

## Article

# Planning for the First and Last Mile: A Review of Practices at Selected Transit Agencies in the United States

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**Abstract:** A transit trip involves travel to and from transit stops or stations. The quality of what are commonly known as first and last mile connections (regardless of their length) can have an important impact on transit ridership. Transit agencies throughout the world are developing innovative approaches to improving first and last mile connections, for example, by partnering with ride-hailing and other emerging mobility services. A small but growing number of transit agencies in the U.S. have adopted first and last mile (FLM) plans with the goal of increasing ridership. As this is a relatively new practice by transit agencies, a review of these plans can inform other transit agencies and assist them in preparing their own. Four FLM plans were selected from diverse geographic contexts for review: Los Angeles County Metropolitan Transportation Authority (LA Metro), Riverside (CA) Transit Agency (RTA), and Denver Regional Transit District (RTD), and City of Richmond, CA. Based on the literature, we developed a framework with an emphasis on transportation equity to examine these plans. We identified five common approaches to addressing the FLM issue: spatial gap analysis with a focus on socio-demographics and locational characteristics, incorporation of emerging mobility services, innovative funding approaches for plan implementation, equity and transportation remedies for marginalized communities, and development of pedestrian and bicycle infrastructures surrounding transit stations. Strategies in three of the plans are aligned with regional goals for emissions reductions. LA Metro and Riverside Transit incorporate detailed design guidelines for the improvement of transit stations. As these plans are still relatively new, it will take time to evaluate their impact on ridership and their communities' overall transit experience.



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**Keywords:** public transit; first and last mile; emerging mobility services; multimodality; transportation equity; sustainable transportation; suburban and rural transit

## 1. Introduction

A “transit trip” inevitably involves modes other than just transit. To use transit, an individual must first get from their origin to the transit stop and then from the transit stop to their destination. These trips to and from transit stops are commonly referred to as “first mile” and “last mile” trips, though they vary in length as well as mode. The first and last mile trips are a crucial component of transit planning as the success of transit depends on the provision of sufficient access to and from transit stops [1–3]. Nonetheless, there is a dearth of peer reviewed research in this important aspect of transit which has a potential to increase the transit ridership [4].

Planning for improved transit access is practiced worldwide through different innovative approaches. In Asia, Singapore is rolling out its National Cycling Plan with strategies of utilizing the bicycle as a first and last mile mode to connect Mass Rapid Transit [5]. In the UK, the Milton Keynes Council provided a more detailed strategy for mode aggregation for first and last mile travel including emerging mobility and on demand transit with the traditional fixed route transit. The Cambridge railway station developed a mobility hub concept for transit station improvement by integrating buses, taxis, and bicycles [6]. In New South Wales, Australia, the transit authority is experimenting with on-demand mobility options with a goal of providing customers with personalized services [7]. Europe has developed a

Sustainable Urban Mobility Plans (SUMP) to guide cities with making strategies to shift communities towards more use of sustainable mode of transport with an emphasis on public transit [8]. Additionally, new concepts are evolving for more multimodal integration at the local level such as Mobihub where different sustainable and shared modes are linked at the neighborhood level [9]. However, the US is far behind such innovative approaches for achieving multimodality and transport sustainability. Although Europe is significantly ahead of the curve in restricting car access, some cities in the US such as New York and San Francisco have started implementing projects for car free zones in certain areas by providing more transit and active transport access [10].

Compared to other western countries, public transit in the US has lower per capita trips and service quality [11]. The public transit condition is also worse in the US compared to other car-oriented countries. US transit ridership has declined since 2014 while the operating costs have increased [12]. The share of walking and cycling which are the main modes that people use to access transit is considerably lower in the US compared to other western countries [13]. Car ownership, car use, and fuel consumption per capital are much higher in the US compared to other western countries [14]. Whereas in Europe and in other parts of the world, public transit has attracted a broader cross-section of society, the US transit customer base is limited to mainly two markets: downtown commuters and the transit dependents, who are mainly low-income people who live close to transit stops [11,15]. In the US, there is also a lack of complementary multimodal policy, regional integration policy, restrictive automobile policy, and land-use policy that exacerbates the declining transit ridership [11]. The average farebox ratio is 35 percent compared to 44 percent in Europe and 56 percent in Canada [16]. The US transit system is mainly dependent on funding from the state level and federal level, both of which are recently reducing funding [16,17]. These funding cuts are compelling transit agencies to cut service and further reducing ridership [18,19].

According to the American Public Transportation Association, 45 percent of Americans have no access to public transportation [20], a number that is much higher compared to Europeans [21]. However, without service expansion, many Americans could access transit if they had better connections to rail stations and transit stops. As a part of a broader effort to increase ridership through connection improvements, transit agencies in the US have started focusing on innovative first and last mile strategies [22]. Expanding access to transit through the first and last mile access improvements can help communities realize the numerous health and economic benefits that transit generates [20,23–27]. As public transit innovations are much more challenging in the US context [28], a review of the current innovative practices planned by some transit agencies can help others innovate as well. Therefore, in this study, we are focusing on the service innovations that different local transit agencies in the US are advancing to improve first and last mile access to transit.

Transit agencies in recent days are being pushed to address the first and last mile (FLM) issue by changes in the emergence of new mobility services (e.g., ridehailing, electric bike-share, electric scooter-share) which have contributed to important differences in the travel patterns of millennials in comparison to previous generations. On one hand, research links the rise of emerging mobility services such as ridehailing services (e.g. Uber, Lyft) and bike-share systems to the recent decline in transit ridership as they substitute some portion of transit trips [29,30]. On the other hand, millennials, who are the leading users of emerging mobility services [31], also use transit more compared to Generation Xers and Baby Boomers [32]. These phenomena are pressing the transit agencies to leverage the potential of the new mobility services for providing first and last mile access. While European cities are investing in connecting public transit with active modes and new mobility services [28,33], the US is far behind in similar approaches. A study using different European city data shows that the average share of bike-share trips connecting to transit is 34% and overall, 3% of transit trips connected to bike-share trips [34]. In the case of the US, the integration of the new mobility with transit is still in its infancy. Some transit agencies have responded by integrating their service with new mobility services in innovative ways,

such as door to door service, micro-transit, free rides for bike-share users, vouchers for ride-hailing in transit deserts, etc., though often on a limited and ad-hoc basis. Integrating transit with other modes can attract more commuters to transit by improving first and last mile service as well as transit service itself [35].

Federal policy is also pushing transit agencies to address the issue of first and last mile access. The Federal Transit Administration (FTA) is an agency under the United States Department of Transportation which provides assistance (both technical and financial) to the local level public transit agencies. Transit funding in the US is a combination of federal funds, state funds, and local funds (usually sales tax), with fares covering a small share of costs [36]. A large portion of the transit capital expense is covered by the FTA funds [36]. Therefore, change in the focus of the FTA will likely influence the planning practice of the local transit agencies. The focus of the Federal Transit Administration (FTA) has recently moved towards the “complete trip” concept, rather than only the transit portion of the total trip [37,38]. Current federal funding for active transportation projects that improves transit connection provides an additional motivation for transit agencies to examine first and last mile access in a holistic way [39]. Transit agencies are beginning to respond to these policies. Several transit agencies in the US have recently adopted plans or studies focused on the first and last mile connection, going beyond traditional practices, such as filling sidewalk gaps.

These first and last mile studies and plans offer a holistic approach to integrating various transit innovations and have the potential for long-lasting impacts through their financing and implementation strategies. As most of these plans are relatively new, they may both inspire and serve as models for the development of such plans by other transit agencies. An evaluation of these plans with respect to issues such as transportation equity, the inclusion of new mobility, and innovative approaches in first and last mile problem-solving could help other transit agencies advance first and last mile planning and practices. Additionally, learning from this study will be not only helpful for the other transit agencies in the US, but also helpful for transit agencies and local authorities across the world for achieving their goal of increasing ridership and shifting communities towards more sustainable modes. Toward these objectives, this paper addresses the following questions:

- Broadly, how is transportation equity considered in these FLM plans?
- What are the different transportation themes around which the FLM plans developed, and what are the different transport issues covered by the FLM plans?
- How do different geographic, built environments, and various socio-demographic contexts contribute to different strategies in the FLM plans?
- How are emerging transportation technologies and services, environmental and climate change, and transit induced gentrification addressed in the FLM plans?
- How are these FLM plans measuring their stated goals, such as increasing ridership or improving service for existing riders?
- What is missing from these FLM plans? Are there areas of importance to transit that these FLM plans are not covering?

## 2. Materials and Methods

### 2.1. First-Last Mile Strategic Plans

We identified eleven FLM publications in total through online searches. These publications can be divided into two categories: first and last mile strategic plans (four plans) and first and last mile strategies studies (seven studies). This paper focuses on the former category of publications because they represent a more developed consideration of the first and last mile problem by transit agencies than the strategies studies, which may be the first step towards a plan. For simplicity, we will use the term “FLM plans” to refer to the four first and last mile plans. The broad goals of these FLM plans are to maximize multimodal efficiencies, enhance transit connectivity, and increase transit ridership.

The selected FLM plans are from both the regional and municipal levels: Los Angeles County Metropolitan Transportation Authority (LA Metro) [40], Riverside Transit Agency

(RTA) in Southern California [41], Denver Regional Transit District (RTD) [42], and the City of Richmond in Northern California [43]. The Riverside Transit and Denver RTD plans have substantial rural components as these two transit agencies serve both urban and rural areas. Among these four systems, only the Riverside Transit system includes just bus service; the other systems have both bus and rail service. Table 1 provides additional information on the selected transit agencies, which vary not only in their geographic size, population served, and densities, but also in socio-demographic and economic characteristics. Every data provided in the table are from 2017, except otherwise mentioned in the table. All the agencies except the City of Richmond were going through a decline in ridership which may have been a motivation for focusing on the FLM issue to improve accessibility and increase ridership. One common aspect of all the transit agencies is their low fare box ratio, which is very common in the US context.

**Table 1.** Comparison of the Selected Study Areas.

Characteristics	LA Metro	City of Richmond	Riverside Transit	Denver Regional Transit District (RTD)
First and last mile (FLM) Plan Publication Year	2014	2019	2017	2019
Urbanized Area Population	12,150,996	108,853	1,932,666	2,374,203
Density (per square mile)	2344	3603	4139	4789
Service Area (square mile)	1433	52.51	2500	2342
Median Income (US dollar)	68,093	61,045	66,964	68,377
% Poverty	17%	15.7%	15.6%	15.1%
% Zero Car Households	12.2%	8.1%	5.3%	9.4%
Ridership Per Capita (2018)	32.45	NA	10.43	44.10
Ridership Trend	Declined	Increased	Declined	Declined
Modes Included	Bus and Rail	Bus, Rail, Ferry	Bus	Bus and Rail
% Black	7.76%	20.2%	6.15%	8.48%
% Hispanic	48.6%	42%	49.6%	29.7%
Fare Box Ratio	0.177	NA	0.138	0.247
% Commuters Use of Transit, 2018	5.69%	14% (2017)	1.16%	5.86%
% Commuters Use of Active Transport, 2018	3.67%	2.47%	3.20%	7.66%

Source: American Public Transit Association, Census Data, and National Transit Database [44–49].

## 2.2. Framework for Analysis

As this review of the FLM plans is a completely new approach, we looked into similar types of plan review articles to define our methods of review. Doran et al. (2021) developed a framework to analyze the consideration of the equity aspect of the regional level transportation plan of Canada [50]. Marsden (2001) reviewed selected local plans of England based on how the strategies of the plans were developed and how they meet the overarching goals of the government [51]. Noerager and Lyons (2002) reviewed 48 statewide transportation plans in the US based on a framework consisting of eight elements including financial component, public involvement aspect, state-level transport issues, performance measures, etc. [52]. Handy and McCann (2011) used a framework to assess the six selected Metropolitan Planning Organizations to explore whether the federal funding for bicycle and pedestrian projects has led to increasing attention for pedestrians and bicyclists in the transportation planning process [53]. These studies show that an explicit or implicit framework is important in guiding the review process.

To appraise the four selected plans, we developed an analysis framework based on extensive literature reviews, examples of international first and last mile and transit access improvement planning, and research questions described in the previous section. We subdivided the analysis framework into three parts:

1. the process of the plan preparation,
2. strategies used for FLM,
3. the intended outcome of the FLM plan.

Transportation equity is one of the key components of this analysis as one study estimates that 60 percent of the transit trips in the US are taken by people of color, people with low-income, and people who may not be able to own, operate, and maintain a car [54]. Although transportation equity is one of the elements of the framework under the intended outcome section, we also examined how the plan-making process and how different strategies of the plan have addressed the equity issue. In addition to equity, we considered how the FLM plans address transit coverage and ease of connection, as according to Weyrich and Lind (2009) these are important qualities of a good transit system [55]. The elements of the framework and the qualities we were looking for with respect to each element are described in the following section and a summary of the elements is provided in Table 2.

**Table 2.** Summary of the Analysis Framework.

Framework Content	Description
<i>The Process of Plan Preparation</i>	
Public Participation	How the public were engaged during the plan-making and plan-implementation processes
<i>Strategies Used for FLM</i>	
Socio-spatial gap analysis and stop/station level strategies	Plan's analysis of spatial gaps in service by considering the socio-demographics and disadvantaged populations for developing stop/station level strategies
Micro-level Detail Design Strategies	Plan's focus on the design-based approach for improvement of the micro-level transit stop/station and the ADA compliance
Strategies for Integration of Suburban and Rural Services	Plan's integration of both suburban and rural services
Strategies for Integration of Multimodality	Plan's strategy of achieving multimodality
Strategies for Integration of New Mobility Services	Plan's emphasis on the integration with other modes, especially new mobility services with transit
Active Transportation Infrastructure Development Strategies	Plan's strategy of improving active transport infrastructure
Financing and Implementation Strategies	Proposal for funding for the plan's strategy implementation
Gentrification Consideration	Plan's focus on affordable housing surrounding a transit stop/station to combat gentrification due to transit service improvement
<i>The Intended Outcome of the FLM Plan</i>	
Environmental Benefit	Plan's stated quantification of environmental benefits
Transportation Equity	Plan's focus on achieving transportation equity
Success Measure Indicators	Different success measurement indicators used to measure the outcome of the different strategies of the FLM plan

### 2.2.1. The Process of Plan Preparation

*Public participation:* The Intermodal Surface Transportation Efficiency Act of 1991 required transportation agencies to put more emphasis on public involvement [56]. Public involvement in the transportation planning process is crucial as it enriches the whole planning process, provides credibility to the plan, and ensures that the plans are responsive

to the needs of the public [57,58]. Public involvement is also important for ensuring procedural equity, or the requirement for inclusivity and participation of underprivileged groups in the processes [59]. Planners should be concerned about equity in all levels of the plan as Weinstein and Sciara (2006) describes, “equity concerns emerge at different times in different projects, from the very conceptual stages of project planning to well after implementation” (page 181) [60]. However, Stehlin and Tarr (2017) note that although the plan formulation process includes different stakeholder participation, plan implementation often lacks those [61]. Therefore, it is the responsibility of transportation planners to ensure that all stakeholders, especially local residents, are able to effectively participate in the entire planning process and that their voices are heard and incorporated in the FLM plan-preparation and implementation phases. We assess each FLM plan based on public participation in both the plan-making and plan-implementation phases.

### 2.2.2. Strategies Used for FLM

*Socio-spatial gap analysis and stop/station level strategies:* Transportation planning and investment decisions are heavily influenced by spatial, social, and demographic factors [62]. Providing appropriate coverage of the transit service in different areas of a community, especially in low-income communities, is important for addressing the transit access gap issue as well as the equity issue. We assess stop/station level strategies for each of the plans in conjunction with socio-demographics of the riders served, built environment, consideration of geographical gap in service, and other site characteristics.

*Micro-level detail design strategies:* As FLM plans mainly focus on the micro-level transit stop/station connection and accessibility improvement, a detailed design guideline component can greatly assist the plan in visualizing the strategies. This design guideline can also assist the large transit agencies to communicate their ideas at the local level. Additionally, in recent days, design considerations incorporate the aspect of Planning for All Ages and Abilities [50]. We assess each FLM plan based on their inclusion of a micro stop/station level design guideline for meeting the needs of all types of mode users and all segments of the population, especially addressing Americans with Disabilities Act (ADA) compliance.

*Strategies for integration of suburban and rural services:* Focusing on the suburban component by extending the coverage can be attributed to transit agencies’ initiative to recapture suburban commuters as jobs moved to suburban locations [63]. Although adequate transit provision is difficult in suburban areas, it can play a significant role in workers’ job access [64]. In rural and small urban areas, the benefits of transit services may exceed the costs [65]. European countries are also heavily focusing on transit integration in low-density suburban areas to improve transit service access through first and last mile strategies [7,66]. We examine the degree to which FLM plans address the needs of suburban and rural commuters.

*Strategies for integration of multimodality:* Multimodality is beneficial for travelers and transit play a significant role in achieving multimodality [67]. Development of the transfer station is important, as quality and facilities in the transit transfer station can appreciably improve the travel experience of the multimodal passengers [68]. In addition, some transit agencies are currently experimenting with integrated payment-based approaches for seamless transitions within multimodal trips. We assess each of the FLM plans based on the strategies used for achieving multimodality, ease of access, and integrating payment systems across modes.

*Emerging mobility services integration:* The effects of emerging mobility services on transit and how transit can integrate with these emerging services are growing concerns in transit planning [69,70]. New micromobility modes such as dockless and docked e-bike and e-scooters are also becoming important FLM modes [71,72]. Transit riders are already using these new mobility services for the first and last mile connections [73,74]. Nonetheless, in North America, the early implementation of the bike-share systems was more opportunistic than strategic [75–77]. Research finds if planned properly, these new mobility services such

as bike-share and ridehailing can complement transit [30,70,78], increase bicycling [79], and reduce competition in the mobility market [80]. The flexible pattern of the emerging shared mobility service can encourage people to use those modes rather than using cars as FLM mode of travel [72]. We assess the degree to which the FLM plans integrate new mobility services with transit and focus on infrastructure improvement to support these services so that they complement transit rather than substitute it.

*Active transportation infrastructure development strategies:* Studies show that bicycling and transit mostly act as complementary modes [81] and that the design of active transport infrastructure can increase both active transport and transit mode share [82,83]. The Federal Transit Administration's (FTA) 2011 Final Policy Statement on Eligibility of Pedestrian and Bicycle Improvements under Federal Public Transportation Law (76 FR 52046) states that "All pedestrian improvements located within one-half mile and all bicycle improvements located within three miles of a public transportation stop or station shall have a de facto physical and functional relationship to public transportation" [39]. This expanded the scope for the integration of bicycle and pedestrian improvements funds to improve the accessibility to transit. Currently, transit agencies are eligible for funds for bicycle and pedestrian improvement from a long list of programs provided by the FTA [84,85] and from other federal funding sources [86]. Distinct plans for first and last mile access to transit can be a way of utilizing these funds and exploring new funding options to improve the transit system. The development of the active transport infrastructure should be done in conjunction with transit as this practice benefits active travel and transit as well as the health and wellbeing of the community [87]. Thus, selected FLM plans are an assess based selection and distribution of infrastructure projects that enable active transport as an access mode to transit.

*Financing and implementation strategies:* In some places, local transit agencies use different innovative sources of funding beyond the farebox, such as land value capture [88], toll-road revenues, special district tax, etc. However, state and federal subsidies remain the most important source of transit revenue [89]. Financing is the most important component of a transit plan as currently most of the funding for transit is generated from the federal subsidy rather than fares from riders (Table 1). Therefore, each of the FLM plans is assessed based on innovative financing and project implementation strategies.

*Gentrification consideration:* While increasing transit investment in low-income areas can help improve mobility and accessibility, a growing concern is the fear of gentrification associated with transit investments. Recent research suggests that transit infrastructure can be a driver of gentrification [90] by increasing the housing prices near transit stop and displacing low-income households. Gentrification is much less of an issue in European cities and in some Asian cities, where transit service is more ubiquitous, compared to the US where transit service is uneven and relative advantage of access is high [91,92]. This trend in the US has severe equity implications as transit induced gentrification may push the low-income who were the main transit riders from transit high access locations and further reducing ridership [93]. We assess the FLM plans based on their consideration of combating gentrification through affordable housing strategies surrounding transit stop/ stations.

### 2.2.3. The Intended Outcome of the FLM Plan

*Environmental benefits:* Transit, as a potential substitute for driving, is widely acknowledged as a means of reducing transportation carbon emissions [94,95]. The assessment of each FLM plan will examine the estimated environmental benefits as an outcome reported in the plan.

*Transportation equity:* In many cases, transportation project outcomes either exclude or adversely affect disadvantaged communities [96,97]. Studies have found that equity is inadequately addressed in transportation planning [98,99]. Transit service is especially important for disadvantaged populations, and one study found that strengthening first and last mile access has more impact on low wage job accessibility than improving transit

service frequency [3]. We examine each of the FLM plans based on the extent to which the outcome of the plan will meet the transportation needs of disadvantaged populations.

*Success measure indicators for different FLM strategies:* Finally, the inclusion of indicators for specifically measuring the success of the different proposed strategies of the plan with a defined time horizon is a necessary element of each plan. All the selected FLM plans are assessed based on the inclusion of the success measure indicators.

### 3. Review of the FLM Plans

#### 3.1. The Process of Plan Preparation

##### Public Participation

Three of the four selected plan making agencies conducted a public participation process while preparing their FLM plans, though not all proposed public participation in the plan implementation phases. In the case of Denver Transit, the resident of the community and other stakeholders were extensively involved during the plan-making process through pop-up events at different locations and online surveys. Comments were collected through social media, an interactive online map showing transit stations, and a designated page on the Denver RTD website. However, the proposal for public participation in the implementation process is weak in the Denver RTD plan.

In the LA Metro document, public participation in the plan-making process is not explicitly outlined. However, this document provides directions for including stakeholders when developing the connectivity of transit stations at the local level.

In the case of Richmond, the public was involved through focus meetings, workshops, employers focus groups, phone interviews, and pop-up events. Additionally, the plan directed that public input will be required in selecting the tools of the multimodal strategies for the FLM plan. Public involvement is further emphasized at specific project implementation levels in Richmond.

The Riverside Transit Plan also followed an extensive public outreach process to learn from citizens through workshops, community events, meetings, and surveys at transit stations. However, the proposal for public participation at the implementation level is not briefly explained in the Riverside Transit plan.

Thus, most of the selected FLM plans lack a public participation component either at the preparation level or at the implementation level.

#### 3.2. Strategies Used for FLM

##### 3.2.1. Socio-Spatial Gap Analysis and Stop/Station Level Strategies

All the FLM plans offered innovative approaches to address the geographical gap in transit service while simultaneously considering the socio-demographic context of the site in developing strategies at the stop/station level.

The Denver RTD FLM plan classified transit stations based on their urban or rural context (i.e., urban core, urban, suburban mixed, suburban residential, and rural) so that the FLM strategies could be applied based on site-specific context. In addition to the classification typologies, six overlays were developed based on locational characteristics. A detailed planning toolkit was developed based on reviews of best practices and adapted based on the local context. Fifteen transit stops and stations were initially selected to use the toolkit. Each of the planning strategies was evaluated based on the urban-rural typologies and the six overlays.

Similar to Denver RTD, Riverside Transit also developed station typologies based on urban and rural locations. Station rankings were developed for each of the typologies based on transit ridership, land use mix, demographics, geographic, and project development potential criteria. An FLM strategies toolbox was developed based on the review of best practices that will be applied based on the regional, local, and site conditions.

The LA Metro developed a design-based concept named “Pathway” to increase the speed of active travel, to reduce point to point distance, and to support multimodal transfer activity. A detailed network identification, design, and implementation strategies were

developed under this framework to make transit access safe and efficient. Additionally, a series of checklists were developed to evaluate existing site conditions and to define improvement requirements.

The City of Richmond plan is different from the other FLM plans as their transit system is an amalgamation of different transit agencies operating in the San Francisco Bay Area. In addition, the city transit system incorporates the ferry, which is a unique mode of transit in comparison to the other locations. Their plan focuses on infrastructure improvements of the three-transit hubs, namely the Richmond BART Station, the El Cerrito del Norte BART Station, and the Richmond Ferry Terminal. A series of FLM projects were considered and ten priority projects were selected. Strategies for intermodal station improvements were included to ease the transfer experience of passengers.

Overall, the Richmond planning document is the most detailed regarding micro-level site-specific strategies, whereas the other FLM plans use case study sites to illustrate planning strategies. This was possible in Richmond as the planning jurisdiction is small compared to others.

### 3.2.2. Micro-Level Detail Design Strategies

Among the four FLM plans, LA Metro and Riverside Transit provided design guidelines for stop/station level access improvement. The LA Metro followed a unique design-focused approach named “Pathway.” A Pathway toolbox was developed and through illustrative approaches (designs and models) toolbox components are described for selected transit stations. Although not as extensive as LA Metro, Riverside Transit also developed prototype designs for their ideal transit station as a form of mobility hub with necessary interconnected facilities. Whereas aforementioned in Europe, mobility hubs are already prevalent in planning practice as a means of strengthening multi-modality and transit access. Both of these transit agencies considered the ADA compliancy while developing the checklist of site-level conditions. Both Denver RTD and the City of Richmond do not provide much detail about the design guidelines for the transit stop/station development. Nonetheless, Denver RTD considered the ADA requirements while developing stop/station level strategies so that the locations with a nearby population that require ADA accessibility receive higher priority. The City of Richmond Plan conducted a detailed existing condition and needs assessment (including the ADA compliance status of the site).

### 3.2.3. Strategies for the Integration of Suburban and Rural Services

Except for Richmond’s FLM plan (which does not have suburban or rural areas), all the other selected FLM plans have strong suburban elements to significantly reduce personal car dependency in those areas. The Denver RTD and Riverside Transit incorporates strategies for rural stations through integrating a separate rural station typology. The Denver RTD Plan mentions that the implementation of the FLM strategies in suburban and rural typologies will have the highest potential in increasing transit ridership. The Riverside Transit also focuses on suburban integration by incorporating suburban typology in their station typologies. The LA Metro focuses on transit-friendly zones in the form of sub-regional centers that will act as a transit hub for suburban neighborhoods. The LA Metro planning document cites the requirement of the Countywide Sustainability Planning Policy (CSPP) for creating an alternative mode of transportation in suburban communities.

As suburban typologies usually consist of low-density areas where the bike and pedestrian networks are under-developed, these areas would benefit from the recommended bike and pedestrian infrastructure improvement, transit-oriented development, and place-making strategies. Therefore, the integration of suburban and rural components of these FLM plans indicates the agencies’ commitment towards attracting more suburban and rural commuters towards transit in locations where reductions to personal car dependency have been challenging.

### 3.2.4. Strategies for the Integration of Multimodality

Multimodal integration is a key goal and is outlined in detail in each of the FLM plans. The Denver RTD Plan focuses on a project for developing a multimodal wayfinding system and signage system. Additionally, they focused on the safety issue of the transfer passengers in their urban station typology. Richmond's plan highlights "key travel corridors" which refers to priority corridors for implementing multimodal connectivity projects. They also considered an intermodal station improvement strategy for easing the transfer activity. The LA Metro cites the Regional Transport Plan's requirement of considering multimodal planning in all transportation planning projects. The "Pathway" concept heavily focused on different strategies to improve the multimodal transfer experience of the riders. The Riverside Transit Plan similarly focuses on multimodal enhancements in their stations through design with an emphasis on accommodating transfer activity on several urban, suburban, and commercial station typologies. Table 3 summarizes the different multimodal options these FLM plans have considered.

**Table 3.** Different Multi-modal Mobility Initiatives and Incorporation of New Mobility Services.

Multimodal Options	LA Metro	City of Richmond	Riverside Transit	Denver RTD
Autonomous shuttle		✓		✓
Bike Share	✓	✓	✓	✓
Carshare	✓	✓	✓	✓
Carpooling Integration/Incentive	✓		✓	✓
Commuter Tax Benefit				✓
Electric Vehicle Priority	✓		✓	
Free Event Transit Service				✓
Guaranteed ride home	✓		✓	✓
Integrated App	✓	✓	✓	✓
Micro Transit/Shuttle	✓	✓	✓	✓
On-Demand Vehicle	✓	✓		✓
Park and Ride/kiss and ride	✓		✓	✓
Ridehailing Incentive			✓	
Rideshare priority parking			✓	✓
Ridehailing pick and drop off zone	✓	✓	✓	✓
Rolling Lane/Bike Lane	✓	✓	✓	✓
Scooter Share	✓	✓	✓	✓
Signage and Wayfinding	✓	✓	✓	✓
Sidewalk/Pedestrian Priority	✓	✓	✓	✓
Smartphone App for Seamless Mobility	✓		✓	✓
Taxi Incentive/Integration			✓	✓

The LA Metro, the Denver RTD, and the Riverside Transit have considered the integration of new mobility services into their transit apps. Richmond also considered this innovation in their review. The incorporation of diverse multimodal options in the FLM plans indicates that selected transit agencies are continuously seeking to improve the integration of transit services with other modes of transport.

### 3.2.5. Strategies for the Integration of New Mobility Services

New emerging mobility services that can heavily influence how people use transit and complete their FLM connections are focused on all the selected FLM plans. The Denver RTD developed a “Mobility Working Group” constituting of mobility practitioners from different agencies across the Denver region to consider the impact of technology on the future of transportation and the FLM plan’s solutions. The City of Richmond also focuses on emerging shared mobility services that can contribute to FLM solutions. The LA Metro emphasizes how car-share, bike-share, and bike stations can be integrated into the “Pathway” design guidelines to improve station access. The Riverside Transit also incorporates bike-share in their prototype design of transit stations and mobility hubs. Overall, these initiatives highlight the forward-thinking attitude of these selected transit agencies by utilizing the potential benefits of emerging transportation options and easing their negative effects on transit.

### 3.2.6. Active Transport Infrastructure Development Strategies

All the planning documents focus on substantial investment in active transportation infrastructure as this is the most common mode people use to connect to transit. The Denver RTD focuses on developing bicycle and micro-mobility parking and storage in transit stations, providing bicycle amenities, private micromobility parking, improving pedestrian infrastructure, improving bicycle and micromobility infrastructure, and pedestrian scale lighting.

The City of Richmond also focuses on developing new infrastructure to make bicycle and pedestrian connections to mobility hubs, improving crossings, creating new sidewalks, bike racks, and pedestrian islands.

The LA Metro focuses on the Pedestrian Environment Quality Index and the Bicycle Environment Quality Index to assess the quality of infrastructure along access routes to the transit stations. The “Pathway” details design guidelines on how to construct new infrastructure for active transportation improvement.

The Riverside Transit developed a checklist of pedestrian infrastructure and bicycle deficiencies for their initial assessment of transit stations. Based on the results of their initial assessment, the recommendation for infrastructure improvement is provided. One key aspect is that Riverside Transit provides general and specific cost estimates of pedestrian and bike infrastructure for selected stations. This approach will be helpful in better planning for these infrastructures and can be followed by agencies who want to make FLM plans in the future.

One important aspect associated with transit trips is transfer activity, as 64% of the LA Metro’s one-way trips consist of at least one transfer [40]. This transfer activity is often largely dependent on the active transport network connected with the transit station and all the selected plans consider this issue while developing strategies for transit stations.

Overall, these investments in active transportation infrastructure will create a win-win situation for transit agencies by increasing both the mode share of transit and active transportation.

### 3.2.7. Financing and Project Implementation Strategies

All the FLM plans emphasize the financial component for plan implementation. The funding options proposed by the Denver RTD includes future FTA innovative mobility grants, local funds, Business Improvement District fund, funds from property owners, mobility service providers, FTA public transportation innovation grants, Congestion Mitigation and Air Quality Improvement grants, and fees from micromobility providers. The Riverside Transit describes three approaches for ensuring project funding, namely Developers Condition of Approval (COA), Transportation Uniform Mitigation Fees, and Public-Private Partnership. Additionally, the Riverside Transit FLM plan mentions the identification of the Capital Improvement Project (CIP) that can be incorporated with the recommended FLM projects. The LA Metro lists a range of funding options from other plans and strategies such as the Sustainable Community Strategy (SCS), Metro Long Range

Transportation Plan, Bicycle Transportation Strategic Plan, and Short-Range Transportation Plan. Not limited to these funds, the LA Metro FLM plan also lists private initiatives that can contribute to the FLM strategy. Richmond's Plan is specific in terms of funding sources which includes federal funding through their MPO, Bay Area Air Quality Management District Fund, Grant Programs, Caltrans Active Transport Program, and fees on private e-scooter companies.

Thus, for implementing FLM projects, these agencies explored and recommends a variety of innovative sources of funding for improving transit.

All the FLM plans strongly focuses on implementation strategies. The Denver RTD and Riverside Transit list different organizations responsible for the implementation of the FLM strategies. The Richmond Plan provides detailed implementation strategies for each project. The LA Metro provides a detailed list of agencies and also a timeframe for implementation.

### 3.2.8. Gentrification Consideration

Measuring the gentrification aspect of the transit development is rather difficult but important to understand the service reach to the disadvantaged groups. All the plans, to a different extent, have focused on affordable housing strategies surrounding transit stop/station to address this issue. The LA Metro Plan is most extensive in considering the affordable housing issue with respect to Transit-Oriented Development (TOD) as their FLM plan has to comply with the goals set by other regional-level plans. Other plans also address the strategy of affordable housing development surrounding the transit stop/station so that the low-income population can reap the benefits of transit service improvement. The affordable housing strategies around transit development will likely minimize the effect of gentrification and give transit access to the low-income transit-dependent people and will increase ridership.

## 3.3. The Intended Outcome of the FLM Plan

### 3.3.1. Environmental Benefits

Three of the plans from the State of California cite their compliance with the State's regulations. The FLM plan of LA Metro reports that it will assist in achieving the emission reduction goal of the region (i.e., reducing greenhouse gases by 9% by 2020 and by 16% by 2035). City of Richmond and Riverside Transit FLM plan also indicates that the FLM plan will be the supporting document for achieving that goal (AB32: an 80% reduction below the 1990 level by 2050) [100]. On the other hand, the Denver RTD plan does not mention or quantify any environmental or greenhouse gas emissions reduction goals they want to achieve through their FLM plan. The City of Denver has a climate action plan which aims for an 80% reduction of greenhouse gas emission by 2050 [101]. Still, it is quite interesting that the Denver RTD plan does not mention any of these requirements in its main FLM plan document.

Three of the four selected FLM plans' devotion towards achieving regional emission goals indicate mainstreaming of regional climate action goals through transit plans and the transit agencies' commitments towards achieving those emission reduction goals.

### 3.3.2. Transportation Equity Outcome

Transportation equity, a necessary component of any transit plan, is both directly and indirectly mentioned in all four FLM plans outcomes. In a broader sense, the entire idea of making the FLM plan is attached to achieving transportation equity as these plans aim to integrate different means of travel options to transit and to improve accessibility for under-served populations. Thus, analysis of equity of the FLM plans considers different aspects, namely the design of projects specifically for the low-income population, distribution of infrastructure investment, access to jobs by transit, and consideration of the affordable mode for the first and last mile trip.

The Denver RTD explicitly mentions a targeted program of special discount cards and low-income passes. This is already a proven approach as several agencies have seen positive effects of providing subsidized passes on transit ridership [102]. The Denver RTD also mentions a commuter tax benefit program in their FLM plan.

The City of Richmond explicitly mentions affordable options for low-income residents and specifically oriented their project strategies to serve the needs of the low-income population. They also consider equity and access issues in the deployment of autonomous shuttles and in providing e-scooter permits that will provide mobility options for people who do not bike, do not own bikes, or cannot afford a private vehicle. In the case of infrastructure development, Richmond notes that active transport infrastructures should directly serve the community of concern by referring to previous socially inequitable infrastructure investment practices in the region.

The LA Metro explicitly mentions that achieving equity is one of the targets of the “Pathway” program, as 75% of the transit riders of LA Metro has income less than 25,000 US dollars [40]. Their focus is on creating mobility solutions for peoples who cannot afford, operate, or want to forgo private vehicles. In addition, the LA Metro’s FLM strategies focus on providing more job access by transit to balance the job housing ratio in the region.

Riverside Transit also heavily focuses on different aspects of equity. Through the mobility hubs, Riverside Transit wants to increase transportation options for disadvantaged communities. The Riverside Transit’s industrial and business park station typologies aim to provide jobs in close proximity to the transit station.

The numerous equity considerations by the FLM plans indicate that in the process of making transit more efficient and reaching a different segment of the population, the agencies are not neglecting the fact that transit also aims to provide mobility options for disadvantaged populations.

### 3.3.3. Success Measure Indicators for Different FLM Strategies

Except for the LA Metro Plan, none of the plans provide any metric for measuring planning outcomes of different types of strategies proposed in the plan. Although three plans list emission reduction and transportation equity as the outcome, only the LA Metro also specifically describes quantifies different expected outcomes from proposed strategies and the time horizon associated with those outcomes. The ridership target of the LA Metro includes attaining an 8% increase in rail and bus rapid transit (BRT) ridership within 3 to 5 years and attaining a 12% increase in rail and BRT ridership within 20 years. Of the FLM plans, only the LA Metro Plan includes performance measure tools. The LA Metro developed a Light Rail Transit FLM strategic model to measure the impact of changes in nonmotorized access to the stations. In addition, “Ridership+” is a tool that the LA Metro can use to forecast the change in ridership due to the implementation of first and last mile strategies. Two analysis frameworks were developed focusing on changes in ridership due to the change in non-motorized access to stations and change in motorized access to the station. A combination of these tools can provide an assessment of the impact of the FLM strategies on achieving the goals of the plan.

## 4. Discussion

These FLM plans consider the fact that transit is a part of a much larger ecosystem of modes and focuses on building a mobility ecosystem around transit. All the plans were aligned with the attainment of broad societal objectives such as auto reduction and transportation equity. In addition, FLM plans also focus on the branding of the transit as a system by providing appropriate value propositions through the proposed FLM strategies so that transit can attract a larger ridership base and compete with other modes. As research found that riders are not abandoning transit, rather using it less [103], this access improvement and new value proposition through FLM plans can potentially attract customers to use the service more frequently.

Although the four FLM plans are from different socio-economic and transit agency context, we find five common approaches related to how these plans address the different FLM issues, namely spatial gap analysis with a focus on socio-demographics and locational characteristics, incorporation of emerging mobility services, innovative funding approaches for plan implementation, equity and transportation remedies for marginalized communities, and emphasis on pedestrian and bicycle infrastructures surrounding transit stops. Additionally, most of them linked the FLM plan strategies with their regional level transportation goals.

Some similarities can be between plans as Riverside Transit developed a detailed checklist for assessing the conditions of transit stations similar to LA Metro and developed station typologies similar to the Denver RTD. All the FLM plans except the Denver RTD have a close connection with the region's emission reduction goals. Except for the LA Metro plan, others heavily researched the best practices of different agencies and organizations while formulating their strategies. This is an important takeaway for transit agencies who want to prepare FLM plans in the future.

Different approaches are noticeable from different types of agencies for developing the FLM plan. LA Metro, a large transit agency, has placed more resources to produce documents with details in designs for transit station access improvement. The "Pathway" concept was a unique approach to address the design and connectivity of first and last mile solutions. Denver RTD, also a large transit entity, has assigned more focus on developing strategy toolkits for guiding the development of stations rather than design. FLM plan from the City of Richmond is different from the other plans in many aspects as it was a city-level plan which emphasized an exact specific number of projects to address the FLM issues.

Although only LA Metro and Riverside Transit focused on the micro-level detailed design, it can be an important element of any FLM plan due to the recent COVID pandemic situation. The detailed stop/station level design should address how transit agencies can handle the overcrowding issue for ensuring safety, especially on the major transfer stations where many vehicles arrive at the same time [104]. Thus, future FLM plans by other transit agencies should include a separate section of strategies addressing micro station level detail design guidelines for crowd management to ensure safety and gain the confidence of the customers.

An important aspect of FLM plans within the US context is the focus on access and innovative funding mechanism. As transit agencies experience deeper funding cuts, expanding the sources of funding can help agencies become more self-reliant in their service delivery. Transit stop/station access improvement strategies will help agencies expand access without too much focus on increasing routes. This will lead to more effective utilization of transit funds with improved access and service delivery. Additionally, increased access and service quality improvement through different FLM strategies will likely increase ridership and thus, the fare box ratio.

Although public involvement in the planning process was visible in most of the plans, the proposal for incorporation of the public in the plan implementation process is still a concern, except for the City of Richmond. This element of the FLM plan has room for further improvement. Transit agencies who want to prepare FLM plans in the future can consider this issue while preparing their plan. Additionally, transit planners should keep in mind that infrastructure components of FLM plans need to maintain distributional equity to better serve communities of concern. This can be achieved through the consideration of procedural equity by involving different segments of local communities in the plan-making, strategy development, and implementation processes.

The lack of strategy specific success measurement indicators in all the plans other than LA Metro is a glaring omission that should be considered by other transit agencies while preparing their plans. Although the transit agencies will measure the ridership periodically, more analytical tools should be developed for a quantitative assessment of each of the different strategies which include the changes that can be achieved and the risk associated

with those assessments. Additionally, measuring rider's satisfaction is a major concern and future FLM plans can include an option for detail before and after rider satisfaction surveys. These elements should be an important part of any FLM plan as measurement based on only overall ridership (as ridership can increase for several other reasons) will likely mislead transit agencies regarding their plan outcomes.

Table 4 provides an overall rating (based on two “+” systems) of the four plans on the selected analysis criteria, where “++” indicates a better condition than “+.”

**Table 4.** The Rating of Each Plan on Selected Criteria.

Criteria	LA Metro	City of Richmond	Riverside Transit	Denver RTD
<i>The Process of Plan Preparation</i>				
Public Participation	(+)	(++)	(+)	(+)
<i>Strategies Used for FLM</i>				
Socio-spatial Gap Analysis and Stop/station Level Strategies	(++)	(++)	(++)	(++)
Micro-Level Detail Design Strategies	(++)	(+)	(++)	(+)
Suburban and Rural Integration Strategies	(++)	NA	(++)	(++)
Multimodality/Integrated App-based Strategies	(++)	(+)	(++)	(++)
New Mobility Integration Strategies	(++)	(++)	(++)	(++)
Investment in Active Transportation Strategy	(++)	(++)	(++)	(++)
Financing and Implementation Strategies	(++)	(++)	(++)	(++)
Gentrification Consideration	(++)	(+)	(+)	(+)
<i>The Intended Outcome of the FLM Plan</i>				
Transportation Equity	(++)	(++)	(++)	(++)
Environmental Benefits	(++)	(++)	(++)	()
Success Measure Indicators for Different FLM Strategies	(++)	()	()	()

## 5. Conclusions

The four FLM plans reviewed in this article come from diverse geographic and socio-economic contexts. We reviewed the selected plans based on the planning process used to produce the plan, the different strategies of the plan, and the outcomes of these plans. The review of our selected transit agencies FLM plans show they are increasingly focusing on how to make the transit more accessible, more multimodal, and overall, viable transportation alternative to address the mobility needs of the community. The review of their planning documents revealed some common approaches among agencies for addressing the FLM connection problems. Some of the innovative strategies in these plans such as the creation of mobility hubs, integration of new mobilities, micro transit, etc. are already being implemented in different European cities for transit access improvement. How these strategies assist in improving transit ridership in the US context in comparison to the European context can be an interesting future research topic. Nonetheless, there are some key issues important to transit planning such as public participation, micro-level design approach, and strategy-specific success measure indicators that are either weak or missing from some of these plans. Several findings of this study can be helpful for other transit agencies in preparing their FLM plans for their communities.

Overall, all these plans have initiated a new thinking process for transit where agencies start thinking from the micro-scale of stops and begin generating proposals of how these stops can be used as a starting point of multimodal access. One of the major benefits of such

a plan is to bring all the projects and funding ideas related to the first and last mile access in one platform. These plans bring together all the strategies that can boost the transit ridership, as single standalone FLM strategies are unlikely to have a significant impact on increasing ridership. These FLM plans diversified from solely relying on transit-dedicated funding sources to other sources of funding that could also be tapped to improve transit. This theme of these FLM plans can inspire other transit agencies to prepare FLM plans for their communities.

With the outbreak of COVID-19, adding to the challenges that transit agencies are facing, FLM planning provides a critical opportunity for transit agencies to recapture the attention of their ridership base and promote the various FLM options that may be attractive to users in the post-COVID-19 era. With this new challenge in mind, the outcomes of this study, especially the public participation portion, becomes more relevant as it can guide transit agencies to prepare FLM plans to address the current needs of the communities they are serving.

If properly implemented, this new approach of thinking can also lead to a groundbreaking change in system performance and an increase in ridership. Rather than focusing on the traditional approach of addressing transit ridership by introducing newer technologies, increasing fleets, and increasing service frequency, this new planning process focusing on the micro-level connectivity of the system and providing spaces for current and emerging transportation options could lead to a new period of transit in the US. The outcomes of these plans can increase the mode share of active transport in these communities and can help achieve any emission reduction goals of the community. As these plans are still relatively new, and it will take time to measure the impact on ridership and overall transit experience. When the data on the outcomes of these plans become available, future research can investigate more detail on the impact of these plans on their communities.

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