Policy Memo

Accessibility measures for regional transportation planning

May 2 - June 11

To: Scott Haggerty, chair of governing Commission of Bay Area Metropolitan Transportation Commission

From: Shen Qu, Policy Advisor

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RE: Define and measure accessibility in Plan Bay are 2050

Summary

Clarifying accessibility definition and measures is necessary in Plan Bay Area 2050. Accessibility, the ease of reaching destinations, is a key land use and transportation performance measure(Boisjoly and El-Geneidy 2017b)

accessibility need to be have clearly defined in plans

including clear accessibility indicators in planning documents is key to promoting the use of metrics in policy and practice, as it was stated as a main reason motivating the generation of accessibility metrics.

Furthermore, multi-criteria analysis approaches including accessibility indicators need to guide the decision-making process. (Boisjoly and El-Geneidy 2017a)

ultimatey, informing decision-making and influencing land use and transportation planning

Accessibility-oriented RTPs:

- explicitly define accessibility,
- set goals and objectives in terms of accessibility (not just congestion reduction), and
- use accessibility measures to define regional transportation priorities, including the evaluation of individual projects in the MPO service area.

Background

- Plan Bay Area 2050: they are going to update their regional transportation plan, along with their processes for selecting projects for funding, at all scales.

Plan Bay Area 2050 is a state-mandated, integrated long-range transportation and land use plan developed and adopt by MTC and ABAG. Work on Plan Bay Area 2050 is expected to begin in August 2019 and focused update that builds upon the growth pattern and strategies developed in the original Plan Bay Area 2040 (adopted in July 2017) but with updated planning assumptions that incorporate key economic, demographic and financial trends from the last four years.

The Bay Area can meet its transportation needs through 2050 while preserving the character of its diverse communities and adapting to future population growth. The Bay Area can make progress toward the region's long-range transportation and land use goals. Plan Bay Area 2050 does set a roadmap for future transportation investments and will identify what it would take to accommodate expected growth.

The most common accessibility-based objective is to increase access to jobs, both as a way to foster economic development and to reduce social inequities. For example, Transport for London identified two access to jobs indicators, one to support economic development (through improved employment accessibility) and one to improve social inclusion (through increased access to employment for deprived areas). With respect to social inclusion or social equity, a broader range of destinations is generally included (libraries, health care facilities, greeneries, supermarkets, etc.)

Overall most plans including accessibility objectives focus on economic development and social inclusion, mostly through access to jobs. Access to the transportation system (see Houston-Galveston Area Table 1) or to mobility (see Ile-de-France Table 1) are also often stated as goals or objectives. However, these goals do not directly address access to destinations.

In many plans, however, accessibility or access is used in a way that does not reflect the ease of reaching various destinations and does not translate into accessibility indicators.

the term accessibility (or access) is often not defined, and is used as a vague term that does not translate into clear accessibility objectives.

Accessibility is rather used as a buzzword, together with mobility, and does not refer to a distinct concept.

Even when specific accessibility objectives are stated in the plans, they are often translated into indicators that do not reflect accessibility.

Bay Area (San Francisco)

Objective of Equitable access: Decrease by 10 percentage points (to 56 percent from 66 percent) the share of low-income and lower-middle income residents' household income consumed by transportation and housing

Objective of Access to Jobs: Average travel time in minutes for commute trips.

Although travel time is a component of accessibility, it does not fully reflect access to destinations. It is an indicator of mobility and does not capture the potential of interaction for opportunities, as defined by Hansen (1959). Having shorter travel times does not necessarily equate to having access to a larger number of destinations. Furthermore, as discussed by

Litman (2013), strategies aiming at increasing traffic speed may in some cases lead to an overall reduction in accessibility. In sum, increased mobility does not always result in increased accessibility (Halden, 2011, Levine et al., 2012).

While the concept of accessibility in formal measurement has been around for more than fifty years, and has been a common element in the goals and objectives of transport plans, its actual adoption in transport planning has been limited until recently. Hansen (1959)

The lack of clarity on accessibility leaves vehicle speed as the fundamental criterion for success in previous plans. (**???**{proffitt2019accessibility)

'traditional transport planning, which tends to focus on improvements to the transport system that facilitate mobility, without considering the access needs that drive travel behaviour' (Chapman and Weir, 2008: 7).

travel is a derived demand *(Goldman and Gorham, 2006; Grengs et al., 2010; Halden, 2002; Handy and Niemeier, 1997; Levine et al., 2012).* people travel to places where they can meet their daily needs, not simply to move about. the purpose of most travel is about the destination, not the journey.

in those plans accessibility is often not clearly defined and thus often used as a buzzword.

given the broad and flexible guidelines, accessibility is often "misused" and "abused in practice" (Halden, 2011)

Definition:

- Explains and defines accessibility, including why it should be used in transportation decision making

accessibility can be understood as the ease of reaching services and activities (Litman, 2013).

The most recent federal transportation bills – the Fixing America's Surface Transportation Act (FAST Act) lay out guidelines for how MPOs must develop regional transportation plans. The guidelines require every plan to address eight planning factors, including 'accessibility and mobility of people and freight'. None of the guidelines define accessibility explicitly, and all use it exclusively in the phrase 'accessibility and mobility'. The result is that the terms accessibility and mobility often are conflated in practice, with both terms describing attributes of mobility. Explicitly defining accessibility as the end goal of the transportation network would clarify the concept for all MPOs and local governments.

the US federal government defines eight planning factors that guide the development of the Transportation Plans by the MPOs, one of which is to "increase the accessibility and mobility of people and for freight" (U.S. Department of Transportation, 2014). As accessibility is not clearly defined, access to destinations is often not reflected in the plans. Accessibility goals should hence be clearly defined to encourage the establishment of accessibility-based performance indicators.

Accessibility, defined as the ease of reaching destinations *(Preston and Rajé, 2007)*, is one of the most comprehensive performance measures of land use and transportation systems *(El-Geneidy and Levinson, 2006)*. As such, accessibility reflects the multiple benefits provided by land use and transportation systems *(Ben-Akiva and Lerman, 1979)*. For example, greater accessibility is associated with higher land values *(Koenig, 1980, El-Geneidy and Levinson, 2006, Du and Mulley, 2012)* and employment rates *(Ornati et al., 1969, Pignatar and Falcocch, 1969, Sanchez, 1999, Blumenberg and Ong, 2001, Sari, 2015, Tyndall, 2015)*, as it provides residents with greater access to a variety of opportunities. In the same way, increased accessibility contributes to reducing the risks of social exclusion for vulnerable individuals *(Preston and Rajé, 2007, Lucas, 2012)*. Furthermore, accessibility by transit is associated with greater transit use *(Chen et al., 2008, Owen and Levinson, 2015b)*, and can thus help in reducing car use and the resulting greenhouse gas emissions *(Levinson, 1998, Handy, 2002)*.

"Access is the fundamental force for understanding cities,"... " is a concept that helps understand and conceptualize the complex relationship between transport and land use in a city and their impacts on city organization, development, and planning to achieve more sustainable outcomes."(Levinson and Krizek 2018, 22)

Accessibility is increasingly seen as an alternative to mobility oriented planning paradigm (Geurs et al., 2012), as it allows capturing the complex interactions between land use and transportation systems (Hansen, 1959) and provides a social perspective on transportation planning (Banister, 2008, Lucas, 2012). While mobility merely reflects the ease of moving, accessibility addresses the ease of reaching desired destinations, which is in fact the reason why people undertake trips (Preston and Rajé, 2007). Accessibility is one of the most comprehensive measures to assess the complex performance of land use and transportation systems in a region.(Boisjoly and El-Geneidy 2017a)

- Importance

The accessibility paradigm frames accessibility as the end goal of a transportation system.

Accessibility is instrumental in explaining the spatial form of metropolitan areas. Past writings have claimed accessibility is "perhaps the most important concept in defining and explaining regional form and function."8 Consistent with the standard model of urban economics, it has been observed that living in an area with relatively high accessibility to jobs is associated with shorter trips, as is working in an area of relatively high housing accessibility.9

(Levinson and Krizek 2018, 111) factors that affect land use and rate of development associated with different types of accessibility: e.g. access to suppliers, workforce, customers, desirable environment (aesthetically pleasing surroundings, clean air and water),amenities (access to recreational and other non-work destinations), friendly government, etc.

(Handy 2018) the level of accessibility from a given place reflects the distribution of destinations around it, the ease with which those destinations can be reached by various modes, and the amount and character of activity found there. It tells us something about the choices that the built environment offers to travelers. What matters to people is how easy it is for them to get to where they need to be, and how easy it is to access the services they need or want. Using accessibility as the performance measure by which we assess current conditions and

proposed policies It's a goal that almost everyone can agree on, and it opens doors to a host of strategies that could reduce auto dependence and improve quality of life.

- Accessibility versus Mobility

a clear distinction should be made between access to mobility, access to destinations (Levine et al., 2012) and universal accessibility.

Mobility is concerned with how difficult it is to travel. accessibility how easier it is to reach destinations.

In contrast, the concept of mobility is concerned only with how easy it is to get from one place to another. Mobility is only part of the picture.

accessibility focuses on reaching destinations, the end goal of a transportation network, while mobility focuses on a single means of achieving this goal, travel speeds. Improvements in mobility alone are not sufficient to ensure improvements in accessibility. (**???**{proffitt2019accessibility)

Accessibility does not depend on good mobility.Some places such as San Francisco downtown have good accessibility despite having poor mobility (severe traffic congestion). The Residents live within a short distance of all needed and desired destinations. the travel times between destinations are relatively short, even if travel speeds are low.

A place can also have good mobility but poor accessibility. Think of Manitoba in Canada. Some rural area has ample roads, low levels of congestion, and high speeds of travel, but relatively few destinations for shopping. Thus, good mobility is neither a sufficient nor a necessary condition for good accessibility.

Planning for mobility has taken on the meaning of making it easier to get around. This focus on the ease of traveling along the transport network itself (rather than focusing on the ease of reaching destinations) has aligned well with modern planning paradigms;

road building has been the most popular solution to congestion. These paradigms prize the planning-for-mobility perspective because it accommodates growing levels of travel and increases the potential for movement.

In the suburban areas of Bay Area, transit service is relatively sparse and destinations are generally beyond walking distance, leaving residents with no option but to drive. the practice of planning is largely mobility-dependent, and car-dependent and has deteriorated levels of accessibility. As traffic levels invariably increase in these areas, accessibility ultimately declines for all modes.

Planning for accessibility, in contrast, means making it easier for people to get where they want to go. Land use policies designed to bring destinations within walking distance of residential areas are one example of this paradigm. But planning for access may not even require retrofitting neighborhoods. For example, transit services that link specific groups of users to their desired destinations, such as reverse commute programs and other client-based transport services, are examples of planning for accessibility. Efforts like these reduce the need to drive, although they don't necessarily reduce actual driving.25

(???{proffitt2019accessibility)

conventional practice in transportation planning has employed a 'predict and provide' model that focuses the majority of funding and planning attention on expanding roadway capacity. (Levinson and Krizek 2018, 22)

performance metrics that focus on roadway congestion as experienced by automobile drivers *(Ewing, 1993; Handy, 2005; Krizek and Levinson, 2010)*, with higher vehicle speeds the 'fundamental criterion for success' *(Levine et al., 2012: 158)*. Speed-based metrics include roadway level of service (LOS), peak-period delay, traffic volume/road capacity, travel time/speed, vehicle hours of travel, the duration of peak-period congestion, and others *(Ewing, 1996; Transportation Research Board, 2010)*. Even high-occupancy toll lanes, the most common demand-management strategy used in the USA, are typically added as new capacity, only rarely replacing existing highway travel lanes *(Ewing and Proffitt, 2016)*. Planning for higher travel speeds that facilitate longer and often more frequent trips is the mobility paradigm.

Accessibility is focused on making it easier for individuals to reach destinations where they can meet daily needs such as work, recreation, socialising, shopping, and other forms of social exchange *(Martens, 2015; Miller, 2005)*.

improving mobility – via automobile, transit, or any other travel mode – means facilitating faster travel speeds so individuals can reach more destinations in a given travel time, improving proximity means shortening distances between trip origins and destinations so individuals can reach a satisfactory number of exchange opportunities even if they travel more slowly. In other words, neighbourhoods, cities, and metro areas can be made more accessible by reducing travel distances as well as by facilitating faster travel. The advantage of planning for accessibility versus planning solely for (auto)mobility is that the former allows for a comparison of the tradeoffs among financial, environmental and human health and wellbeing concerns when making decisions about land use and transportation.

it facilitates the evaluation of tradeoffs between land use, transportation and social needs. By combining aspects of land use and transportation into a single measure, accessibility focuses attention on the performance of the system as a whole rather than on just segments of the transportation network.

the clear distinction between mobility and accessibility indicators. In the Baltimore plan, the multi-criteria analysis includes the following goals: safety, accessibility, mobility, environmental conservation, security and economic prosperity. Interestingly, accessibility and mobility are included as two distinct goals with different criteria and methodologies,

Evaluates the accessibility measures

- You evaluation should use clear criteria and draw on existing sources.

Lyons and Davidson (2016) argue for a focus upon the *Triple Access System* of spatial proximity in land use system, physical mobility in the transport system and digital connectivity in

the telecommunications system as a framework for policy and investment decisions that can harness flexibility and resilience.

Levinson and Krizek (2018) introduce four measure methods for accessibility to employment[1], overall accessibility[2], and gravity model[3]. Network size indicates an attribute of the built environment. cumulative opportunities measures Accessibility can describe the "interaction by a function of the travel cost, such that distant interactions have less weight than nearby interactions." gravity models also consider distance or travel time and disclose that the interaction between places is inversely proportional to travel cost.

- activity component, the land use system, goes by the presence of destinations, such as jobs, restaurants, daycares, health care facilities, and households.

Firstly, access to destinations is largely influenced by the distribution of residential, economic, cultural and social activities (the land use component).

location-based metrics are most commonly used in planning as they provide a comprehensive measure of regional accessibility (Boisjoly and El-Geneidy, 2017). These metrics indicate the ease of accessing destinations from a specific location and accounts for the spatial distribution of opportunities (for example, jobs or healthcare services) and the ability to move from one place to another (Geurs and van Wee, 2004).

accessibility is largely contingent on the spatial distribution of destinations, the land use component,

The land use component is related to the spatial distribution of opportunities. Urban

[1] $A_j = \sum_j E_j f(C_i j)$ where: A_i represents accessibility to employment from zone i. E_j is employment at destination j. $f(C_{ij})$ is a function of the travel cost (time and money) between i and j. The higher the cost, the less the weight given to the employment location.

[2] an overall accessibility measure is a summation of the measures of all origins: $A = \sum_j W_i A_i$ where A is overall accessibility for region, W_i represents workers living at origin i

[3] Isaac Newton (1687) first found the relationship between the gravitational force, distance, and mass. Ernest Ravenstein (1876-1889) developed a similar idea in the context of the social sciences. William J. Reilly developed a "Law of Retail Gravitation" (1931) John Q. Stewart developed the notion of demographic force (F) between places, and this demographic force equation forms the basis of the gravity model used in many transport planning models. Alan Voorhees (1956) first applied the gravity model to address problems of urban transport planning.

$$T_{ij} = K_i K_j \frac{T_i T_j}{f(C_{ij})}$$

$T_i = \sum_j T_{ij},\ T_j = \sum_i T_{ij},\ K_i = \frac{1}{\sum_j K_j T_j f(C_{ij})},\ K_j = \frac{1}{\sum_i K_i T_i f(C_{ij})}$ where: T_{ij}: trips between origin i and destination j T_i: trips originating at i (for example, workers) T_j: trips destined for j (for example, jobs) f: distance decay factor, as in the accessibility model C_{ij}: generalized travel cost between i and j K_i, K_j: balancing factors solved iteratively This gravity model suggests several things. First, as city size increases, mean commuting time increases. The structure of gravity models implies diminishing marginal returns to job opportunities at the edge, since each additional job is less and less likely to be taken and thus less likely to increase travel time. Second, these models are largely independent of density—except to the extent that density changes network speed. A uniform increase in density increases the opportunities within each time band proportionately, and thus does not change the distribution of travel times. Third, if preferences shift, mean travel time will change inward or outward. Fourth, if congestion rises, more opportunities will be farther away in terms of travel time, and fewer nearby—implying that average commuting time will rise.

opportunities can include, but are not limited to, jobs, health services and retail stores.

- the transport component. This is some measure of how easy or difficult it is to move along the network.

Accessibility further depends on the transportation network which determines the travel time, costs and convenience from a place (for example, home) to another (for example, work) (the transport component).

The transport component, the ability to move from one place to the other, is generally mode specific and based on travel time or distance (Hansen, 1959, Vickerman, 1974, Handy, 1994, Geurs and van Wee, 2004, Owen and Levinson, 2015a).

and the ability to move from one place to another, the transport component (Geurs and van Wee, 2004).

The transport component refers to the transport infrastructure specific to each mode.

- utility measures (which quantify the benefit individuals get from destinations), A second type of measures is the utility-based measures, which capture the economic benefits provided by changes in the network. Utility-based measures account for most components of accessibility and can be included in traditional cost-benefit analysis (van Wee, 2016).

Access measures: location level (place-based). the availability of opportunities close by

Location-based accessibility is most commonly used by policy-makers as it provides a comprehensive measure of the land use and transport system at the regional level (Dodson et al., 2007). Location-based metrics typically accounts for the number of opportunities that can be reached from a specific location, based on the travel costs to destinations using a specific mode (Handy and Niemeier, 1997).

Travel costs are generally measured based on travel time or distance

Two location-based measures are commonly used in accessibility research.

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* cumulative opportunity indices (counting exchange opportunities within a defined geogr
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A common location-based metric is a measure of cumulative-opportunities, which counts all opportunities that can be reached within a travel costs threshold. For example, the number of jobs that are within 45 min of travel times by transit from a specific place is used to assess the access to jobs by public transit.

only counts the opportunities that are within a specific travel costs threshold.

cumulative-opportunity measures are easy to generate and interpret. Furthermore, these measures are highly correlated with gravity-based measures (El-Geneidy and Levinson, 2006),

and hence represent an adequate measure of regional accessibility (Boisjoly and El-Geneidy, 2016).

cumulative-opportunity metrics provide indicators that typically reflect the ease of reaching destinations and is thus encouraged. More specifically, the use of cumulative-opportunities measure of accessibility to jobs by public transport and car is suggested. These measures provide adequate indicators of the regional patterns of accessibility, and are easy to generate, to interpret, and to communicate (Boisjoly and El-Geneidy, 2016, Geurs and van Wee, 2004).

Accessibility metrics are typically location-based and focus on the transport and land use components of accessibility. In all cases, measures are based on cumulative opportunities, using a travel time or distance threshold, mainly for public transport and driving (Fig. 1, right). Cumulative-opportunity measures are easy to communicate and interpret, and thus better suited for planning documents (Geurs and van Wee, 2004).

access to destinations, and access to or from public transport station. Access to public transport is the most common measure used in the plans. This measure is generally presented as the percentage of people or jobs that are within 0.5 mile of a public transport station. it does not directly addresses the ease of reaching urban opportunities.

The second type of metrics (access to urban opportunities) directly measures the ease of reaching various destinations, generally jobs, using a specific mode. This measure is however more complex to generate, as the locations of the destinations is needed.

In terms of modes and thresholds (Fig. 1), accessibility to jobs is generally generated for transit or automobile, using travel time thresholds varying from 30 minutes to 60 minutes.

Access measures: the ease and worth of travel to destinations far away

`* gravity-type models (pitting the importance of given exchange opportunities against tr`

Another common metric is the gravity-based measure, which discounts opportunities based on a distance-decay function. Accordingly, opportunities that are located farther (by distance or time) receive less weight than closer opportunities. While this measure is more reflective of travel behavior, cumulative-opportunities are simpler to generate, interpret and communicate.

discounts all opportunities based on their travel costs.

Gravity-based measures better reflect travel behavior as it accounts for the travelers' perceptions of time (Ben-Akiva and Lerman, 1979). This measure is, however, more complex to generate, as a distance-decay function must be calculated, and more difficult to interpret and communicate, as it is not directly expressed in terms of the number of opportunities (Geurs and van Wee, 2004; A. Owen and Levinson, 2014).

Overall, the cumulative-opportunities accessibility metrics are generated for access to transport, and to a lesser extent, for access to destinations, mainly jobs. Ideally, plans would

integrate both types of metrics. Access to transport provides a good indication of transport coverage, whereas access to destinations captures the performance of the land use and transportation systems, which better reflect the social and economic benefits (Banister, 2008, Koenig, 1980, Wachs and Kumagai, 1973).

Options

- Defines different options for measuring accessibility for use in the regional transportation plan, as well as at the project level (e.g. new roadway capacity, transit infrastructure, bike/pedestrian infrastructure, demand and system management projects, etc.).
- the individual level (person-based). Person-based measures of accessibility are generated at the individual level, and are concerned with the level of accessibility experienced by a specific person (Geurs and van Wee, 2004, Miller, 2005, Owen and Levinson, 2015b).

In addition to the exogenous factors, individual characteristics such as income, level of education, gender and vehicle ownership affect one's abilities and needs to access destinations (the individual component).

whereas personal characteristics such as income and car ownership reflect the individual component.

With respect to the individual components, many areas segment the accessibility analysis by socio-economic groups. However, only few of them (Atlanta Regional Commission, Boston Region Metropolitan Planning Organization) do address destination segmentation. This is an important improvement as the accessibility to all jobs may not represent the opportunities that are available to different groups of populations

- space-time prisms (three-dimensional constructs measuring individuals' range of possible geographic movement within specified time constraints)

  Time restrictions also play an important role in determining accessibility. These include land use, transport and individual constraints such as the availability of opportunities (i.e., opening hours), personal schedules, and the schedule of public transport services.

the attractiveness of destinations based on the number of opportunities available there and an impedance factor based on travel cost/time.

The availability of opportunities for example (opening hours of shops and services, job starting time) represents temporal elements,

More detailed analysis can include other types of destinations, or segmentation by job types, to address specific social issues, all depending on the context of analysis. Temporal fluctuations in accessibility can also be addressed to improve the quality of the accessibility analysis. Furthermore, while most plans focus on car accessibility, and to a lesser extent on accessibility by transit, all modes should be included in the accessibility objectives and indicators. Increasing accessibility by transit, cycling and walking can contribute to achieving broader environmental, economic and social goals.

accessibility indicators should systematically be included in multi-criteria analyses.

it offers an alternative to mobility-based decisions and potentially provide greater transparency in the decision-making process (Halden, 2011). Furthermore, national and regional authorities can require local authorities to address accessibility in their project analysis. One especially effective way of doing so is by including accessibility criteria in the selection process of projects,

- be measured by destination
- Absolute vs. Relative Accessibility[4]

Absolute accessibility is the total measure of accessibility within a particular area. A transport improvement increases overall accessibility—analogous to increasing the size of the pie. Relative accessibility is the share of total accessibility associated with a particular place. A new transport facility increases the relative accessibility of those points that can directly use the facility—analogous to increasing the percentage of the pie that a particular slice comprises. For a new infrastructure improvement (a faster bus, a new link, etc.), while society overall receives greater accessibility, the markets served by the improvement gain in both absolute and relative accessibility.

- be measured by mode
- Regional and Local/neighborhood Accessibility[5] be measured by scales

Regional accessibility is determined by the regional structure of a metropolitan area and incorporated variables such as location, type of activities, and size of activities that affect shopping behavior. Local accessibility is primarily determined by nearby activity (where "nearby" is used to refer to the neighborhood unit, approximately one-half to one mile (800 to 1,600 m) in residential areas). Areas with higher local accessibility would be oriented to convenience goods, such as supermarkets and drug stores, and located in small centers.

Many policy initiatives speak to increasing accessibility on both regional and local scales; and, while the two scales are intricately related, each calls for different policies. regional transport–land use policies may speak to issues of urban growth boundaries, increasing densification, and diversifying the geographical distribution of employment centers.

Access to jobs provides an adequate indicator of regional accessibility, as many people commute across the region for work. Access to jobs can also be a reflection of the level of

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services available around a certain location, as the delivery of services often equates a certain number of employees.

Neighborhood accessibility policy initiatives speak more to issues of mixing uses on a parcel or neighborhood scale, site design, and more directly, facilitating circulation patterns that enhance walking, bicycling, and transit use.

Other types of destinations include libraries, schools, grocery stores, hospitals, public parks, educational services as exemplified by the Atlanta Regional Commission. Many of these destinations reflect local accessibility and are thus often associated with cycling and walking.

The most common metrics for cycling and walking are measures of local accessibility (to grocery stores, schools, parks or public transport station for example),

With respect to local accessibility walking and cycling distance thresholds are used instead of travel time thresholds (0.5 miles for walking). These appear to be appropriate measures of accessibility, as time is generally proportional to the distance travelled by bicycle or foot.

(Proffitt et al. 2019) increasingly tight budgets and a growing awareness that it simply is not possible for regions to pave their way out of congestion do seem to be pushing many MPOs to look for alternatives to expanding roadway capacity. Improving accessibility by coordinating land-use and transportation rather than an exclusive focus on automobility is one such alternative.

Analysing future development scenarios in terms of their levels of accessibility could leverage MPOs' influence on municipal-level land-use decisions even without explicit authority over them. Highlighting the connections between land use and transportation infrastructure facilitates cost-benefit analysis of providing accessibility rather than relieving congestion. Such comparisons could help MPOs provide better information about the performance and the costs of different transportation-infrastructure and land-use scenarios. Better information about the tradeoffs inherent in different development scnearios can help regions choose projects more objectively.

OECD (2017) provide some latest research findings, methodologies and data sources on urban accessibility.

Another good practice to address accessibility in transport plan is the use of visualization tools such as maps. Accessibility maps provide a clear way to communicate gaps and benefits of a transportation and land use network, and thus helps decision-makers, planners and the general population to better grasp the impacts of transportation investments.

All Transit: https://alltransit.cnt.org/

WalkScore: https://www.walkscore.com/

Bicycle Network Analysis: https://bna.peopleforbikes.org/#/ (city-level only)

Mobility Score: https://transitscreen.com/mobilityscore/

EPA Access to Jobs & Workers via Transit Tool: Overview: https://www.epa.gov/smartgrowth/smart-location-mapping#Trans45 Link to tool: https://epa.maps.arcgis.com/

home/webmap/viewer.html?webmap=3bffc086a9b34928a632ab6c8530ebcf

EPA Walkability Index: Overview: https://www.epa.gov/smartgrowth/smart-location-mapping#walkability
Link to tool: http://www.arcgis.com/home/webmap/viewer.html?url=https%3A%2F%2Fgeodata.epa.gov%2Farcgis%2Frest%2Fservices%2FOA%2FWalkabilityIndex%2FMapServer&source=sd

One of the most systematic and transparent way to inform decision-making is by including accessibility indicators into multi-criteria analyses, as done by the Baltimore Regional Transportation Board, the Puget Sound Regional Council, Transport for London and the Greater Manchester Combined Authority. For example, in Baltimore, a multi-criteria analysis was conducted to compare the projects submitted by local jurisdictions and to select the ones to be included in the Regional Transportation Plan (Maximize 2040). Similarly, the Puget Sound Regional Council included accessibility in their multi-criteria analysis used to conduct a prioritization of the projects. With respect to scenario assessments, Transport for London used a multi-criteria analysis including accessibility indicators to assess the effectiveness of various modelling scenarios.

The accessibility indicators included in the multi-criteria analyses range from broad questions to specific quantified metrics, which influence the flexibility of the analysis. For example, Transport for London defines clear specific accessibility metrics, for example the change in the number of jobs accessible by public transport within 45 minutes travel time (see Table 1). These access to jobs metrics are relatively easy to generate and to interpret. Accordingly, they foster the inclusion of accessibility indicators that adequately reflect the ease of reaching destinations. Furthermore, given their specific nature, they are easy to communicate as exemplified in the plan: "Implementing the schemes will increase the employment catchment area of central London (the number of people within 45 minutes of central London employment) by almost 25 percent." (p.74).

In contrast, accessibility criteria in the Greater Manchester plan are defined with broad questions such as "Will the LTP help improve accessibility through integrated spatial planning?" and "Will the LTP improve access to jobs, particularly for people who suffer income or employment deprivation?" (see Table 1). These questions provide greater flexibility in the assessment of the plan, which can be beneficial as quantified metrics do not always reflect the benefits provided by improvements in accessibility (Curl et al., 2011). However, as emphasized by Halden (2011), it can also lead to the use and misuse of the concept of accessibility.

An intermediate way of defining accessibility indicators is by attributing scores (from 1 to 3 for example) based on specific guidelines. This approach has the advantage of defining clear weights associated with accessibility criteria, thus providing greater transparency.

quantified metrics provide more specific guidelines that directly reflect the ease of reaching destinations. However, they provide lower flexibility and might not adequately reflect the outcomes of the different investments.

including accessibility indicators in multi-criteria analysis provides a systematic alternative

to mobility-focused decision-making.

Accessibility maps and metrics are useful tools to provide an overview of the land use and transportation network and they illustrate an underlying accessibility analysis.

other dimensions of accessibility might currently be neglected in metropolitan transportation plans. For example, affordability, transfer and multimodal connectivity, as well as travel information did not come up as main aspects of accessibility objectives.

equity analysis

Discusses how equity could be incorporated in the accessibility measures. In doing so, how are you defining equity?

Equity analysis based on accessibility indicators generally assess the level of accessibility of specific vulnerable groups relatively the general population, using detailed accessibility metrics.

However, in most cases the use of the generated accessibility metrics is limited to the environmental justice assessment, although accessibility is also stated as a main planning factor by the federal government.

Accessibility is mainly perceived as an equity indicator, while it has the potential to address multiple aspects of a land use and transportation system.

It is also important to note that accessibility indicators should be used as general performance indicators and should not be limited to social equity analyses.

Many plans from American metropolitan areas generate accessibility measures to address the environmental justice federal requirement.

Yet, accessibility allows tackling multiple objectives, including environmental and economic benefits (Handy, 2002, Koenig, 1980), and should hence also be used to assess the overall benefits of potential investments.

Measures of generalized costs (including the costs and time of travel) have been developed in the literature (Bocarejo and Oviedo, 2012, El-Geneidy et al., 2016). These measures better reflect the total costs of travel as they include both financial and time burdens. They are however very challenging to generate due to complex fare structures and availability of data. Yet, excluding the financial costs of travel results in an overestimation of accessibility (El-Geneidy et al., 2016), especially for low-income individuals. In this regard, accessibility based on financial and time costs is closer to reality and can also provide an insight on fare structures and trip affordability. From a planning perspective, travel time measures of accessibility adequately represent accessibility patterns with respect to the transportation networks and locations of activities, but do not address the financial constraints that vulnerable individuals may face.

Conclusion

Neccessary define and measure accessibility in updating Plan Bay area 2050.

Choose proper method and criteria

incorporate measures of accessibility into decision making and needs the MPO board to agree.

Integrating RTP goals with accessibility-focused performance measures could help MPOs make better decisions about the selection and prioritisation of transportation infrastructure. For instance, prioritising transit improvements to connect key origins and destinations can increase ridership *(Badoe and Miller, 2000; Chakraborty and Mishra, 2013)* Accessibility tools that take into account benefits from both transportation and land-use decisions provide a more complete picture than mobility measures alone.

National and regional governments and organizations can play a key role in setting clear accessibility requirements for transportation planning processes and planning documents. clear guidelines must be provided and a clear distinction between mobility and accessibility must be made.(Boisjoly and El-Geneidy 2017b)

Accessibility, the ease of reaching destinations, is increasingly seen as a complimentary and in some cases alternative to the mobility oriented planning paradigm, as it allows capturing the complex interactions between land use and transportation systems while providing a social perspective on transportation planning. how accessibility is incorporated into metropolitan transportation plans and translated into performance indicators around the world, to ultimately derive policy recommendations. few plans have accessibility-based indicators that can guide their decision-making processes. plans need to have clearly defined accessibility goals with a distinction between accessibility and mobility. Furthermore, multi-criteria analysis approaches including accessibility indicators need to guide the decision-making process.

More efforts are needed to effectively implement accessibility-based approaches.

Table 3. Best Practices for a Greater Inclusion of Accessibility Planning and Metrics.

|Recommendation |Description| Key examples Accessibility goals and objectives |Clearly defined goals and objectives are included in the plan. The plan is structured around the goals and objectives.|London | — | — | — | Distinction between accessibility and mobility |Distinct accessibility and mobility objectives and indicators are defined. |Baltimore |Multi-criteria analysis including accessibility indicators |Accessibility indicators are systematically included in the performance analyses. Accessibility metrics are used to assess the general performance of the land use and transportation system, in addition to social equity.|London, Baltimore, Puget Sound (Seattle), Manchester, Melbourne |Access to destinations metrics |The accessibility indicators are based on access to destinations (e.g.: jobs), rather than to transport amenities (e.g.: public transport stop) |Boston |Multiple modes |Accessibility is measured for various modes of transport |North Central Texas, Atlanta |Visualization tools |Accessibility maps are included in the plan. |London, Sydney

Overall, clear multi-criteria analysis, using clearly defined indicators, provide greater transparency and typically foster the inclusion of accessibility aspect in the decision-making process.

Notes

References

Boisjoly, Geneviève, and Ahmed M El-Geneidy. 2017a. "How to Get There? A Critical Assessment of Accessibility Objectives and Indicators in Metropolitan Transportation Plans." *Transport Policy* 55. Elsevier: 38–50.

———. 2017b. "The Insider: A Planners' Perspective on Accessibility." *Journal of Transport Geography* 64. Elsevier: 33–43.

Handy, Susan. 2018. "Enough with the 'Ds' Already—Let's Get Back to 'a'." Transfers Magazine. https://transfersmagazine.org/enough-with-the-ds-already-lets-get-back-to-a/.

Hansen, Walter G. 1959. "How Accessibility Shapes Land Use." *Journal of the American Institute of Planners* 25 (2). Taylor & Francis: 73–76.

Levinson, David M, and Kevin J Krizek. 2018. *Metropolitan Land Use and Transport: Planning for Place and Plexus*. Routledge. https://doi.org/10.4324/9781315684482.

Litman, Todd. 2017. *Evaluating Accessibility for Transport Planning*. Victoria Transport Policy Institute. http://www.vtpi.org/access.pdf.

Lyons, Glenn, and Cody Davidson. 2016. "Guidance for Transport Planning and Policymaking in the Face of an Uncertain Future." *Transportation Research Part A: Policy and Practice* 88. Elsevier: 104–16.

OECD, International Transport Forum. 2017. "Linking People and Places." ITF. https://www.itf-oecd.org/linking-people-and-places.

Proffitt, David G, Keith Bartholomew, Reid Ewing, and Harvey J Miller. 2019. "Accessibility Planning in American Metropolitan Areas: Are We There yet?" *Urban Studies* 56 (1). SAGE Publications Sage UK: London, England: 167–92.