelihood of taking public transportation. Any score below 5 would indicate a probable decrease in likelihood of taking public transit. However, a negative score would not necessarily indicate that a person would be more likely to drive a car, as an intervention could divert riders to other driving alternatives. For instance, increasing the presence of scooters may decrease likelihood of public transportation take-up if riders are able to get to their end destinations quicker with more ease. An inclusion trigger is set at 8.

Equity

When examining a transportation system or design, one must always ask "who was this built for?" Historically, the field of transportation planning has excluded minority and low-income populations. This criterion looks at the equity implications of an alternative. As transportation, as a field, has historically overlooked equity, it is important to begin consideration. Racial and income equity implications of each alternative will be researched.

For this criterion, any alternative that scores below 5 will be automatically excluded from consideration. On the scale of 1 to 10, a score of 5 indicates a do-no-harm (and no good) approach. Anything below would imply that an alternative decreases equity in a system built unequal. An exclusion trigger is set at 4.

Cost

The costs of each alternative must be considered. In this criterion, the likely budget impact of each alternative will be analyzed. As the LA Metro's adopted budget has tightened for the fiscal year 2021 (FY21), proposed alternatives should be sensitive to cost (LA Metro, 2021). The adopted budget for allowed expenditures for OEI is \$11.8M for FY21.[13]

Each alternative's cost will be divided equally over a five-year period with the spread of costs and interest rates considered. The discounted cash flow analysis will assume a 2% interest

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[13] From the Los Angeles County Metropolitan Transportation Authority FY21 Proposed Budget which was later adopted for FY21.

rate.[14] The projected costs will then be compared to OEI's FY21 budget. To be conservative, budget increases were not factored in, each year's budget will be assumed equal to FY21.

The percentage of budget used, in a five-year period, will be looked at (projected costs/Office of Extraordinary Innovation budget) and given a score out of 10. A score of 10 indicates that an alternative's annualized cost is projected to be close to 0% of the FY21 budget. A score of 5 indicates that an alternative's annualized cost is roughly equal to 100% the FY21 budget. A score of 0 indicates that the alternative's annualized cost will be over 200% the FY21 budget. This simple methodology ignores the possibility of an alternative being funded by multiple entities.

Novelty

This criterion examines how innovative an alternative is. As CAH is a research center with a mission to contribute new knowledge to the scientific community, evaluating if an intervention pushes established boundaries is relevant. This criterion will ask a simple question: "does it exist?" Innovation can also occur in finding new ways to apply a design or finding.

To figure this out, a review of each alternative will be carried out. Case studies and pilot programs are good indicators that an intervention has been tried before. If an alternative only exists in the form of an idea (it has not been created or tested), it will not count against the novelty score. To obtain a score of 10, maximum novelty, an alternative must be completely new in design and not exist in any field. An inclusion trigger is set at 8.

Scalability

Before an alternative is implemented, a pilot program will be run to show proof of concept. As such, each alternative must be scalable. This criterion evaluates the ease in which a pilot version of an alternative can be effective in one context and expanded to another context. Expansion takes time and resources. A review of literature will be done to estimate the ease of expanding a limited program to a full-fledged one.

A score of 10 will indicate an alternative can be expanded into new contexts seamlessly. An example of this would be transitioning a test feature on a digital application from being limited to test users to becoming available to all users.

Note on Excluding Political Feasibility

To avoid overcrowding of evaluation criteria, political feasibility will be excluded. This is largely justified through the realm the alternatives will operate in: public support for public transportation. In recent elections, LA voters were presented with ballot measures to increase funding for the LA Metro by raising sales tax (see Background section). These ballot measures

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[14] Though interest rates are low for FY21, below 1%, assuming an interest rate similar to the consumer price index may be more representative to times after Covid-19.

were passed with an overwhelming majority of 75% of voters voting "Yes." It is evident that LA's voting public is in wide support of increasing investment in public transportation, even to the point of paying higher taxes.

Scoring Methodology

The alternatives will be evaluated on their ability to meet each criterion on a scale of 1 to 10, with 10 being the best score an alternative can receive. The sum score will then be measured as the final score.

However, aside from sum score, certain criteria will hold more significance than others. Some criteria will have exclusion triggers (i.e., if an alternative falls below a score of 5 in the equity criteria, it is automatically excluded from recommendation). Likewise, some criteria will have inclusion triggers (i.e., if an alternative scores above an 8 in the novelty criteria, it is automatically included as a recommendation). An alternative must not activate an exclusion trigger if it is to qualify for an inclusion trigger.

Criteria Assessment

Off-board Fare Collection with Check-In Payments

Impact: 7

Off-board fare payment and verification has been known to speed up boarding processes. Researchers found off-board fare collection to be especially effective during high-demand hours (Tirachini, 2013). During low-demand hours, the methods of fair payment have little impact on boarding times (Tirachini and Hensher, 2011).

Equity: 7 (4 – if this alternative is implemented without cash accommodation)

This alternative can make the boarding process easier for low-income riders, especially those who pay by cash, as they can pay off-site without holding up the line. Should many passengers pay their fares with cash, off-board fare collection would negate the time needed to process a cash payment given that a cash-processing fare machine is present. This alternative would enhance the boarding experience by reducing boarding time for both rich and poor passengers. As long as a cash payment process is available, this alternative could increase the availability of cash-enabled ticket machines, potentially making the system more equitable. This alternative scores a 7 if cash-accommodating machines are present. If a cash option is not provided, the alternative will likely be hurtful for passenger equity and score a 4 instead of a 7.

Cost: 5

This alternative would require significant investment. The primary costs associated with this alternative would be shifting ticket kiosks off the buses and onto the bus stops. Currently, the payment process takes place inside the buses (LA Metro, 2021). It is safe to assume that the

payment dials can be moved from the buses to the bus stops, decreasing the number of additional payment dials needed to be purchased. The LA Metro has 13,978 bus stops and 2,308 buses (LA Metro, 2020). If each bus has one TAP dial, 11,670 more dials will be needed in order to equip each stop with an off-board payment system. If each TAP dial costs $500, installing additional 11,670 dials will cost $5,835,000. This is only the cost for cashless payments.

Cash payment systems will be needed to accommodate equity concerns for (physical) cash-based riders. Information on ticket kiosk pricing is scarce. As such, an assumption will be made that the cost of a ticketing kiosk is the same as the cost of an automated teller machine (ATM). The cost of an ATM ranges from $1,390 to $3,180 (Cost Figures, 2021). Given that advanced features of a kiosk will not be needed, as TAP kiosks already process the cashless payments, we will assume the cost of a cash-based ticketing kiosk is $1,390. The cost of putting a cash-based ticketing kiosk at every bus stop would then be $19,429,420.[15]

For the payment verification aspects of this alternative, assuming the average salary for a ticket inspector is $40,000, if we have one inspector per bus route, the total salary expense would be $6,600,000 per year.[16] Having a small number of inspectors perform random ticket inspections would be significantly cheaper than having an inspector in every bus. This is assuming that the LA Metro does not currently have employees performing payment verification. The annualized costs were roughly equal to 100% of the FY21 budget of $11.8M. As such, this alternative gets a 5. See Appendix I for more details regarding costs.

Novelty: 4

Off-board fare collection is in existence in a few instances in Curitiba, Brazil, Los Angeles, USA (partial) and Cleveland, USA (Grossman, 2006). This system is known in concept but rare in practice. There are plans by other transit bodies to eventually implement off-board fare collection (Chase, 2005). Though this concept is new and yet to be implemented in most transit systems, there are cases of this alternative in practice.

Scalability: 8

This alternative would be able to be replicated with high success across other environments to a larger degree. As a bus can only load up to capacity, off-board fare collection, per bus, only needs to hit the bus's capacity. In other words, if an empty 50-person bus arrives at a bus stop with 90 people, the off-board fare collection would only need to efficiently collect fares from the first 50 people who are to board the bus. The remaining 40 people at the stop can have their fares collected in the time it takes for the next bus to come.

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[15] $1,390/kiosk * 13,978 kiosks
[16] 165 routes * $40,000

As such, the LA Metro can identify which stops experience high boarding volumes and plan accordingly by placing extra kiosks or TAP dials for improved fare collection rates.
Total Score: 31

<u>Augmented Reality Guide</u>
Impact: 7

This alternative directly addresses information concerns highlighted and emphasized in the 2017 LA Metro customer service report . Augmented reality (AR) directions would allow riders unfamiliar with the public transit system to walk with visual guidance, allowing them to navigate with confidence. One of the biggest concerns for high potential riders is the lack of familiarity and knowledge of the Metro system. An AR application that directly addresses this concern can effectively eliminate the knowledge and confidence gap. This alternative would be close to equivalent to walking with someone guiding you through the Metro system.

One AR pilot program, in the space of navigation and direction was with Google Glass - AR-capable glasses. DHL, in partnership with Google, tested out Google Glass in a warehouse setting. Warehouse workers use Google Glass's AR in the picking process, a process of selecting inventory off the shelves for a delivery order. DHL reported that during a picking process, results showed a 25% increase in efficiency (DHL, 2015). By providing the workers with live, visual directions, workers were able to navigate the many shelves and sections of the warehouse and know exactly what they were looking for.

If this result stands true, the improvements to public transit navigation can be just as great, if not greater. If the Google Glass intervention increased worker efficiency by 25% for workers who were already familiar with navigating the warehouse, it is possible that a new worker's efficiency could increase by even more. Likewise, a new commuter on the Metro might experience a greater increase in navigational efficiency than an experienced rider. As those most likely to take up this intervention are people unfamiliar with the metro, I could be argued that the effect could be greater than that witnessed in the DHL case. An increase of 25% would roughly translate to a score of 6. However, given that the likely users of this alternative will be new to the metro, the effect would likely be greater because the users are likely starting with less information than the DHL workers. This alternative scores a 7.

Equity: 5

Per a 2019 LA Metro survey, 45% and 28% of sampled bus and rail riders, respectively, did not have a smartphone (LA Metro, 2019). Without a smartphone, an AR application cannot be utilized, as other phone types do not have the capabilities to run an advanced program. Given that the rates of smartphone ownership decreases with income, lower-income riders will be less likely to be served by this alternative. For those with a smartphone, iPhone users must have a phone that can run iOS 11, meaning owning an iPhone 5s, released in 2014, or newer

(Apple, 2021). For Android users, their phone must run Android 7.0, released 2016, or later (Google Developers, 2021). As this intervention depends on users having a smartphone, that is new enough to run this application, equity is neither served nor hurt.

Cost: 9

As costs of building, hosting, and maintaining are highly variable, coming up with a cost estimate is difficult. Per a price quote from Clavax, an AR app developer, a high estimate for a fully immersive AR application, in two languages, would cost approximately $50,000 to develop (Clavax, 2021). This cost can also be offset by the selling of advertising space in the AR environment. Then comes of costs of hosting the application. According to Amazon Web Services (AWS), a web app that has 10,000 daily active users and is updated 2 times per month would cost $65.98 per month (Amazon Web Services, 2021). If these estimates hold, the AR guide would cost $50,000 to develop with a recurring yearly cost of $791.76.[17] The 5-year annualized cost would be roughly equal to 0.1% of the FY21 budget. As such, this alternative gets a 9.

Novelty: 8

While there are a few pilot programs experimenting with AR applications, most studies on the AR applications on navigation are prospective. There are exploratory simulation studies on applying AR to driver navigation (Medenica et al, 2011). A prototype of AR-based car navigation was made in 2005 with some lab success (Narzt et al, 2005). Mobile-based AR applications have been created before. The most famous example is Pokemon Go, by Niantic. Pokemon Go is an AR game that attaches game locations and events to physical locations. Niantic, a Google startup, is a company that is dedicated to developing and advancing AR in the public sphere (Niantic, Inc, 2021). Though personal navigation is not part of Niantic's product offerings, navigation does not drift too far away. An AR navigation guide for public transportation would be highly novel in application though not entirely new in its underlying technology.

Scalability: 8

As the proposed alternative is a mobile application, the primary scaling challenges will be gaining user adoption and capabilities to host the user growth. As the technical challenges can be addressed by buying additional space from a third-party server provider, this challenge is relatively simple and easy. The main challenge will be getting users to adopt the technology. As concerns over navigation are large among high potential users, this app may experience

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[17] $65.98/month * 12 months

adoption as it can be seen as an obvious solution for the riders. The amount of advertising can influence the rate of adoption as well. Challenges to scalability are likely to be few.

Total Score: 37

Installing Loading Screens
Impact: 6

  In the context of waiting for a website to load in a lab setting, subjects who were presented with a website that was loading chose to wait 62% if the time when the website was transparent versus 42% when the website was not transparent (Buell and Norton, 2011). Given that the waiting time was 30 seconds for the website, the effect will very likely be smaller for a longer waiting time for the metro. However, the value presented by the Metro service would also be greater than the content of the website. Given that other settings-based interventions, such as environmental contexts, have suggested an effect, using showing train/bus progress in waiting areas may also help (Lagune-Reutler et al, 2016).

  This alternative is unlikely to directly attract new riders to the metro. However, if the theory of change holds, riders who experience a lessened pain of waiting may be less critical of the public transit systems' speed (time spent in the system). This includes riders trying the Metro for the first time.

Equity: 5

  The loading screen would not give misleading information on arrival times or influence the actual time spent waiting, it would only influence the feeling of the time. The effect of loading screens on time perception will vary by individual rider. It is possible that race, income level, gender, and other personal factors can influence the effect a loading screen has on perceived time. However, it is unlikely that any group able enough to ride the Metro will be unable to interpret a simple loading screen. Under reasonable assumption, this alternative will unlikely hurt nor help the equity of the transit system.

Cost: 9

  The costs associated with intervention would be employee hours spent designing the loading screen visual and connecting data points. The estimated time to arrival data is already available, as station and stop screens already show an estimated arrival time. Simply visualizing the estimated arrival time would constitute the loading screen. At the very most, the LA Metro would contract hire a user experience (UX)/graphic designer to develop the new visual. Assuming the labor cost of contracting someone to create this graphic is $80,000. This cost will unlikely constitute a material amount in the LA Metro budget. As this will likely be a one-time immaterial cost, projections only included one year. This means that someone would be paid

$80,000 to design the intervention that can run on its own without continued work. As such, this alternative scores a 9 on cost.

Novelty: 8

This alternative is most common in web page loading (loading the search results for flights) and has recent adoption in waiting time for goods (loading your pizza). Websites, such as Expedia,
utilize loading screens to load search results or purchase pages - the goal of the loading screen is to keep the user from leaving the website or cancelling the search result. Companies such as Domino's use loading screen to update the customer on the status or their pizza - the goal is to increase transparency and manage time expectation (Hinshaw, 2016).

Scalability: 10

Once the loading screen is created, it can be instantaneously distributed to any connected device. This intervention can be scaled to all specified screens in the LA Metro system seamlessly.
Total Score: 38

Summary of Total Scores:

	Off-board Fare Collection with Check-In Payments	Augmented Reality Guide	Installing Loading Screens
Impact (8)	7	7	6
Equity {4}	7	5	5
Cost	5	9	9
Novelty (8)	4	8	8
Scalability	8	8	10
Total	**31**	**37**	**38**

( ) - Inclusion Trigger
{ } - Exclusion Trigger

Recommendation

Upon criteria evaluation, implementing loading screens in waiting areas scored the highest out of the four interventions. This alternative is the cheapest and the most scalable, as it is a digital image that can be uploaded to any connected screen that the LA Metro has access to.

If this alternative works, it will improve the rider experience by making waiting less painful. When riders recall their Metro experience when deciding whether to take public transit, their memory of their experience would be more positive (or less negative). This

intervention helps address the time-related concerns of the LA Metro, as mentioned by both the high-potential transit users (HPTU) and drivers who occasionally ride rail (DWORR).

Like any theory, the theory the alternative is based on is based on an assumption that users have a positive view of the service they are waiting for. If this alternative can translate to transportation, riders may need to have a positive enough view of the services they are waiting for (Buell and Norton, 2011). Buell and Norton also point out the difference between a labor illusion and operational transparency, as discussed in the Alternative section. To refresh, a labor illusion is the user's perception of work done by the service provider. Operational transparency is allowing a user to see the actual workings of the service provider up to the point of delivery. If a user realized the labor illusion is an illusion, they may not trust the progress indicator (loading screen). If possible, provide transparency that pushes an illusion. In the context of the LA Metro, this could mean using real time trip data, from the incoming train or bus, that feeds into a graphic that shows broader trip milestones.

[Noteworthy Subscores]

The Augmented Reality Guide alternative scored above an 8 or above in criteria with inclusion triggers: impact and novelty. Any alternative that scores an 8 or above in the impact or novelty criteria are automatically included as part of the recommendation. As such, the AR guide is also recommended as an alternative. Through the timing and delivery of information (showing the user where exactly to go via AR), this alternative has high potential to address the concerns of HPTUs and other people unfamiliar with the Metro system. By making the Metro system easier to navigate, riders may be more likely to use the metro. Riders would feel an increased sense of confidence and know-how in approaching the LA Metro system.

Implementation

The LA Metro may have the capacity to implement multiple alternatives alongside the recommended alternative. As CAH's project with the LA Metro will likely include multiple randomized controlled trials (RCT), it is reasonable to assume that each alternative has a non-zero chance of being implemented. Below are the broad steps for implementation of each alternative.

Off-board Fare Collection with Check-In Payments
- gather support and excitement for initiative from the LA Metro management, the Los Angeles Department of Transportation, and the community
- identify available TAP readers currently owned by the LA Metro
- determine number of TAP readers and ticket machines required for each stop
- ensure city regulations and zoning allow installation of readers and ticket machines in each stop

- contact TAP reader and ticket machine vendors to fill demand (number of required machines - available machines = extra machines needed)
- ensure new installations follow National Association of City Transportation Officials (NACTO) guidelines[18]
  - new installations do not reduce available sidewalk width
  - new installations are at a wheelchair accessible height
  - new installations do not block bus entrance and exits
- collaborate with relevant departments (for power, maintenance, cash collection, security, etc.)

Augmented Reality Guide
- gather support and excitement for initiative from the LA Metro management, LA Metro employees, and the community
- conduct rider focus groups to gauge potential acceptance and likely uptake of an AR app
- send request for proposals (RFP) out to companies that develop augmented reality (AR) programs
- sort proposals and find AR company to contract
- establish project liaisons to handle app requirements
- create safety plan for safe use of AR guide
- determine optimal marketing strategy to reach high potential transit users
- prototype and test app versions
- finalize and release to Google Play and Apple App Store

Installing Loading Screens
- gather internal support for this project through departmental buy-in
  - include employees from different departments in the design process
- gather relevant data to feed into loading screen
  - i.e., connection to train location relative to individual stop/station location
- determine type of loading screen (animation vs generic)
- draft loading screen designs and test efficacy through testing or focus groups
- finalize design
- upload design to the central screens at stops and stations

Before full-scale implementation, CAH and the LA Metro will likely test an alternative through study to test efficacy inside the LA Metro's context. Please see the research proposal document for proposed research designs to test each alternative in this report.

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[18] For more information, visit https://nacto.org/publication/transit-street-design-guide/station-stop-elements/stop-elements/fare-vending/.

Conclusion

   Public transit take up is a key factor in determining the traffic congestion levels and following health consequences from vehicle emissions. The perceived and experienced difficulties of using the public transit system can be a barrier to public transit take up by commuters. By working on improving the public transit experience, commuters may be more open to taking public transit as opposed to driving.

   The alternatives discussed are all directed at improving the public transit experience based on the rider preferences revealed in the 2017 LA Metro customer satisfaction survey. Creating and implementing loading screens in the Metro stations and stops can help ease the pain of waiting for the Metro vehicle (bus or rail) to arrive. Developing and distributing an AR guide that helps riders navigate the Metro can help in attracting and retaining new riders by easing the use of the Metro system through guided navigation. Each examined alternative can be tested as part of a pilot program should the LA Metro decide on it.

Appendix I - Cost

Off-board Fare Collection with Check-In Payments

Rate	2%				
Years	5				
TAP Dial Cost	$500				
Number Needed	11,670				
Total Cost	$5,835,000				
Kiosk Cost	$1,390				
Number Needed	13,978				
Total Cost	$19,429,420				
Total Cost of TAP and Kiosk	25,264,420				
5 yr Annualize Cost	5,052,884				
Annual Salary	6,600,000				
Annual Cost	$11,652,884				

Year	1	2	3	4	5
Cash Flows	-11,652,884	-11,652,884	-11,652,884	-11,652,884	-11,652,884
Discounted Cash Flow	-11,424,396	-11,200,388	-10,980,773	-10,765,464	-10,554,376
OEI Budget	11,800,000	11,800,000	11,800,000	11,800,000	11,800,000
Discounted Budget	11,568,627	11,341,792	11,119,404	10,901,376	10,687,624
Percent Budget Used	98.75%	98.75%	98.75%	98.75%	98.75%

Augmented Reality Guide

Rate	2%				
Years	5				
Development Cost	$50,000				
Number Needed	1				
Total Cost	$50,000				
5 yr Annualize Cost	10,000				
Annual Server Cost	792				
Annual Cost	$10,792				

Year	1	2	3	4	5
Cash Flows	-10,792	-10,792	-10,792	-10,792	-10,792
Discounted Cash Flow	-10,580	-10,373	-10,169	-9,970	-9,774
OEI Budget	11,800,000	11,800,000	11,800,000	11,800,000	11,800,000
Discounted Budget	11,568,627	11,341,792	11,119,404	10,901,376	10,687,624
Percent Budget Used	0.09%	0.09%	0.09%	0.09%	0.09%

Installing Loading Screens

Rate	2%
Years	5
Development Cost	$80,000
Number Needed	1
Total Cost	$80,000

Cost	-80,000
OEI Budget	11,800,000
Percent Budget Used	0.68%

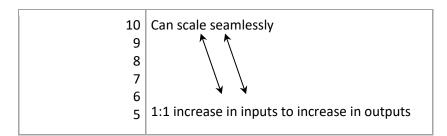**Appendix II - Criteria Scales**

Novelty Score	Implication
10	Exists in theory, no cases in application exist
9	Exists in theory with few cases in a different field
8	Exists in theory with few cases in a similar field
7	Exists in theory with few cases in field
6	Exists with few prominent cases in field
5	Exists with many prominent cases in field

Cost Score	Implication
10	Annualized cost roughly equals 0% FY21 budget
9	Annualized cost roughly equals 20% FY21 budget
8	Annualized cost roughly equals 40% FY21 budget
7	Annualized cost roughly equals 60% FY21 budget
6	Annualized cost roughly equals 80% FY21 budget
5	Annualized cost roughly equals 100% FY21 budget

Equity Score	Implication
10	Greatly helps
9	
8	
7	
6	
5	Neither hurts nor helps

Impact Score	Implication
10	100 % increase
9	80 % increase
8	60 % increase
7	40 % increase
6	20 % increase
5	0 % increase

Scalability Score	Implication

10	Can scale seamlessly
9	
8	
7	
6	
5	1:1 increase in inputs to increase in outputs

Appendix III - Interview Summaries

Expert	Interview Summary

Tayo Fabusuyi (Economist/Researcher - University of Michigan Transportation Research Institute)	**Two strong predictors of public transit uptake:**
	    -number of vehicles owned
	    -years of education
	
	How do you couple fixed routes with flexible routes?
	    -micro-transit (example: church/community groups that provide transportation)
	
	    Summit, NJ is a good case study of coupling fixed transit routes with flexible routes
	        -fixed private/public sector and flex routes (community)
	        -land use policies may allow or prevent this intervention
	        -may be tough to pull off in a sizeable sprawl
	
	Can you name some success factors in reducing solo driving?
	    -Land use policies can be a factor in the success of interventions (i.e. walkability)
	
	Mobility as a Service shows promise
	    -pay for your first ride and can move seamlessly through mode transfers (irrespective of who the service provider is)
	    -being able to pay once in the commute reduces frictions in public transit
	    -keep costs in mind: explicit dollar and implicit effort
	
	Looking forward, what are some things we should pay attention to?
	    -integrating connected modes
	    -what do we have when things improve? What do we have when we move further away from transit?
	    -how do we create policies that foster increased mobility?
	    -look at failed policies that could come around and cripple transit innovation (example: LA's urban sprawl may cripple FMLM)

Lyndsay Gavin (Behavioral Scientist - Center for Advanced Hindsight)	**Public transit take up can be stymied by hesitancy influenced by identity**
	    -some people are hesitant to become bus riders themselves because they have negative associations with bus riders
	    -people my not identify as strongly with the image of a bus rider as they do to a car driver
	
	How transit agencies can take advantage of the ridership dip in covid
	    -reduced car traffic increases bus efficiency
	    -reduced car traffic allows us to trial new innovations
	
	What are some promising behaviorally-informed solutions in increasing public transit take-up?
	    -reward wallets*
	        -funded incentives through grants (charitable foundations, govt grants)
	        -new companies fund free rides
	        -past behavior predicts future behavior, reward wallets can help
	    -interventions utilizing the fresh start effect**
	        -good target: people who tend to move to different parts of town
	        -when the move occurs, is that a good time
	        -Portland bikeshare study
	            -group 1: just moved near
	            -group 2: people who were already living near
	            -new movers had higher take up of bikeshare offers
	
	From beginning to end of the commute, where is pain most preventative for a choice? Where is reward most motivating?
	    -pain of payment for parking, timing would be a factor
	    -incentives should be pretty high upfront
	    -personalized route should overcome pain of planning
	        -recommitment
	        -presenting barriers and asking how they would overcome those barriers

	*reward wallets are incentive programs where people earn rewards based on task completion **fresh start effect is the phenomenon where a person perceives a clean sheet and feels motivation to set and pursue their goals (example: New Year's Resolutions)

Jacquilyne Brooks de Camarillo (Transportation Planning Manager - LA Metro)	**What have you seen work in changing commuting behavior?**
	    -shift people's idea of commuting
	        -people don't have to take the same commuting mode everyday
	        -ask "what is the best way to get to your destination TODAY?"
	    -educating people about all their options
	
	Have you encountered negative social perceptions related to public transit?
	    -a majority of people who think the bus is not safe, never took the bus before
	        -an underlying problem is that people are anxious about public transit is because they don't know how to take it
	        -people are more willing to try something new when someone sits down and speaks with them
	        -try public transit on the weekend to avoid the crowd
	    -route planners don't give information a first time user needs
	        -people need a good first time experience
	    -public transit systems tend to have many safety protocols
	
	What organization does the LA Metro need to go through to help set transportation solutions, such as new bus routes or private sector partnerships?
	    -LA Metro can implement new programs themselves
	    -LA Metro has a group that performs a study
	        -performs public comments
	        -propose a number of planned options
	        -discussion with board
	        -end of process, environment la impact study
	        -confer with cities

	-board votes on it
	
	What is the political landscape around LA transportation?
	    -political context is more encouraging than discouraging
	    -becoming a Transportation Demand Management*
	    agency
	    -a lot of political support for TDMs
	    -raising taxes to pay for transportation funds, much of it
	    has passed, much support from voters and politicians
	
	What is the political landscape in zoning?
	    -curb space (bus stop, parking, taxis)
	    -push and pull between groups in each city
	    -everyone is fighting for
	        -ride hailing
	        -taxis
	        -parking
	        -outdoor restaurant seating
	        -some communities don't want a bus stop
	        -some communities do want it
	        -may be easier for DTLA
	    -balancing act between metro, cities, businesses,
	    residents
	
	Where do you see most interventions fail?
	    -good, robust programs fail because of poor marketing
	    or outreach to commuters
	    -not doing the marketing and 1 on 1 outreach
	    -cities have failed also because of marketing
	    -programs never gain traction
	        "if we build, they will come" is the wrong
	        approach
	    -inform commuters on the "WHY?"
	    -1 on 1 is easier for employers
	    -for 1 on 1, cities can use an app
	        -every transportation option, how to get there,
	        transportation options, pay for fare
	    -a lot of people want to do a MaaS intervention
	    -TAP program, has a TAP wallet
	        -idea is that parking, bikeshare
	        -currently working on it

	What are some recommendations for thinking about the issue of traffic going forward?
	    -congestion pricing study
	    -painful to drive their cars, traffic isn't painful enough
	        -raise the pain point
	        -can't just raise, give people a more convenient option
	
	What are some recommendations for thinking about solutions going forward?
	    -having a solid FMLM for transit
	    -bus/carpool
	    -effective first mile last mile solutions that are convenient and quick
	
	*Transportation Demand Management: understanding how people use public transit and how infrastructure influences mobility and then reducing peak demand by redistributing demand

Senior Manager from the LA Metro Office of Extraordinary Innovation	**What does the Office of Extraordinary Innovation (OEI) do?**
	    -look at other depts works to adapt to change in the future
	    -works in project financing
	
	What has OEI done in the realm of FMLM in public transit?
	    -utilized a data-centric approach to study how people access the Metro system
	        -insight: most people access by foot or by bicycle
	    -looking at how data and insight can drive policy based on strategic plan (vision 2028)
	        -one goal: double non solo driving trips
	    -understanding how women travel by looking at safety and safety perception
	
	Would you tell me more about the bikeshare system
	    -one challenge to overcome is people's identity of car-orientation
	    -LA is seen as the capital of the car
	    -sprawl and history of LA being a streetcar suburb (roger rabbit is an example)
	    -cities are often built around cars and highways
	    -culturally, Angelinos are at odds with public transit

	-people are open to the rebirth of the system
	-LA attracts a lot of out of town people
	-may need more infrastructure
	    -safety concerns
	    -high injury network
	
	What are some strategies to reshape people's perceptions of travel/commuting?
	    -visioning exercise to imagine what could be
	        -CicLavia is an exercise where the city shuts off vehicle usage for certain street segments and creates temporary open spaces for people to use
	    -tactical urbanism
	    -$2M/year for cities to do these events
	
	What are some noticeable demographics trends witnessed by public transit?
	    -the rise of young students in the Metro system
	    -younger people are more open to change
	    -going from car to transit is different and may be more difficult
	    -we need to incentivize people to take the Metro instead of car
	        -a current LA Metro example is U-Pass: discount transit passes for universities

Jessica Roberts (Principal - Alta Planning + Design)	**What are some levers that can determine public transit take up?**
	    <u>Contextual Factors:</u>
	    -area density (number of units per acre)
	        -higher density means higher ridership
	    -mixed use areas (homes and shops)
	        -integration of land uses makes shorter trips possible
	    -design of streets themselves
	        -low density residential units
	            -correlates with wider streets and faster car traffic
	            -grid is bigger and more hostile
	    -problem of street connectivity
	        -lower transit ridership
	        -lower pedestrian infrastructure
	    -curb tight sidewalks in LA

	-higher quality and presence of active transportation
	-taming major streets
	    -road diets*
	    -not advised as it is a hot political issue
	-active support related to public transit
	    -many people in LA drive all the time may still theoretically support transit investments but not at their personal cost of losing parking and lanes
	    -NIMBYism
	        -politically powerful
	    -Seattle is a good example of matching political support and actual action
	
	Transit Service Factors:
	    -time tax (additional time it takes to ride transit)
	    -reliability issues
	
	    Fixes
	    -take lanes away from cars and give it to buses
	        -bus only in certain hours
	        -fix pinch points
	    -if every bus is stuck behind cars in rush-hour, it will be intolerable
	    -transit priority is one of the most powerful tools available
	        -14th street bus only street in NYC
	    -bus rapid transit (light rail with buses)
	        -in lane boarding
	        -pay off board
	        -all-door boarding
	        -LA has the silver line BRT
	    -signal priority bus lanes
	    -keep SOVs out of the way of buses
	    -good idea: increase the frequency of bus arrivals
	        -frequency is very important (LA Metro knows this)
	
	What are some operational issues where transit agencies have the opportunity to improve?
	    -there is untapped potential in operations under the categories of payment processes and friction points
	    Payment Process

	-if people have to pay one by one, slow!
	-cash slows things down
	    -sticky because every agency who tried to eliminate cash has gotten spanked by equity advocates
	    -RCT underway of King County
	-agencies that speed up boarding process by eliminating friction see improvement
	    -card scans
	    -apps
	    -example: oyster card in London
	<u>Friction Points</u>
	    -friction points that cause rider to give up
	    -stored value card do not work on every transit provider in a region
	    -changing between transit providers is a big deal
	        -education can be done to reduce anxiety and ambiguity
	    -real time transit arrival
	        -not quite as good in some places
	
	What are some overlooked areas outside of transit operations?
	    -rideshare services have cannibalized transit ridership
	        -often are cheap and easy
	        -can outcompete public transit
	        -venture capital funding
	            -over half of every ride is subsidized by VC funding
	        -new studies have shown vast majority of rideshare trips have replaced walking trips in areas with transit options, not in transit deserts where subsidies intend
	        -single ridership in rideshare is still subsidized
	
	*reducing the number of car lanes in a street

Paulo Nunes-Ueno (Principal - Nunes-Ueno Consulting)	**How were you able to conduct these initiatives (including paid parking) equitably across all employee income levels?**
	Variability in price of the parking
	    -did not do price discrimination by income levels
	    -Vanderbilt project used this by splitting staff into income quintiles

	-Seattle children's varied based on time of day
	    -time of day was highly correlated with income level (showing up early with income professions)
	    -fewer transit options (thus had lower parking price)
	-flexibility (not asking lower income people to commit a big part of paycheck)
	    -if people were able to reduce their driving a little, they reduce costs
	Used broad base of subsidies
	    -overlooked: the structural barriers that programs put in place
	    -many people qualify for subsidies but don't take up due to constraints
	        -got around this by providing bus pass
	            -Seattle got charged for pay by use (cheaper than paying for whole months' worth)
	        -asking "would you like to buy a monthly bus pass?" is a lot for some people
	            -free bus pass offer
	            -possible because the transit agency had a product (charge per usage) that King County could buy from King County transit
	                -Orca card, program: **orca passport**
	            -King County Metro is innovative agency
	                -early 2000s developed flex pass
	                -they figured out pricing structure before smart passes existed
	                -used survey to give companies first year contract, based on base level ridership
	                    -charge for first year and look at commute reduction survey and use it to true up the costs
	                -fare pay parking has regressive impact on low income users (as designed for high income people)
	                    -people who use daily rate are the poor (they can't afford monthly pass)
	Daily cash out incentive for not driving ($5 into pay)
	    -trust involved
	    -control of parking lots and shuttle

	-paid people for biking to work
	In thinking about structure and design, how did the physical layout of the streets or other open areas play into the current success?
	-starts with policy commitment and direction
	-acts as container for later projects
	-hospital needed to double in size
	-concern about traffic impact
	-create comprehensive transportation plan
	-reduce SOV and make it easier for people to bike, walk and take transit
	-reduce overall demand
	-mitigation money + fund
	-created criteria for kinds of investments to be used for
	-liaised with Seattle Department of Transportation
	-critical piece: have a good surveillance system for auto-centric projects
	-we don't know where the pedestrian connections that are missing
	-lesson: there is not a direct linkage between master plans and funding
	-create data agreements with big mapping and then creating processing power to say where are the missing pedestrian spaces?
	-pinpoints shortcomings
	If Seattle Children's were significantly bigger, would you have tackled this problem differently?
	-no
	-same approach to different sized clients
	-boiled down to:
	-culture
	-commitment (sustainability)
	-work is rooted in core elements
	-at hospital many patients have asthma which is related to air pollution (biking fights asthma as culture of helping others)
	-cost
	-don't make driving cheaper
	-convenience

	-understanding customer experience -concrete 　　-design of build environment -have something major in those areas -more freedom of mobility -don't act as driving is an outcome of nature **Did any of this spill over to the hospital visitors? Was the data collected?** 　-unknown, no data 　-anecdotal evidence 　　-redesigned shuttle system 　　　-shaped service to demand 　　　-used savings to connect shuttles to downtown light rail station (mid day) 　　　-people come to hospital and boarding shuttles
Matt Hansen (Strategic Planning Manger - King County Metro)	**How did King County Metro become a central figure in the commuting discussion?** 　-distinctive to approach: in the 80s, they pursued the employer as a primary customer 　　-mix of incentive and regulatory strategies 　　-state, county and cities set an expectation that employer will subsidize travel 　　-over half of fare revenue comes from employers 　　　-don't want to build parking which reflects the environmental ethic of Pacific Northwest 　　-state of WA passed a commute trip reduction law 　　-avoids federal clean air guidelines 　　　-fines for employers with >X employees will need a transportation coordinator, though no employer has been fined 　　-subsidy programs 　-perceptions are more off the bus than on in regards to safety 　　-longitudinal data Orca system 　-7 agencies 　-unique: recognize intersystem transfers and do transfer credits

| | -out only pay once
-revenue sharing between agencies

How did Seattle overcome the information barrier for new public transit riders in navigating metro?
    -call center and social marketing
        -In-Motion
        -Just One Trip
    -language barriers, knowing the map

Other Focus
    -helping people understand relevance of transit to their immediate travel need
    -many people never really investigate whether transit will meet their needs
    -done a lot of social marketing, neighborhood-based programs
        -understand options
        -incentive to try (Orca card with month pass)
    -dangers: pros tend to project interests and values to market they try to serve
        -transit is never an ends of itself

Would you please elaborate on the Orca card program: orca passport? How does this program make subscription-based riding more equitable?
    Passport
    -passport program came from University of Washington U-pass
    -had empty seats to fill so they decided to market to employers
    -employers give everything upfront and do a true up at the end of the period, for the next program year (current year cost is fixed)
    -over 1,000 employers

    Equity
    -low-income fare programs (Orca Lift)
    -with public health agency (has income verification via affordable care act)
        -built transport component with their program
    -nice but not enough ($1.50 may still be unaffordable) |

	-3 big partners
	-basically give free annual pass
	    -agencies pay
	    -state assistance programs
	    -TANF enrollment, etc.
	        -case manager will offer free annual pass
	        -check in every two years
	
	How did Seattle overcome perceptions of unsafe public transit?
	    -Metro's service structure is focused on peak-hour service
	    -based on geography and demographics, commuter routes have a lot of middle and upper middle class
	    -heavily used all day routes tend to be more diverse
	    -for the commuter routes, there is a perception of safety
	    -may people who use the service really use one or two routes
	        -don't change routes often
	
	How was your off-board payment process implemented? Who checks for proof of payment?
	    -only place with fare inspection on BRT program (rapid ride)
	    -6 lines
	    -major stations have checks via fare reader at stop
	        -tap on board
	    -moving toward mounting orca readers at all of the doors
	    -less on off-board payment than board and pay at any door
	    -fare enforcement has been difficult thing to implement
	        -lots of repeat offenders
	        -fines are regressive
	        -bad outcomes and over-representing minorities
	        -backed off on fare enforcement
	    -instead of ticket, give them an orca card, maybe
	
	How did you get the city to surrender car lanes to buses?
	    -was difficult to accomplish

	-rely on city to work with them with transit signal priority
	      -led to the creation of the bus priority lane
	-Seattle has become more progressive
	-not a lot of dedicated lane, but has business access lanes
	-lots of highway HOV network
	      -leverage that for long haul stuff

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