MOVING TO ACCESS
BROOKINGS

Measuring Performance:

Accessibility Metrics in Metropolitan Regions around the World

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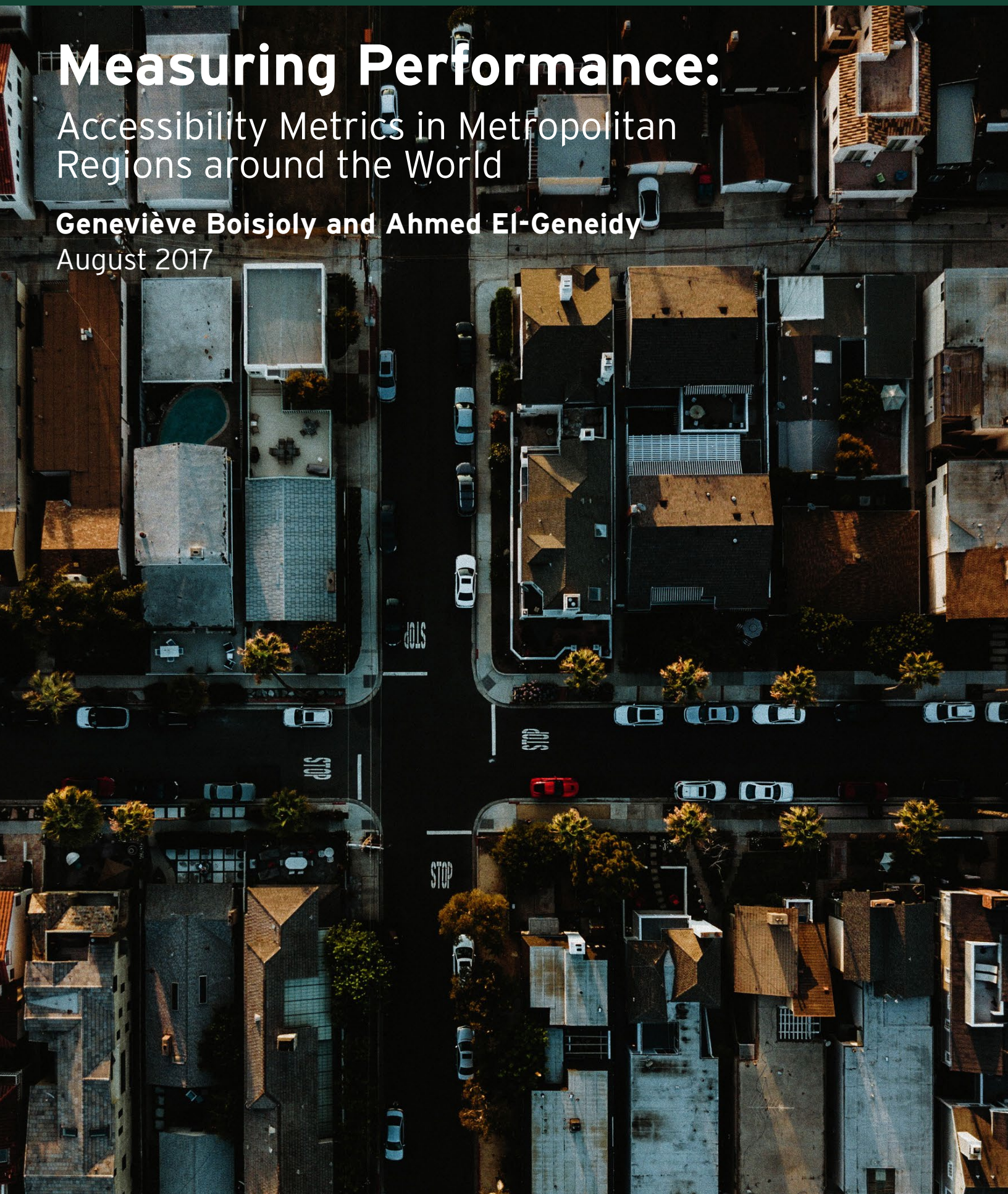

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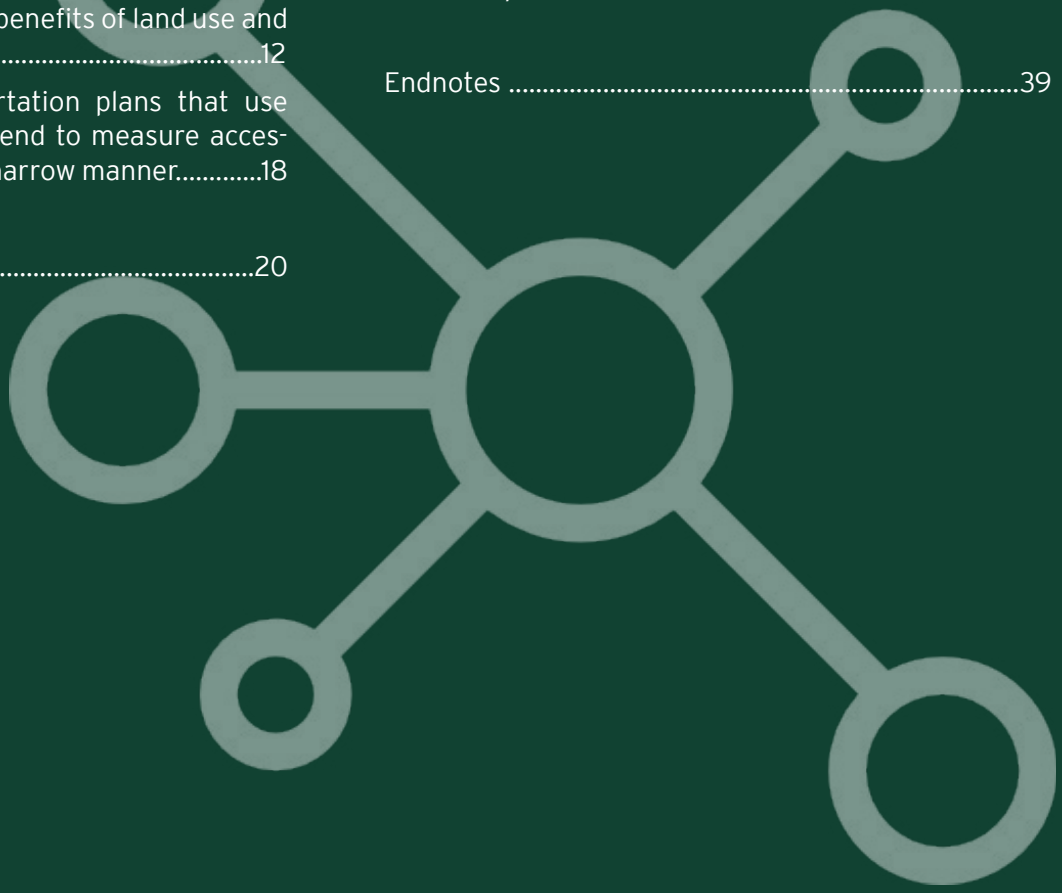


Executive Summary

Accessibility, or the ease of reaching valued destinations, is a key land use and transportation performance metric. While researchers have studied the concept for decades, its implementation in policy and practice is generally limited.

The aim of this report is two-fold: first, to present how metropolitan areas currently incorporate accessibility into their transportation plans; and second, to examine how practitioners around the world have designed and implemented accessibility metrics. After reviewing 32 recent metropolitan transportation plans in North America, Europe, Australia, and Asia, plus surveying 343 different land use and transportation practitioners worldwide, the report finds:

Most metropolitan transportation plans—22 of the 32 plans analyzed in this report—include accessibility in their vision, goals, or objectives, but many of these plans are not specific in their use of the term. Consequently, few plans include formal accessibility indicators to guide their decision-making processes. More often than not, accessibility is a buzzword with little tangible meaning.

Whereas about half (17) of the metropolitan transportation plans analyzed define "access-to-destination" indicators, only eight of them use these indicators to comprehensively evaluate the benefits of land use and transportation projects. This step is, however, key to encourage the development of a more accessible built environment.

Among metropolitan transportation plans that use specific indicators, the plans tend to measure accessibility in a relatively uniform, narrow manner. Oftentimes, this means looking strictly at reaching all opportunities by either private vehicle or public transportation. This overlooks distinct accessibility levels among specific neighborhoods, for specific demographic groups, and walking or biking.

While nearly all practitioners surveyed for this report are familiar with the general concept of accessibility, only 55 percent use accessibility metrics in their work. These differences were consistent across all types of occupations and organizations. In turn, there is a considerable gap between the familiarity with the concept of accessibility and its practical implementation, including the use of particular types of metrics.

For practitioners who do not use accessibility metrics in their work, 52 percent express a lack of knowledge as a major barrier to implementation. Meanwhile, for practitioners who do use these metrics, 36 percent express that the use of such metrics is largely a result of their own initiative. As a result, many practitioners do not fully understand how to incorporate accessibility metrics into plans and other processes while facing certain technical barriers to adoption, including a lack of data.

Most practitioners agree that accessibility metrics can and should influence decision-making processes in their organizations or agencies, including 95 prcent of practitioners who already use these metrics in their work. Although a lower share of practitioners who do not already use accessibility in their work agree with this sentiment, a majority still find that metrics can and should play an influential role in future decisions.

Overall, this research illustrates the need to bridge the gap between accessibility research and practice. To support and successfully implement accessibility metrics into governing frameworks, it is essential to educate practitioners and follow best practices demonstrated in metropolitan areas that successfully implemented accessibility metrics into their formal governance frameworks. If the goal is to expand the adoption of accessibility planning and metrics, there is a demonstrated path forward.

1 Introduction

Accessibility is one of the most comprehensive ways to measure the performance of transportation systems. By considering how many valued destinations can be reached from specific origins, accessibility can reflect how land use and transportation systems work in tandem to connect people to opportunities.[1]

As a result, higher levels of accessibility help metropolitan areas achieve broader objectives, whether reduced car use, increased social equity, or greater economic development. For example, greater accessibility is associated with higher employment rates[2] and land values.[3] Boosting land values in turn provides an alternative and sustainable source of revenue for the transportation investments that help create accessibility in the first place.[4]

From a social perspective, increased accessibility reduces the risks of exclusion[5] and improves the quality of life of individuals.[6] On the contrary, lack of affordable transportation options, namely to job opportunities, educational institutions, and social or cultural activities, can be an important barrier to social inclusion. This is especially the case for vulnerable populations who typically experience greater constraints in terms of travel costs and modal options. Furthermore, the lack of access to healthcare services, green amenities, and sport or leisure centers can have adverse impacts on individuals' health and well-being.

Finally, greater accessibility is associated with higher transit use and can help in reducing car use and the resulting greenhouse gas emissions.[7] Given accessibility's extensive reach and varied impact on the built environment, it increasingly represents a central element in transportation planning efforts.[8]

Yet even with such significant benefits confirmed by extensive academic research, little is known on the implementation of accessibility metrics in transportation practice. In fact, although transportation issues are increasingly framed in terms of access to opportunities,[9] the implementation of accessibility in policy and practice is generally limited.[10]

To better understand the gap between research and practice, this report assesses how metropolitan areas and practitioners around the world have designed and implemented accessibility metrics, identifying barriers and best practices for expansion and improvement.

The core of the report is divided into two sections. The first section presents a critical assessment of how accessibility is incorporated into metropolitan transportation plans and translated into performance indicators around the world. This analysis seeks to identify best practices and provide guidelines on how to effectively use accessibility in planning documents. The second section presents the results of a survey on accessibility metrics conducted among land use and transportation practitioners around the world. The survey aimed at understanding the factors that foster and prevent the use of accessibility metrics by land use and transportation practitioners. This report contributes to a greater understanding of practical challenges and successes associated with accessibility planning and is relevant to policymakers and transportation planners wishing to foster accessibility-based planning approaches.

2 Theoretical Background

What is accessibility and how is it measured?

In the most basic terms, accessibility can be understood as the ease of reaching destinations.[11] It is an inherently multidisciplinary concept, contingent on the spatial distribution of destinations (land use) and the ability to move from one place to another (transport).[12] The land use component is related to the spatial distribution of opportunities such as jobs, health services and retail stores. The transport component refers to the physical infrastructure specific to each mode of travel. In addition to transport and land use, accessibility also considers temporal components like opening hours of shops and services.[13] Accessibility also can consider demographic characteristics such as income and car ownership. Finally, and still in nascent development, accessibility can consider monetary components like transportation pricing, value of land, and operating service and capital costs.[14]

While accessibility measurement can vary widely, policy-makers most commonly think of accessibility

through the lens of location-based measures to comprehensively judge their land use and transport systems at the regional level.[15] Location-based metrics typically account for the number of opportunities that can be reached from a specific location, based on the travel costs to destinations using a specific mode.[16] Travel costs are generally measured based on travel time or distance.[17]

Two location-based measures are commonly used in accessibility research. The first one is the gravity-based measure which discounts all opportunities based on their travel costs. In essence, gravity-based measures give preference for destinations that are closer. The second one is the cumulative-opportunity measure, which only counts the opportunities that are within a specific travel costs threshold. While gravity-based measures better reflect travel behavior—as it accounts for the travelers' perceptions of time—they are more complex to generate and more difficult to interpret and communicate.[18] On the other hand, cumulative-opportunity measures are easy to generate and interpret. Furthermore, these measures are highly correlated with gravity-based measures[19] and represent an adequate measure of regional accessibility.[20]

Practical challenges to implementing accessibility

Accessibility was first introduced by Walter Hansen in 1959 to capture the interaction between land use and transportation networks. Following Hansen's work, researchers emphasized the need to include accessibility as a performance indicator in land use and transportation plans as well as an alternative approach to mobility-based transportation planning.[21] They argued that accessibility better reflected the economic and social benefits of the network, namely in terms of land values and quality of life.[22] More recently, accessibility has been put forward as a central theme of research, namely with respect to social equity, economic development and environmental impacts.[23]

Although accessibility has been a central theme of research in recent decades and has gained attention in the planning sector, transportation planning is still dominated by a mobility-oriented paradigm. Unlike accessibility, the mobility paradigm focus almost exclusively on the ease of moving people along a given transport corridor, and is flexible enough to consider any mode of travel. However, by overlooking the associated land uses and household characteristics that drive transport demand, it is not interdisciplinary. Just as importantly, the heavy use of civil engineering principles within the mobility paradigm often means it can be conducted strictly within transportation departments, rather than through coordination with peers in land use planning or housing departments.

Considering the pervasiveness of the mobility paradigm, research consistently finds a lack of formal accessibility policies relative to mobility measures. In an assessment of four metropolitan plans in California, plans were developed around mobility with only minimal mention of accessibility issues.[24] More recently, researchers found that only 23 percent of transportation plans in larger U.S. metropolitan areas included access-to-destinations indicators compared to 45 percent for vehicle-miles-traveled indicators.[25] Furthermore, only 10 percent of the plans formally defined the term.

The lack of consensus around accessibility measures is another barrier to adopting an accessibility-focused paradigm. In the United Kingdom (UK) context, the concept of accessibility has been widely used, mainly due to the establishment of accessibility planning requirements by the national government.[26] However, given the broad and flexible guidelines, accessibility is often "misused" and "abused in practice."[27] Furthermore, there is no consensus about which accessibility indicators and metrics should be used.[28] While a plethora of measures have been developed in academic settings, their practical implementation remains limited, which raises questions about their usability.[29]

Overall, past research consistently shows the paradigm shift from mobility to accessibility is far from complete. Accessibility is not yet a mature concept in planning, and is accordingly not being used effectively. This report hence stems from the increased interest in accessibility planning and the challenges related to its implementation.

3 Methodology

This report relies on two distinct research phases: first, a critical assessment of metropolitan transportation

plans, and second, a direct survey of practitioners concerning accessibility metrics.

Reviewing metropolitan transportation plans

To understand how accessibility metrics are used in planning documents around the world, a total of 32 metropolitan transportation plans were evaluated with respect to their goals, objectives, indicators and metrics. More specifically, the following questions were investigated:

- To what extent and how is accessibility included in metropolitan transportation plans around the world?
- To what extent are accessibility goals translated into performance indicators reflecting the ease of reaching destinations?
- What are the best practices and how could accessibility objectives be better integrated in metropolitan transportation plans?

The selection of plans was limited to those available in English or French and to large metropolitan areas located in high-income countries. Metropolitan areas with a population greater than 2.5 million inhabitants were included. A lower population threshold (2 million) was set for Europe, in order to include a broader variety of metropolitan areas. In total, 18 metropolitan areas in the U.S. were selected, three in Canada, eight in Europe, two in Australia, and one in Asia (Singapore). While the majority of selected metropolitan areas are located in North America, the inclusion of metropolitan areas in Europe, Australia and Asia provides us with a diverse picture of planning documents from high-income countries.

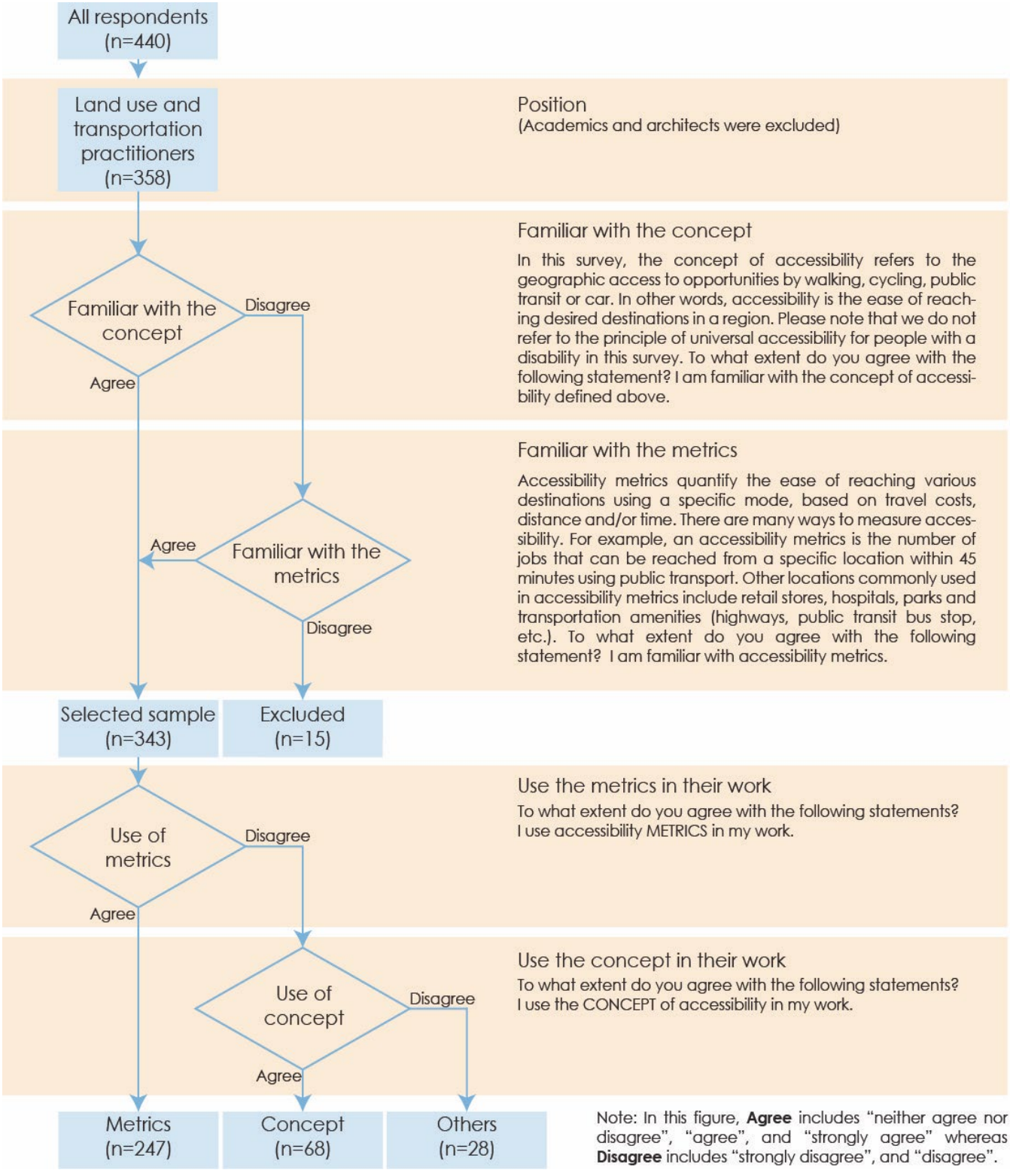
The selection was limited to areas in high-income countries in order to assess a relatively homogenous sample, especially in terms of planning processes and transportation systems. Furthermore, the lack of transparency around governance frameworks made it impossible to apply this project's standardized methodology in every country. Nevertheless, the assessment of metropolitan transportation plans from high-income countries can be beneficial for high- and low-income countries as it provides general insights on the best practices to implement accessibility-based approaches.

The selected metropolitan areas are presented in Table 1, with more details regarding each plan included in Appendix A. For each metropolitan area,

Table 1: Metropolitan areas included in the study, by governing authority (and major city)

Transport for London (London), UK	Bruxelles Mobilité (Brussels), Belgium
Conseil Régional d'Île-de-France (Paris), France	Greater Manchester Combined Authority (Manchester), UK
Senate Department for Urban Development and Environment (Berlin), Germany	Lille Métropole Communauté Urbaine (Lille), France
CENTRO - West Midlands Combined Authority (Birmingham), UK	Maricopa Association of Governments (Phoenix), US
City of Stockholm (Stockholm), Sweden	Metropolitan Council (Minneapolis/St. Paul), US
Singapore Land Transport Authority (Singapore)	Metropolitan Transportation Commission (San Francisco), US
City of Melbourne (Melbourne), Australia	National Capital Region Transportation Planning Board (Washington, DC) US
New South Wales Governments (Sydney), Australia	New York Metropolitan Transportation Council (New York), US
Mayor's Council on Regional Transportation (Vancouver), Canada	North Central Texas Council of Governments (Dallas), US
Ville de Montréal (Montreal), Canada	North Jersey Transportation Planning Authority (Newark), US
Metrolinx (Toronto), Canada	Puget Sound Regional Council (Seattle), US
Atlanta Region Commission (Atlanta), US	San Diego Association of Governments (San Diego), US
Baltimore Regional Transportation Board (Baltimore), US	Southeast Michigan Council of Governments (Detroit), US
Boston Region MPO (Boston), US	Southern California Association of Governments (Los Angeles), US
Delaware Valley Regional Planning Commission (Philadelphia), US	Southwestern Pennsylvania Commission (Pittsburgh), US
Houston-Galveston Area Council (Houston), US	Chicago Metropolitan Agency for Planning (Chicago), US

Figure 1: Accessibility survey question tree and sample counts



Source: Author-administered survey.

the most recent transportation plan was selected. All plans but four date from 2010 or later. Due to differences in governance structures, there are some discrepancies in the type of governing authority responsible for developing regional plans. Overall, it was typically a metropolitan planning organization, a city administration, or a transit agency.

Accessibility survey details

To better understand the factors influencing the implementation of accessibility metrics, a survey was conducted among land use and transportation practitioners. The survey was conducted online and disseminated through various mailing lists and social media groups of planners. The main goal was to identify planners that use accessibility in their work and determine the motivations and barriers behind implementing accessibility metrics.

The selection and subdivision of respondents included in this study is presented in Figure 1. In total, 440 fully completed surveys were collected. As the objective was to focus on transportation planning practice, academics and architects were excluded from the original sample. Furthermore, all respondents were asked about their familiarity and use of the concept and metrics; respondents that were neither familiar with the concept nor the metrics were removed. In total, 343 non-academic respondents were included in the final sample, of which 274 were from North America, 45 from Europe, and 24 from other regions.

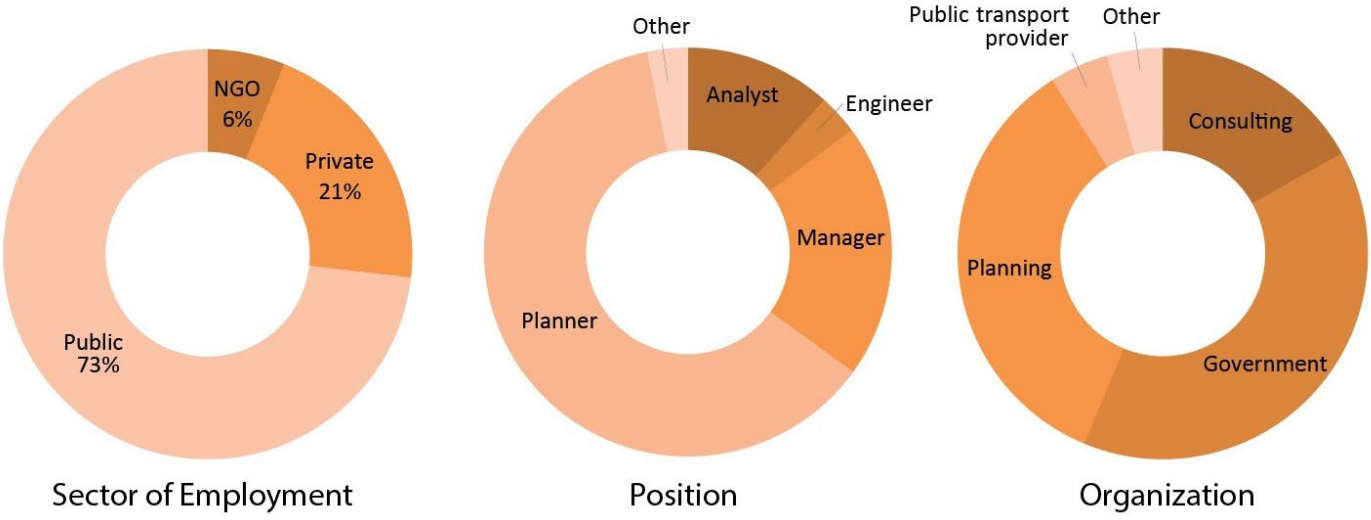
These respondents were then divided in three sub-samples, based on whether they used the concept and metrics of accessibility in their work.

The survey included general questions about the respondents' work context and their perception of decision-making based on accessibility metrics, using a 5-point Likert scale. Furthermore, the first sub-sample (respondents that used metrics) were asked specific questions about the design and implementation of metrics, whereas the second sub-sample (respondents using the concept, but not the metrics) were asked specific questions about their use of the concept, and reasons for not using metrics. Additional details on the survey questions can be found in Appendix B.

The characteristics of the 343 respondents are presented in Figure 2. Most respondents worked in the public sector, and the majority were planners (62 percent). Respondents mainly worked within a governmental organization, planning organization, or consulting agency, while very few worked within a public transport provider. Furthermore, the majority of respondents were involved with transportation projects (public transit, walking, cycling, driving, parking or land use) at the local or regional scale.

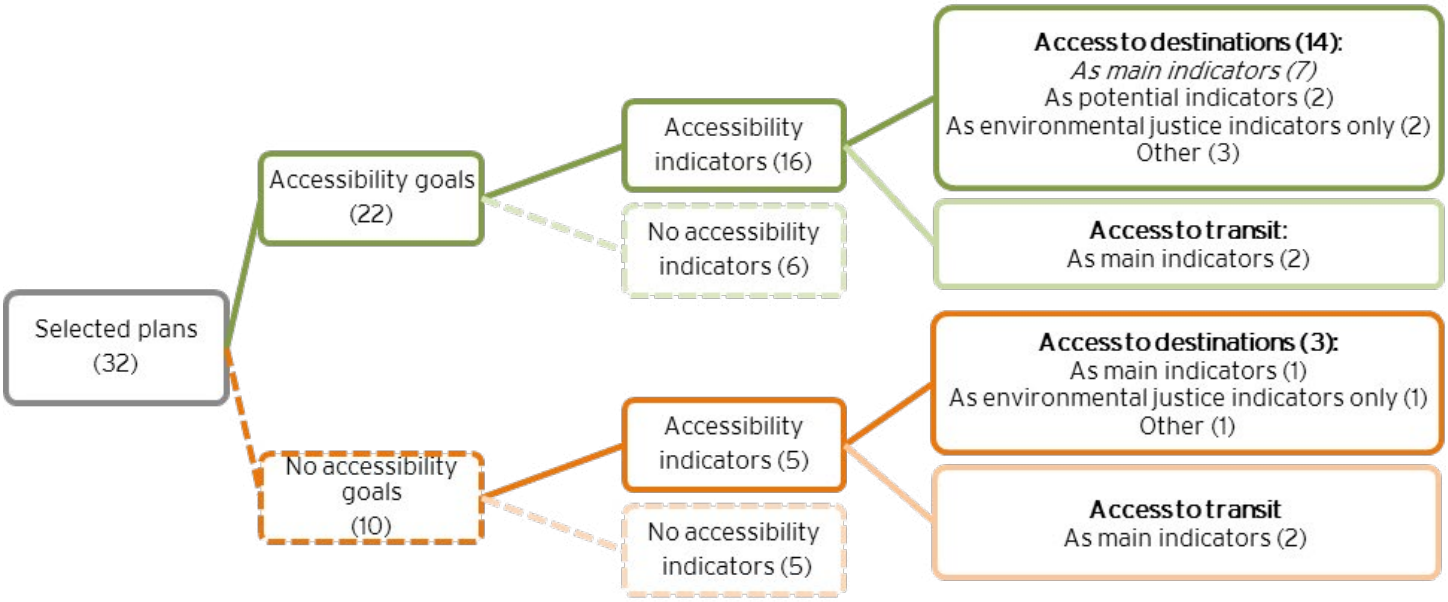
Note on accessibility indicators and accessibility metrics: In this report, the terms "accessibility indicators" and "accessibility metrics" are used interchangeably and refer to the quantitative or qualitative measurement of the level of accessibility provided by land use and transportation systems.

Figure 2: Profile of the respondents, by sector of employment, position, and organization



Source: Author-administered survey.

Figure 3: Summary of the assessed plans



Source: Author analysis of selected metropolitan transportation plans.

4 Transportation Plan Findings

This analysis has assessed plans based on their accessibility goals and objectives, as well as the performance indicators and types of metrics used. The accessibility-related goals, objectives and indicators are presented in Appendix A for each of the 32 metropolitan areas, while Figure 3 summarizes the results of the common assessment.

This section includes the core findings from this assessment. The first finding addresses the extent that plans include the concept of accessibility, especially with respect to goals and objectives. The second finding narrows its focus to those plans that do include specific accessibility indicators, and details the different approaches used to integrate accessibility indicators. The third finding analyzes the different types of accessibility metrics used in the plans.

Most metropolitan transportation plans—22 of the 32 plans analyzed in this report—include accessibility in their vision, goals, or objectives, but many of these plans are not specific in their use of the term.

Metropolitan transportation plans generally touch on accessibility as a theoretical concept. Where earlier transportation planning approaches focused solely on mobility,[30] 22 of the 32 plans assessed include accessibility somewhere within their vision, goals, or objectives (Figure 3). Yet while the majority of regions now use the term, their application of it is often methodologically imprecise, unrelated to access to destinations, or divorced from broader economic, social, and environmental objectives that the metropolitan areas hope to achieve.

The initial issue is how the regions frame their accessibility goals. The term accessibility is often not defined, and is used as a vague term that does not translate into clear accessibility objectives. The 2040 vision of the Houston-Galveston Area Council illustrates this vague use of the term access: "In the year 2040, our region will have a multimodal transportation system through coordinated investments that supports a desirable quality of life, enhanced economic vitality and increased safety, access and mobility." Similarly, the Southern California Association of Governments (Los Angeles) uses accessibility as a vague goal to "Maximize mobility and accessibility for all people and goods in the region" (p.64). Furthermore, their chosen title, "A Plan for Mobility, Accessibility, Sustainability and a High Quality of Life," reiterates the importance of accessibility. Yet, in both the Houston-Galveston Area Council and the Southern California Association of Governments (Los Angeles) plans, access to destinations is not addressed, although it is stated as a

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

In fact, accessibility and mobility are often used interchangeably in the plans, and most of the time, the focus lies on mobility. Furthermore, the plans do not address accessibility through specific objectives or indicators. Access to mobility, rather than to destinations, is also often emphasized in transportation plans, as in the case of the plan of the Conseil régional d'Île-de-France: "Ensure access to mobility." This is often reflected in the choice of accessibility indicators related to access to public transport, rather than destinations. In sum, although accessibility is mentioned in many plans, it does not imply that the ease of accessing destinations is a formal goal.

Since accessibility is often used as a rather vague concept, it is essential to look beyond the use of the word to understand what it refers to. In fact, even when specific accessibility objectives are stated in the plans, they are often translated into indicators that do not reflect accessibility. As seen in Table 2, travel time is used as an indicator of accessibility in the Metropolitan Transportation Commission (San Francisco and Bay Area) plan, the South California Association Council of Governments (Los Angeles) plan, and the San Diego Association of Governments plan. The following quotation from the Southern California Association of Governments plan illustrates how specific accessibility indicators are sometimes translated into mobility indicators:

> *The Accessibility outcome is used to evaluate how well the transportation system performs in providing people access to opportunities. Opportunities may include jobs, education, medical care, recreation, shopping or any other activities that may help enhance a person's quality of life. For the 2016 RTP/SCS, accessibility is simply defined as the distribution of trips by mode by travel time. (p.161)*

In this case, accessibility is defined by the travel time for different modes. 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. Although people have shorter travel

Table 2: Accessibility objectives translated into indicators that do not reflect accessibility

Metropolitan Area	Objective	Definition
Baltimore	Accessibility - Transit	Average Weekday Ridership
	Accessibility - Pedestrian / Bicycle	Percentage of urban area directional roadway miles that have sidewalks Bicycle/walk-to-work mode share
Minneapolis/ St. Paul	Access to Destinations	Average annual hours of delay per capita Transit ridership Number of miles of managed lanes Number of miles of bus-only shoulder lanes
Bay Area (San Francisco)	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
	Access to Jobs	Average travel time in minutes for commute trips
San Diego	Job Access	The percentage of work trips lasting up to 30 minutes during peak periods by driving alone, riding in a carpool, and taking public transit
Los Angeles	Performance measures of accessibility and mobility outcome	Person delay per capita Person delay by facility type Truck delay by facility type Travel time distribution for transit, SOV and HOV modes for work and non-work trips Work trips completed within 45 minutes

times, they might not have access to a large number of destinations. Indeed, increased mobility does not always result in increased accessibility.[31] In addition to travel times, some plans, such as those by the Metropolitan Council (Minneapolis/St. Paul) and the Baltimore Regional Transportation Board, use the presence of transportation infrastructure (length of bus lanes, roads or bicycle lanes, and proportion of roads to sidewalk) as an indicator of accessibility (Table 2). Mode share is also included as an indicator of accessibility in these plans.

Overall, though these indicators are relevant in measuring the quality of a transportation network, they do not indicate the achievement of an accessibility objective.

Meanwhile, the 22 plans tend to not connect accessibility objectives to broader economic and social goals, such

as economic development, social inclusion, and equity. In most cases, metropolitan plans fail to make explicit connections. Access to the transportation system, like within the Houston-Galveston Area Council and Conseil régional d'Île-de-France plans, is also often stated as a goal or objective. This however does not comprehensively reflect accessibility in the sense of ease of reaching destinations. While almost all of the plans mention accessibility in one way or another, 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. Instead, it is used as a buzzword.

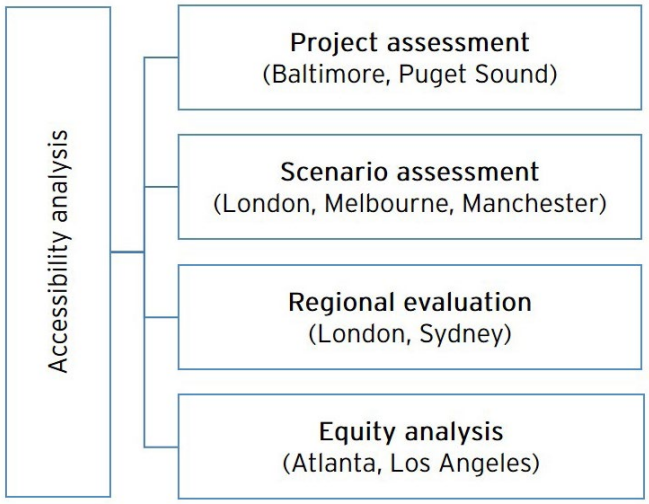
However, there are exceptions. Table 3 presents the most promising examples of specific accessibility objectives tied to explicit economic, social, or environmental goals. Transport for London, the NSW Government in Sydney, the San Diego Association of Governments, the Greater Manchester Combined Authority (UK), and

the Berlin (Germany) state government all use access to jobs as an accessibility-based objective, both as a way to foster economic development and to reduce social inequities. Transport for London, the NSW Government in Sydney, the San Diego Association of Governments,

Table 3: Example of accessibility-based objectives and the related overarching goal

Metropolitan area	General goal	Accessibility objective
London (UK) (p.25)	Supporting economic development	Improvement in employment accessibility.
	Improving social inclusion	Improved access to employment from deprived areas.
Manchester (UK) (p. 16-19)	To support economic growth across the subregion and improve access to jobs for all	Improve access to jobs, particularly for people who suffer income or employment deprivation. Reduce journey times and improve accessibility for local businesses.
	To contribute to the improvement of physical and mental health and wellbeing for all and reduce health inequalities.	Improve accessibility to health care facilities, particularly for those who need the most health services, e.g. the elderly, people with disabilities, and those without a car. Encourage healthier lifestyles by promoting the use of walking, cycling, and public transport and increase accessibility to open greenspace and sports facilities, particularly for the most deprived communities and sections of the community whose access needs are often not catered for.
	To reduce CO2 emissions from transport.	Improve accessibility through integrated spatial planning.
	To contribute to the creation of vibrant, sustainable communities with easy access to the transport system for all.	Increase access to and usage of the public transport network for all. Support key sections of the community in accessing social networks and support the development of strong communities.
Sydney (Australia) (p.22)	Support economic growth and productivity	Jobs and services need to be more accessible (p.120) – providing a transport system that responds directly to customer needs, is more efficient, increases freight efficiency and improves the connectivity and accessibility of people to other people, opportunities, goods and services.
	Support regional development	– improving accessibility to jobs, services and people, improving freight connections to markets and providing better links between clusters of business activity disadvantage.
	Reduce social disadvantage	– improving access to goods, services and employment and education opportunities for people across all parts of the State.
Berlin (Germany) (p.5)	Economic target	Further improving links between Berlin and the housing areas along the axes radiating from the city.
	Social target	Strengthening the polycentric city structure through improved accessibility to urban neighborhoods and between districts and the main downtown centers.
San Diego (US) (p.2-6 and 4-4)	Social Equity	Ensure access to jobs, services, and recreation for populations with fewer transportation choices.

Figure 4: Use of accessibility indicators in regional land use and transportation plans



and the Greater Manchester Combined Authority (UK) all include specific job access objectives, making it the most common objective tied to broader criteria.

Whereas about half (17) of the metropolitan transportation plans analyzed define "access-to-destination" indicators, only eight of them use these indicators to comprehensively evaluate the benefits of land use and transportation projects.

Across the 17 plans that deploy accessibility indicators, metropolitan transportation agencies use accessibility indicators for different purposes (Figure 4). The most comprehensive accessibility analyses generally relate to project and scenario assessments. In these examples, accessibility metrics are used to compare the benefits provided by different potential transportation investments. Other metro areas conduct regional evaluations using accessibility indicators to measure current or projected land use and transportation networks at a large scale. The fourth application, equity analyses to determine how well transportation services connect to all populations, has higher relative use in the United States (US) due to federal requirements.[32]

Especially noteworthy is a missing fifth assessment type: financial accessibility. Accessibility is generally not discussed in financial terms, both as isolated measures or in tandem with the four purposes described in the rest of this finding. For example, access effects from project scenarios do not include financial counterpoints. As such, it appears that accessibility analyses are not incorporated into financial assessments. This is a marked contrast from the mobility paradigm, which makes extensive use of cost-benefit accounting and deploys "value of time" financial measures. Moving forward, quantifying the benefits and costs of accessibility and incorporating it into financial planning is an essential step to influence decision-making based on access to destinations.

Table 4: Technical criteria and scoring methodology from the Baltimore Regional Transportation Board plan, Maximize 2040 p.F-2 (author reproduction)

Goal: Accessibility		
Highway	Complete streets features: 5, 3, or 0 points	Degree to which project delivers safety/accessibility benefits for all modes (ADA improvement, improved bike facilities, etc.) – total population first, then EJ population – per mile benefits Significant features = 5 points Moderate features = 3 points Not applicable = 0 points
Highway	Access to job/activity centers: 5, 3, or 1 points	Degree to which project improves infrastructure enabling access to and supporting major job/activity centers – 1/2 mile buffer analysis – per mile benefits
Transit	Transit station/stops: 10, 6, or 2 points	Degree to which project supports access to specific destinations – EJ population – 1/4 mile buffer analysis Improve existing station/stops = 10 points New station/stops = 6 points Operations improvement plan = 2 points
Transit	Access to job/activity centers: 10, 6, or 2 points	Degree to which project improves infrastructure enabling access to and supporting major job/activity centers – 1/4 mile buffer analysis – per mile benefits

Table 5: Puget Sound Appendix P p.C-3 (left) and p.C-7 (right)

JOBS This measure addresses the extent to which projects support existing and new businesses and job creation.			
	Purpose: Access to areas of high job concentration. How well does the project support job retention or expansion by improving access?		
Points	Choose one	3	The area served by this project has an employment density of 18 jobs per acre, and is planned (has unused zoned capacity) to accommodate a density of 32 jobs per acre. (Areas that currently exceed the higher threshold would receive points here as well).
		1	The area served by this project has an employment density of 18 jobs per acre.
	2	The area served by this project has an employment density of 15 jobs per acre for jobs related to cluster employment.	
	2	The area served by this project has an employment density of 15 jobs per acre for family-wage related employment.	
	Purpose: Access to economic foundations. How well does the project provide access to job-related training or educational opportunities (vocational schools, community colleges, universities)?		
	3	In area with, or supports access to institutions identified as economic foundations.	
Total	10 (max)		

SOCIAL EQUITY AND ACCESS TO OPPORTUNITY This measure addresses the extent to which projects improve mobility and/or reduce negative impact to minority, low income, elderly, youth, people with disabilities, and non-vehicle owning populations, and whether they support access to opportunities.			
	Purpose: Improve environmental health. How well does the project avoid creating new, mitigate existing, or eliminate previous negative impacts for the following populations: minority, low income, elderly, youth, people with disabilities, and households without vehicles.		
Points	2		The project avoids creating new negative environmental health impacts or physical barriers for these populations.
	Choose one	4	The project improves environmental health for three or more of these populations.
		3	The project improves environmental health for two of these populations.
		2	The project improves environmental health for one of these populations.
	Purpose: Improve access to opportunity. How well does the project improve access to areas of opportunity?		
	Choose one	4	The process improves access to an area with a low ranking for opportunity and connects it with an area with a high ranking for opportunity (as defined by the Growing Transit Communities opportunity mapping).
		2	The process improves access to an area with a low ranking for opportunity (as defined by the Growing Transit Communities opportunity mapping).
		1	The process improves access to an area with a high ranking for opportunity (as defined by the Growing Transit Communities opportunity mapping).
Total	10 (max)		

Source: Author reproduction.

Project Assessment

The most detailed accessibility analyses are found in relation to project assessment. In these plans, specific accessibility criteria are used to compare the benefits provided by different projects as part of a multi-criteria analysis. Among the plans that we have assessed, only the Baltimore Regional Transportation Board and the Puget Sound Regional Council utilize such explicit analysis.

In Baltimore, a multi-criteria analysis was conducted to compare the projects submitted by local jurisdictions and to select which ones would be included in the Regional Transportation Plan, Maximize 2040. The multi-criteria analysis includes the following goals:

safety, accessibility, mobility, environmental conservation, security and economic prosperity. Regarding the accessibility goals, projects are evaluated based on four criteria, two in relation to highways (or road transport) and two in relation to transit (see Table 4). The criteria emphasize access to jobs and activity centers. Scores are given for each of the criteria based on specific guidelines. The Baltimore multi-criteria analysis illustrates how clear accessibility indicators can be used to inform decision-making. The weight of each indicator is clearly defined, and each project must be assessed based on the accessibility criteria included in the analysis. Furthermore, accessibility and mobility are included as two distinct goals with different criteria and methodologies, whereas in many plans accessibility and mobility are used interchangeably.

Similar to the Baltimore Regional Transportation Board, the Puget Sound Regional Council (Seattle) included accessibility in their multi-criteria analysis, which is used to prioritize projects. The Council ranks projects based on the following prioritization measures: air quality, freight, jobs, multimodal, Puget Sound land and water, safety and system security, social equity and access to opportunity, support for centers, and travel. Accessibility is included as a component of two of the prioritization measures—jobs and social equity and access to opportunity—and the Council scores projects based on explicit employment, training, and social equity dynamics (Table 5). Specific guidelines determine the score that should be given for each criteria. With respect to the jobs measure, a high score is primarily given if the project serves high employment density areas or major educational institutions. Regarding social equity and access to opportunity, a high score is given if the project connects an area with a low ranking for opportunity with an area with a high ranking for opportunity.

In both the Baltimore and Seattle examples, including accessibility indicators in multi-criteria analysis provides a systematic alternative to mobility-focused decision-making. Furthermore, clear multi-criteria analysis, using clearly defined indicators, provide greater transparency and typically foster the inclusion of an accessibility dimension in the decision-making process.

Other metropolitan areas such as the Metropolitan Council, Southwestern Pennsylvania Commission, and Southeast Michigan Council of Governments have developed accessibility indicators to evaluate projects. However, these metropolitan areas only set accessibility-based performance measures as guidelines or potential indicators for future project assessments. Unlike Baltimore and Puget Sound, these regions did not conduct an accessibility-based assessment of the projects. Nevertheless, they provide guidelines to influence local authorities to take accessibility into account. Indicators such as the

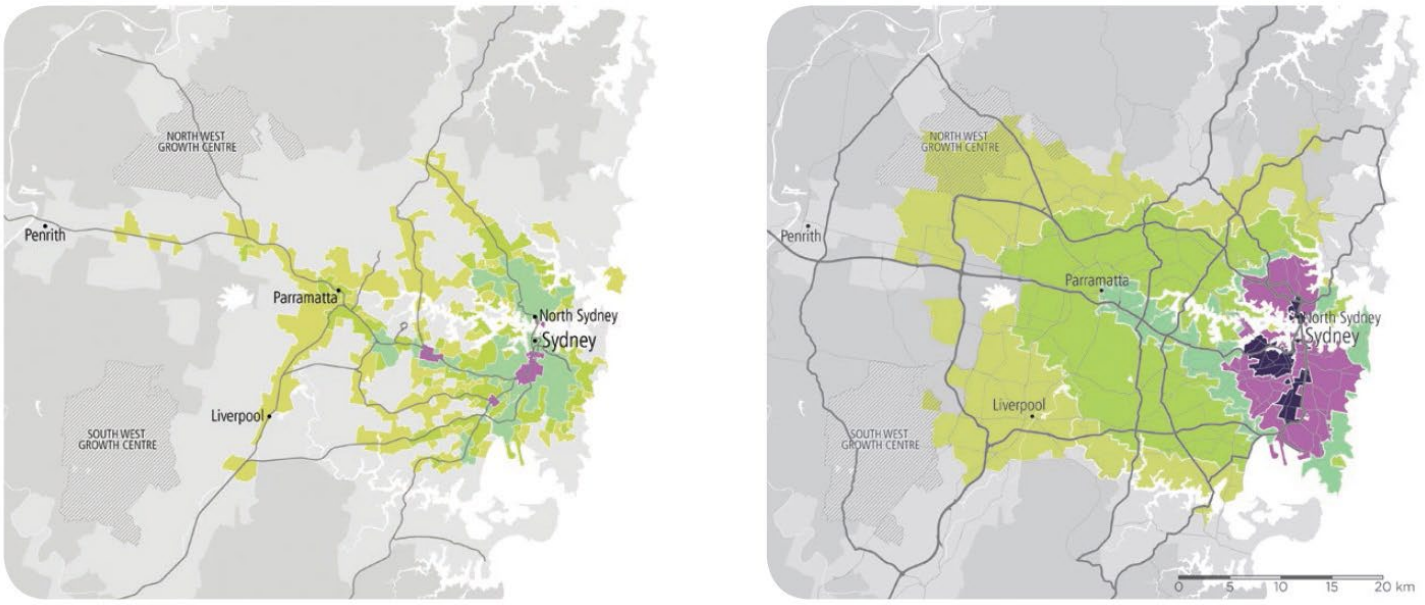
increase in job accessibility within 45 minutes on the transit system, and the number of regional job concentrations served by a project are suggested by the Metropolitan Council - St-Paul to assess access to jobs and activities as a technical investment factor. This is a move forward compared to the traditional mobility factors guiding technical analysis and investments. In a similar way, the Southwestern Pennsylvania

Table 6: Key London T2025 performance indicators p.25 (author reproduction)

Objective	Indicator and *measure*
Supporting economic development	Increase in productivity benefits arising from greater agglomeration *Agglomeration benefits £bn present value over 60 years* Increase in GDP attributable to transport investment *£bn present value over 60 years*
	Improvement in employment accessibility *The change in the number of jobs accessible by public transport within 45 minutes travel time*
	Reduction in public transport crowding *Crowding - percentage of tube and rail networks over planning guidance capacity in am peak*
	Reduction in traffic congestion *Road congestion, total hours delay, am peak*
Tackling climate change and enhancing the environment	Reduction in CO2 emissions *Percentage reduction in tons emitted per annum from transport* *Percentage mode shift from car travel to public transport, walking and cycling*
Improving social inclusion	Improved access to employment from deprived areas *Percentage of population in the 10 percent most deprived areas of London within 45 minutes travel time of international and metropolitan centers*

Figure 5: Sydney Long Term Transport Master Plan accessibility maps, public transport (left) and private vehicles (right) (p.121)

Figure 4.42 Proportion of metropolitan jobs accessible within 30 minutes by public transport and private vehicle



Commission identifies accessibility indicators (housing units within 0.5 miles of a transit stop and proximity to parks and trails) as guidelines to assess the performance of various projects.

Taken together, these results highlight the discrepancy between plans that include accessibility criteria in their decision-making processes and plans that merely provide guidelines to do so. In the first case, the regional land use and transportation plans systematically evaluate projects on the basis of accessibility. In addition to including accessibility in their own decision-making process, they set a strong example. In the second case, guidelines are suggested but no clear example is provided and indicators are not systematically included in the processes.

Scenario Assessment

Similar to project assessments, multiple metropolitan areas conduct scenario assessments based on accessibility analyses, namely London, Melbourne and Manchester. Scenario planning is a planning method that consists of visualizing and assessing various options in the future. Based on this method, some plans compare the accessibility benefits provided by three or four major investments scenarios.

For example, the city of London defines accessibility metrics to assess the effectiveness of the suggested scenarios. Table 6 presents the performance indicators within their T2025 plan, with two related to accessibility: first, the number of jobs accessible by public transport within 45 minutes travel time; and second, the percentage of population in the 10 per cent most deprived areas of London within 45 minutes travel time of international and metropolitan centers.[33]

London includes clearly quantified accessibility indicators in the criteria for the scenario assessments. These measures are easy to generate and to interpret. Furthermore, given their specific nature, the indicators 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 per cent" (p.74). Accessibility is one of the few indicators stated in the scenario assessment, and thus appears to play a key role for assessing the scenarios. However, the weight given for each indicator is not specified, as was the case for the project assessments in the section above. Furthermore, while accessibility indicators are presented as key performance indicators, accessibility metrics are not presented in the final scenario assessment table (p.130-131). Further investigation would be needed to understand how accessibility metrics are used in the scenario assessment. Nevertheless, London's plan

Table 7: Manchester Integrated Assessments Report p.16 (author reproduction)

Integrated assessments objectives	Guide questions
To support economic growth across the subregion and improve access to jobs for all	Will the LTP improve access to jobs, particularly for people who suffer income or employment deprivation? Will the LTP reduce journey times and improve accessibility for local businesses?
To contribute to the improvement of physical and mental health and wellbeing for all and reduce health inequalities.	Will the LTP improve or reduce accessibility to health care facilities, particularly for those who need the most health services e.g. the elderly, people with disabilities and those without a car? Will the LTP encourage healthier lifestyles by promoting the use of walking, cycling and public transport and increase accessibility to open greenspace and sports facilities particularly for the most deprived communities and sections of the community whose access needs are often not catered for?
To reduce CO2 emissions from transport.	Will the LTP improve accessibility through integrated spatial planning?
To contribute to the creation of vibrant, sustainable communities with easy access to the transport system for all.	Will the LTP help to increase access to and usage of the public transport network for all? Will the LTP support key sections of the community in accessing social networks and support the development of strong communities?

presents clear scenario assessment guidelines that include quantified accessibility metrics.

Melbourne also refers to an extensive accessibility analysis that was conducted to understand the impacts of various measures. They identified that increasing public transport service frequency was key to improving accessibility by transit. Similarly, they state that increasing tram speeds (by 25 percent) "had a significant effect on the accessibility provided by the public transport network" (p.85). Although the specific metrics or indicators are not presented in the plans, the assessment of the plan suggests that the new strategies (increasing tram speeds and frequency) are based on an accessibility analysis.

An integrated assessments report, using accessibility indicators, was produced as a complementary part of the Greater Manchester Combined Authority Local Transport Plan 3 (LTP3). This report includes the requirements for a strategic environmental assessment, a health impact assessment, and an equality impact assessment. These assessments aim at evaluating the various impacts of major projects on the environment, population health and social equity respectively. The Local Transport Plans national Guidance recommends these three assessments to be conducted when developing a LTP.[34] Based on the requirements from these three assessments, an assessment guide was developed and filled with respect to the LTP3. The integrated assessment looked at multiple questions related to accessibility (see Table 1). These questions address a wide range of societal issues, including human health, economic growth, equity and environmental concerns. As seen in the Baltimore Regional Transportation Board and the Puget Sound Regional Council plans, accessibility issues are systematically included. Each question has to be addressed to ensure that the LTP3 meets the various objectives stated at the national and local levels. Although the questions are relatively broad, they encourage accessibility to be taken into account when assessing the plan. Furthermore, a detailed accessibility strategy was developed in 2006.[35] The newer LTP3 builds on this previous strategy, which included detailed indicators.

Not unlike project assessment, scenario assessment based on accessibility measures help foster the inclusion of accessibility in decision-making processes. Furthermore, the use of accessibility metrics, as seen in London and Melbourne, provide potentially greater transparency in the decision-making process.

Regional Evaluation

In these plans, metropolitan areas discuss accessibility in terms of service coverage and/or service gaps based on an entire region's transportation plan and related

benefits. The analysis underlying regional evaluation is similar to the scenario planning process presented above, but focuses on the diagnosis of the current situation or on highlighting the benefits of a future regional plan.

For example, the New South Wales (NSW) Government's Sydney Long Term Transport Master Plan identifies spatial transport gaps by mapping access to jobs by public transport and by car (Figure 5). It uses maps to discuss regional needs in terms of accessibility. Visualization materials, such as maps, are valuable tools to help the reader understand the concept of accessibility and to highlight the impacts of land use

Figure 6: Plan de déplacements urbains Ile-de-France accessibility maps (p. 36): Number of jobs accessible within 30 minutes by private vehicle (top) and public transportation (bottom)

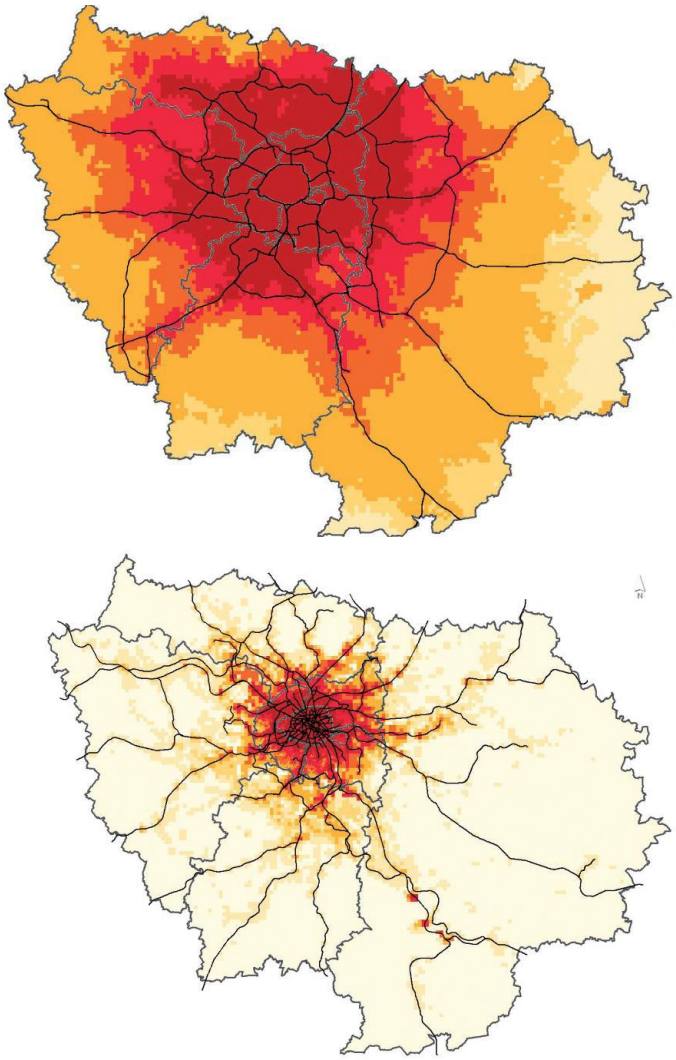
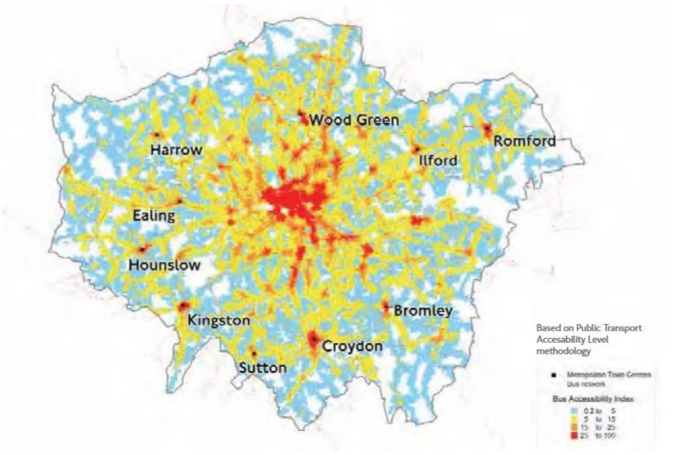
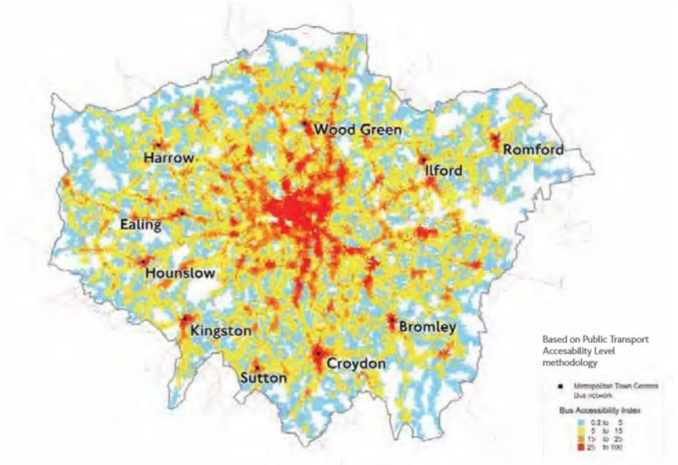


Figure 7: London T2025 bus accessibility maps p.92 and 93





and transportation systems. For example, the NSW Government illustrates the discrepancies between access to jobs by public transport and by car.

Similarly, the Plan de déplacements urbains Île-de-France by the Conseil régional d'Île-de-France (Paris) provides maps of accessibility to jobs by transit and by car in the Paris metropolitan area, with clear accessibility advantages for private vehicular travel (Figure 6). However, the plan does not formally discuss these maps. It is thus unclear to what extent accessibility is part of the planning and decision-making process.

Regional evaluations based on accessibility metrics are also presented to highlight the benefits of new transportation plans or projects. This is namely the case in London and Melbourne. The London plan highlights that the number of people within 45 minutes of central

London will increase by almost 25 percent after the implementation of the plan, which is consistent with the plan's main objectives. The increase in accessibility by bus are presented through accessibility maps, before the implementation of the plan, and after the implementation of the plan (Figure 7).

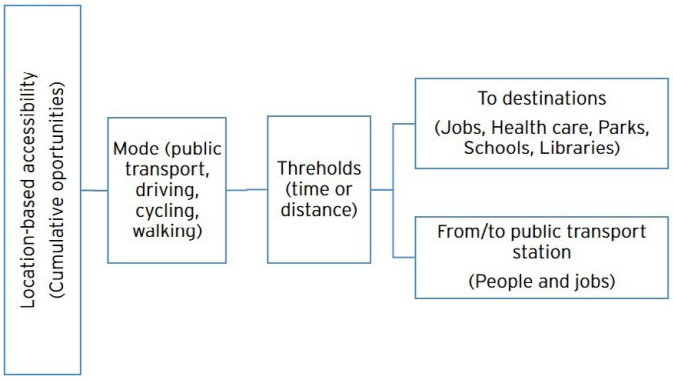
Overall, accessibility metrics are a useful tool to provide an overview of the land use and transportation network, especially through the use of maps. However, in most cases presented above, it is generally unclear how accessibility metrics were used in the decision-making processes. Accordingly, better aligning accessibility indicators and the planning process with a plan's objectives would provide greater clarity.

Equity Analysis

Many transportation plans use accessibility metrics to conduct social equity assessments. They generally assess the level of accessibility of specific demographic groups relative to the general population, often focusing on economically disadvantaged groups. This is especially true for US metropolitan areas, where federal funding requires an environmental justice assessment.[36] The Metropolitan planning organizations (MPOs) in charge of regional transportation planning must demonstrate that they address any disproportionate negative impacts on the target groups (defined by the federal government).

Many regions conduct their environmental justice assessment based on accessibility analyses. For example, the Southern California Association of Governments (Los Angeles) has detailed accessibility indicators to employment, services, parks and schools. The analysis shows that there are "no unaddressed disproportionately high and adverse effects for low income or minority communities" (p.157). Similarly, the Atlanta Regional Commission (ARC) specifically assessed the number of low-wage jobs accessible from equitable target areas. The ARC also looked at accessibility to libraries, schools, grocery stores, major hospitals, and public parks from these areas. Many metropolitan areas in the US have conducted similar detailed accessibility analyses, measuring the number of opportunities (jobs, health care services, libraries, schools) available from areas with high proportions of disadvantaged individuals.

Figure 8: Types of accessibility metrics used in regional land use and transportation plans



However, in most cases the use of accessibility is limited to environmental justice assessments. While the federal government requires such measurement, there is no comparable requirement to use accessibility when prioritizing future investments (that could ultimately reduce any accessibility inequities). By contrast, the London and Greater Manchester transportation plans demonstrate how the environmental justice assessments can be used to assess regional accessibility from a broader perspective. In these cases, accessibility-based social equity indicators are included as main performance indicators under the equity objectives of the overall plan. However, the US federal government does not formally define accessibility or apply it to other planning requirements. This governance feature highlights the need to have clearly defined, formal accessibility goals that do refer to the ease of reaching desired destinations.

Among metropolitan transportation plans that use specific indicators, the plans tend to measure accessibility in a relatively uniform, narrow manner.

The 21 metro areas using accessibility indicators demonstrate a similar pattern among the types of metrics (Figure 8). The measures are typically location-based and focus on the region-wide accessibility for the entire population, rather than focusing on specific demographic groups or target neighborhoods. In all cases, measures are based on cumulative opportunities, using a travel time or distance threshold, mainly for public transport and driving. Cumulative opportunities use a time-based threshold to qualify reachable

opportunities, representing all destinations reached as a share of total destinations in the metro areas.
Among the regional plans, their accessibility measures can be divided into two categories: access to or from public transport station and access to destinations.

Access to public transport is the most common measure. This measure is generally presented as the percentage of people or jobs that are within 0.5 mile of a public transport station. This is a measure of service coverage and is generally used by public transport authorities as a performance indicator.[37] A more specific measure of access to transportation is presented by the Chicago Metropolitan Agency for Planning. In the Go To 2040 update in 2014, the plan recommends that 78 percent of the population (81 percent of jobs) should have at least moderate access to transit. Moderate access is based on transit access that includes the following factors: frequency of service, activities that can be reached via a single direct transit route, proximity to transit, and pedestrian friendliness. This is a composite indicator that includes multiple factors, which better represents the quality of service than simple coverage measures. Nevertheless, while the access to public transport dominates the regional land use and transport plans, Chicago's approach does not directly address the ease of reaching urban opportunities.

The second type of metric—access to urban opportunities—directly measures the ease of reaching various destinations, generally jobs, using a specific mode. This measure is more complex to generate, as it requires geo-located data of the destinations. Nevertheless, access to destinations is not uncommon in the plans reviewed, especially with respect to social equity. Out of the 32 plans, 16 plans discuss access to destinations, typically jobs, and nine of them in relation to social equity. Access to jobs often functions as a region-wide indicator, reflecting the commute sheds that define metropolitan areas. It also naturally weights service and commercial centers, since areas with a high density of services and commercial activities are also characterized by a high density of jobs. Other types of destinations often used include libraries, schools, grocery stores, hospitals, public parks, all of which the Atlanta Regional Commission uses in its regional metrics. Yet, of the 16 plans that address access to destinations, only seven include destinations other than jobs, and in almost all cases, these analyses are limited to the environmental justice assessments.

With respect to more demographic or geographically-targeted measures, many metro areas segment the accessibility analysis by socio-economic groups. However, only Atlanta and Boston address destination segmentation. For example, the Atlanta Regional Commission addresses the number of low-income jobs accessible to capture the level of accessibility of low-income households. In addition, the Boston Region Metropolitan Planning Organization assesses access to industrial, retail and service jobs. This is an important improvement as the accessibility to all jobs may not represent the opportunities that are actually available to different groups of populations.[38]

In terms of modes and thresholds (Figure 8), accessibility to jobs is typically generated for transit or automobile, using travel time thresholds varying from 30 minutes to 60 minutes. Based on the existing literature, accessibility measures based on travel time thresholds adequately reflect accessibility, as they are highly correlated with mode choice.[39] Although none of the plans assessed include financial costs in their indicators, measures of generalized costs (including the personal financial costs and time of travel) have been developed in the literature.[40] These measures better reflect the total costs of travel as they include both financial and time burdens. The financial burdens refer to the trip fare in the case of public transportation, and the cost of fuel, maintenance and parking for private vehicle. They are challenging to generate, however, due to complex fare structures and availability of data. Yet, excluding the financial costs of travel results in an overestimation of accessibility,[41] especially for low-income individuals. In this regard, accessibility based on financial and time costs is a closer approximation of individual preferences and can also provide an insight on fare structures. 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.

While most transport plans concentrate on including accessibility by transit and car, few plans address access to destinations by 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, as done by the Atlanta Regional Commission. Access to jobs by cycling

or walking is included in the North Central Texas Council of Governments plan, as well. 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. With public transport and driving, the travel distance is not always representative of the travel time, due to different speed limits, levels of congestion, and public transport route time efficiency.

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.[42]

This section explored the use of accessibility goals, objectives and indicators based on a critical assessment of metropolitan transportation plans. The next section explores the implementation of metrics in practice, through a survey of land use and transportation practitioners.

5 Practitioner Survey Findings

By conducting an extensive survey of practitioners worldwide, this report identifies several notable trends on how different organizations and places use and implement accessibility metrics. In particular, 343 land use and transportation practitioners were surveyed – across all types of organizations and geographies – to reveal some of the potential pathways to better understanding accessibility's role in future plans, policies, and decision-making processes.

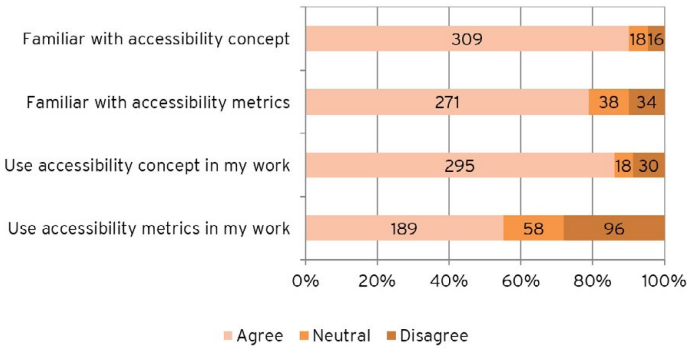
The subsequent sections discuss the following three findings in detail. The first section examines the level of familiarity among respondents with accessibility, including specific metrics. The second section focuses on barriers and opportunities to generating accessibility metrics, as expressed by different respondents. The last section considers how practitioners envision accessibility as a key part of their decision-making processes moving forward. Overall, the survey results demonstrate there is an important gap between knowledge and implementation of metrics, a gap that can be addressed through greater education and planning requirements.

While nearly all practitioners surveyed for this report are familiar with the concept of accessibility, only 55 percent use accessibility metrics in their work.

All respondents were asked about whether they were familiar with accessibility concepts and metrics, and whether they used them in their work (Figure 9). In all cases, more than 50 percent of the respondents agreed with the statement, suggesting that the majority of respondents are familiar with the concept and metrics, and use them in their work. This high penetration rate is partially explained by the non-random selection of participants. In fact, there was an effort to disseminate the survey to practitioners who do work with accessibility, as the aim was to understand how accessibility is designed and implemented. Furthermore, practitioners with a prior knowledge of accessibility were more likely to fill out the survey.

Nevertheless, the comparative assessment of the familiarity and use of the concept and metrics sheds light on current practices. Interestingly, 90 percent of the respondents are familiar with the concept of accessibility and 86 percent of the respondents use the concept of accessibility in their work. Not surprisingly, a slightly lower proportion of respondents (78 percent) are familiar with the metrics. Yet, only 55 percent of these respondents use those metrics in their work. There is an important discrepancy between the number of respondents that are familiar with the metrics

Figure 9: Familiarity with and use of accessibility (Concept and metrics)



and the ones who use it. These findings suggest that although practitioners are familiar with the metrics, some factors prevent them from implementing them in their workplace. These factors are further explored in Finding E.

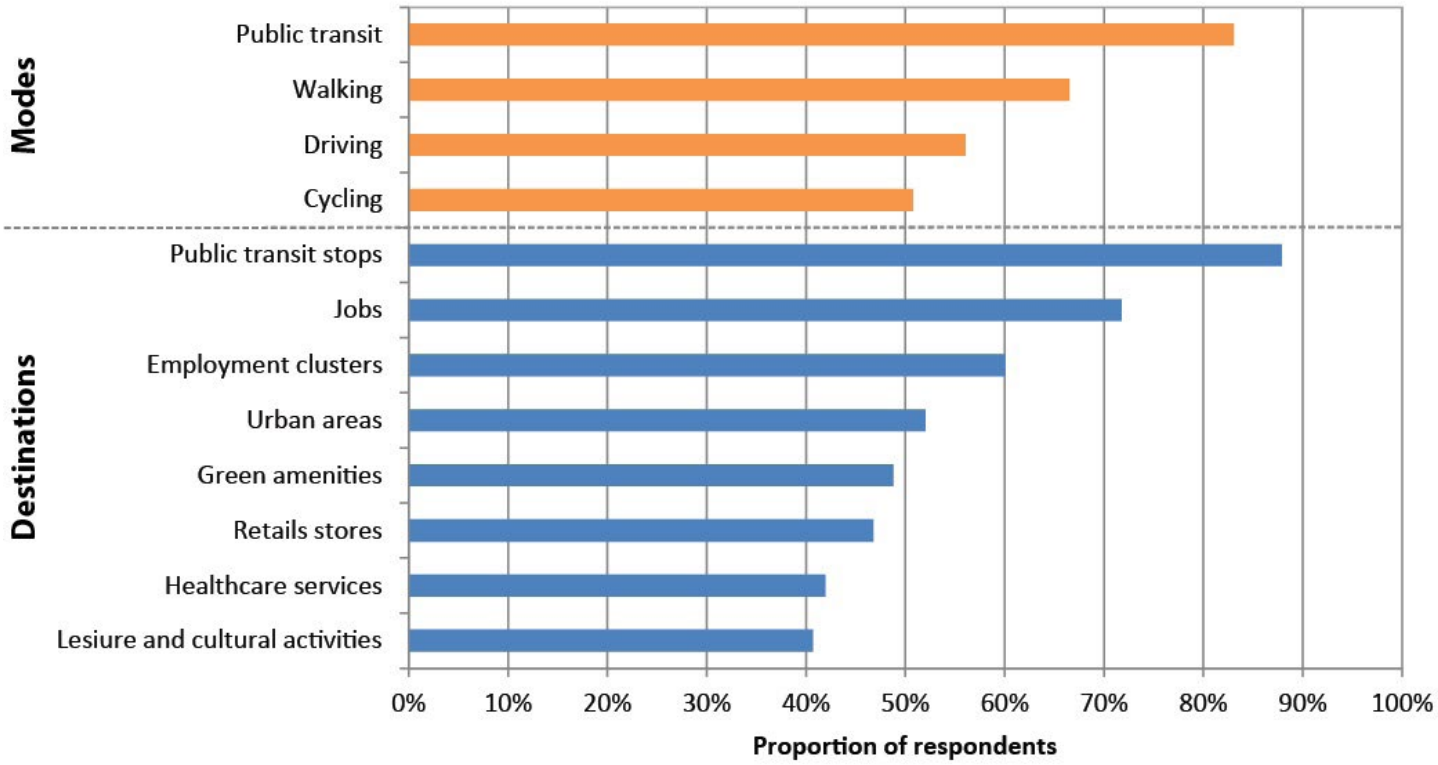
The survey also explored the types of accessibility metrics used by the respondents. As seen in Figures 10 and 11, public transit is dominant, both in terms of modes assessed and types of destinations (access to public transportation stops). Access to public transit is a measure of service coverage that is widely used by public transit providers and in metropolitan transportation plans.[43] Yet such a measure is only one component of accessibility, as it does not include the location of opportunities. For example, an individual may have good access to a public transit stop, but the bus line serving the stop might not connect riders to sufficient opportunities.

To effectively capture the ease of reaching opportunities, access to destinations must be considered. In this regard, access to jobs and employment clusters, although not as commonly used as access to public transit, is used by a vast majority of respondents (72 percent and 60 percent respectively), while access to other types of destinations (green amenities, retail stores, healthcare services, and cultural and leisure activities) is used by a lower proportion (between 40 percent and 50 percent).

In terms of modes, access by public transit is used by the greatest number of respondents. Since the availability of GTFS data, accessibility by transit has become a major trend of accessibility research.[44] Whereas cycling and walking accessibility is not as commonly assessed by practitioners, van Wee (2016) recently emphasized the need for accessibility research focusing on active transportation modes. Although there is emerging research on this topic,[45] the gaps in research likely explains the low penetration of accessibility indicators related to more active transportation modes.

Respondents were also asked to select the types of metrics that they used in their work. As seen in Figure 11, the most commonly used metrics are travel time proxies. In line with these findings, a recent study found that travel time proxies are also widely used in metropolitan transportation plans across the United States.[46] While travel time is a good indication of mobility, it does not fully reflect the ease of reaching destinations. As such, increased travel speeds do no

Figure 10: Accessibility metrics – Modes and destinations



necessarily lead to increased accessibility.[47] In this regard, measures of access to destinations, such as cumulative-opportunities or gravity-based metrics, must be used in addition to travel time proxies to capture the potential access to destinations. Yet, out of the 129 practitioners that used travel time as a proxy, 43 respondents did not use access to destinations metrics as a complementary indicator (cumulative-opportunities or gravity-based).

The single use of travel time proxies can result in a bias towards mobility-based approaches, rather than ensuring a reasonable access to destinations for all.[48] Density and land use mix proxies are also commonly used by practitioners as shown in Figure 11. Increasing density and mix of use has the potential to increase access to destinations, and is thus a relevant metrics to address planning for accessibility.[49] Yet, it does not account for the transport component.

The results indicate that accessibility metrics used by practitioners are generally based on travel time or distance. These thresholds are also largely used in accessibility research, while a few studies have incoporated generalized costs.[50] Although generalized costs better represents the time and monetary values associated with a trip, metrics based on time generally adequately reflect accessibility, as they are highly correlated with mode choice.[51] Nevertheless, the financial costs of travel are essential elements of accessibility for low-income populations.

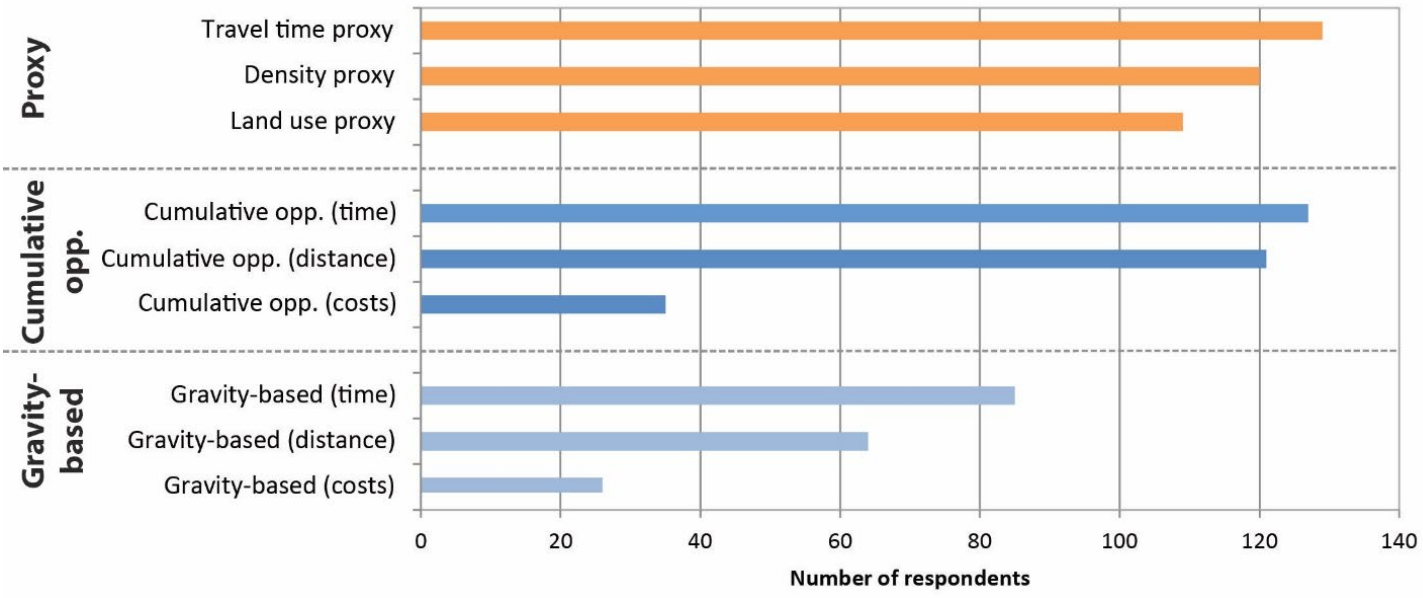
Among the 189 practitioners who agreed ("agree" or "strongly agree") that they use accessibility metrics in their work, 42 respondents did not use indicators that reflect access to destinations and 40 respondents merely used proxies (travel time, density, land use mix). Overall, 43 percent of all respondents (n=343) use metrics reflecting access to destinations, while 55 percent stated that they use accessibility metrics in their work (Figure 9).

Taken together, these findings illustrate the need to train current and future practitioners about accessibility metrics and reiterate the importance of having clearly defined accessibility indicators in planinng documents. More specifically, a clear distinction should be made between mobility and accessibility, and access to destinations should be emphasized. This is, however, often lacking in planning documents.[52]

For practitioners who do not use accessibility metrics in their work, 52 percent express a lack of knowledge as a major barrier to implementation.

To better understand the factors underlying the use of the accessibility concept and metrics, respondents were asked about their rationale for generating accessibility metrics. For those who did not use

Figure 11: Types of accessibility metrics used by practitioners

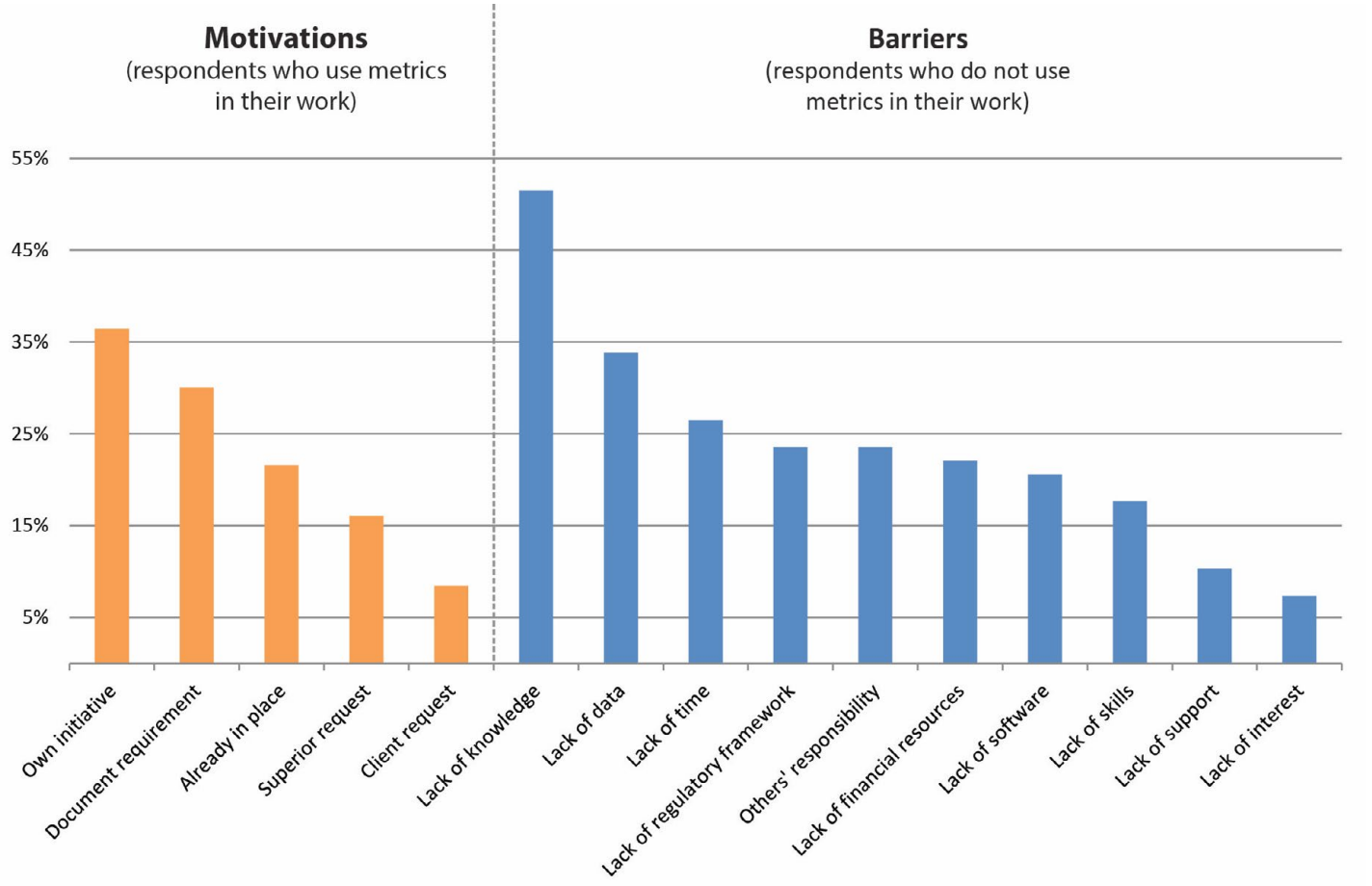


accessibility metrics in their work, the survey asked them about the barriers preventing implementation. Figure 12 shows the motivation for using accessibility metrics (among respondents who use the metrics) and the barriers to using them (among respondents who used the concept, but not the metrics).

Only 22 percent of the respondents that used accessibility metrics in their work stated that the metrics were present as a tool prior to their arrival. Similarly, few respondents (16 percent) stated that it was a request from their superior. These results suggest that, although most practitioners are familiar with the concept and metrics, accessibility is not widely implemented as a planning tool in the survey sample. In contrast, the main motivation for using the metrics comes from the respondent's own initiative (36 percent). This indicates that promoting accessibility among practitioners can be an efficient way to foster the implementation of accessibility metrics as a planning tool. Furthermore, 30 percent of the respondents indicated that the generation of the metrics resulted from a planning document requirement. Accordingly, integrating accessibility indicators in planning documents can help practitioners in implementing accessibility metrics in their work. Finally, a request from a client represented the least important motivation. This could be due to the low representativeness of respondents from the private sector in the sample.

With respect to the respondents who did not use accessibility metrics in their work (right), the barrier most frequently stated by respondents is the lack of knowledge (52 percent). These findings highlight the need to educate future and current practitioners about accessibility metrics, especially since the survey revealed that most metrics were generated as a result of the respondents' own initiative. Furthermore, another important barrier is the lack of data to generate accessibility metrics (34 percent). Yet, many accessibility metrics can be generated through open-source data, for example using General Transit Feed Specification and OpenStreetMap data, and open-

Figure 12: Motivations and barriers to the use of accessibility metrics



source Geographic Information System (GIS) analysis software such as QGIS. With respect to the location of jobs or other opportunities, these can be obtained from various public sources, which in many cases public officials have access to better data than researchers. Accordingly, the lack of data could also be addressed by educating practitioners about how to collect adequate data to generate accessibility metrics and the different data sources and tools that are available in different regions. Finally, it is also interesting to note that the lack of interest (7 percent) and lack of support (10 percent) are the least commonly stated barriers to implementing accessibility metrics. Practitioners hence do not appear to be reluctant to implementing more accessibility-based approaches. Rather, knowledge factors prevent them from generating accessibility metrics.

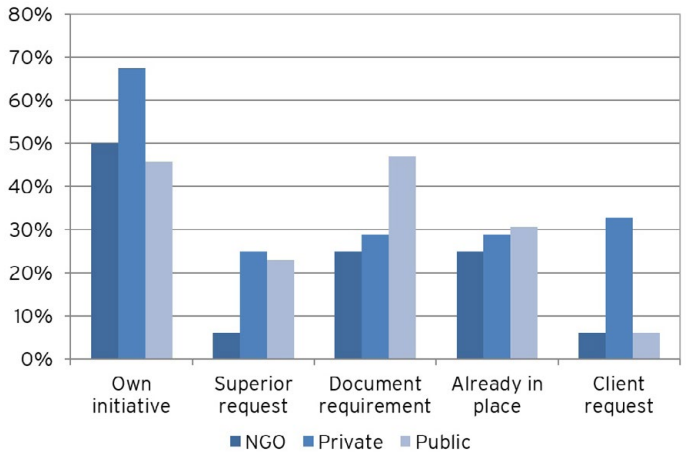
A previous study on the use of accessibility instruments by practitioners in Europe found that the lack of resources, including time, money, data and computational skills in the participants' organization were perceived as important barriers by the participants.[53] Furthermore, the lack of funding and resources has been identified as a major barrier to the implementation of accessibility planning in the UK.[54] Based on this report's survey, between 16 and 34 percent of respondents also identified the lack of resources (either data, time, money, software or skills) as a barrier. Although the lack of knowledge is most commonly cited, our findings confirm the presence of institutional barriers to the implementation of accessibility metrics. While the studies discussed above are based on European practices, our sample is largely represented by practitioners outside of Europe and thus suggests that these barriers are not unique to the European context.

Figure 13 presents the motivations for using accessibility metrics by sector of employment. Unsurprisingly, the proportion of respondents who stated that the generation of accessibility metrics was their own initiative is greater for respondents from the private sector, whereas a requirement from a planning document is most frequently cited by respondents from the public sector. The generation of accessibility metrics due to a requirement from a planning document is in fact the most commonly cited reason in the public sector (47 percent of the respondents), highlighting the potential influence of planning documents on practitioners from the public sector. With respect to the private sector, a request from a client is the second most commonly cited motivation (33 percent of the respondents). As transportation planning clients are often public entities such as municipalities or regional governments, planning documents can also play an important role here. Indeed, having clear accessibility objectives and indicators can support the integration of accessibility metrics in outsourcing contracts.

With respect to planning documents, respondents were asked about the presence of accessibility in the planning documents that they work with (see Appendix B). Around 74 percent of the respondents stated that the concept of accessibility is included in the planning documents of their region, whereas 59 percent indicated that accessibility was stated as a goal (Figure 14). Furthermore, only 38 percent of them agreed that clearly defined accessibility indicators were present in the planning documents. These findings are in line with previous studies that found that although accessibility is included in most planning documents, few of them have clear accessibility goals and indicators that guide the decision-making processes.[55] Yet, the presence of requirements in planning documents foster the use of accessibility metrics by practitioners. Accordingly, it is essential to establish clear accessibility guidelines in regional and metropolitan transportation plans.

The presence of accessibility in planning documents is further explored by comparing the results between respondents that used accessibility metrics, respondents that used the concept but not metrics, and

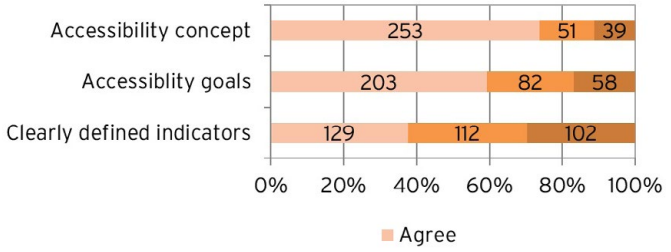
Figure 13: Motivations to the use of accessibility metrics, by sector of employment



respondents that did not use accessibility in their work. Note that, for the purpose of this analysis, respondents who selected "neither agree nor disagree" with respect to the use of concept or metrics were not considered as respondents that used the concept or metrics.

Figure 15 illustrates the proportion of respondents that agreed with each statement, for each group. Respondents that do not use accessibility in their work agreed in a lowest proportion that the concept of accessibility is included in the planning documents they work with and that accessibility is stated as a goal. These results suggest that the presence of accessibility, and its statement as a goal, are associated with a greater use of accessibility (both in terms of concept of metrics). Note that a statistical difference test (Tukey HSD) was performed to compare the average Likert scale values (from 1 to 5) between the three

Figure 14: Presence of accessibility in planning documents



groups: i) respondents that use accessibility metrics, ii) respondents that use the concept of accessibility, but not the metrics, and iii) respondents that do not use accessibility. Statistical differences (at the 90 percent confidence level) were observed between respondents that do not use accessibility, and the ones that do (metrics or concept), further supporting the results discussed above.

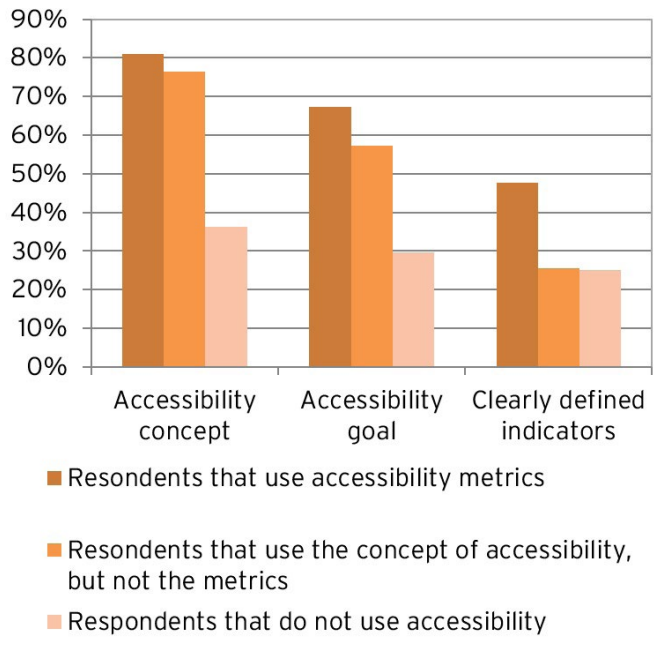
With respect to indicators, the proportion of respondents that agreed that clear accessibility indicators were included in the planning documents is much higher among respondents who used accessibility metrics in their work. In this case, statistical differences in the average Likert scale values were found between respondents that used metrics and the two others groups. These results supports the finding that the presence of clear accessibility indicators in planning documents foster the implementation of accessibility metrics by practitioners. Whereas as goals are associated with respondents that use accessibility in general, clear indicators are more strongly linked to the use of metrics. This is once again not a surprising result, but highlights the strong importance of having clearly defined indicators in planning documents.

Most practitioners agree that accessibility metrics can and should influence decision-making processes in their organizations or agencies, including 95 percent of practitioners who already use these metrics in their work.

Another important component of accessibility metrics is their potential to influence decision-making. In this regard, respondents were asked about the relevance of accessibility metrics to planning and decision-making (Figure 16). As in the previous analysis, respondents who selected "neither agree nor disagree" with respect to the use of concept or metrics were not considered as respondents that did use the concept or metrics, respectively.

Overall, more than 95 percent of the respondents who do use accessibility metrics agreed that accessibility metrics can and should influence decision-making, while effectively all of this group believed accessibility

Figure 15: Presence of accessibility in planning documents, by use of accessibility



metrics are useful planning tools. The share of affirmative answers drop, however, as the respondents use accessibility metrics less. Although not surprising, this finding could suggest that as more practitioners use accessibility-based approaches, a greater proportion will perceive accessibility metrics as a potential planning tool to inform decision-making. It could also reflect that practitioners who perceive accessibility as useful for decision-making are more incline to using accessibility metrics.

Statistically-significant differences were observed in the average Likert scale values between respondents that use accessibility metrics and the two other groups, whereas the difference between the respondents that use the concept (not the metrics), and respondents that do not use accessibility were not statistically different.

Respondents who did use accessibility in their work were also asked for what purpose they used the concept or the metrics of accessibility. In both cases, the main purpose was for decision-making (Figure 17). These findings are coherent with the results discussed above. Clearly, there is an agreement among most practitioners that accessibility is an important component of decision-making.

Figure 16: Relevance of accessibility metrics to planning and decision-making

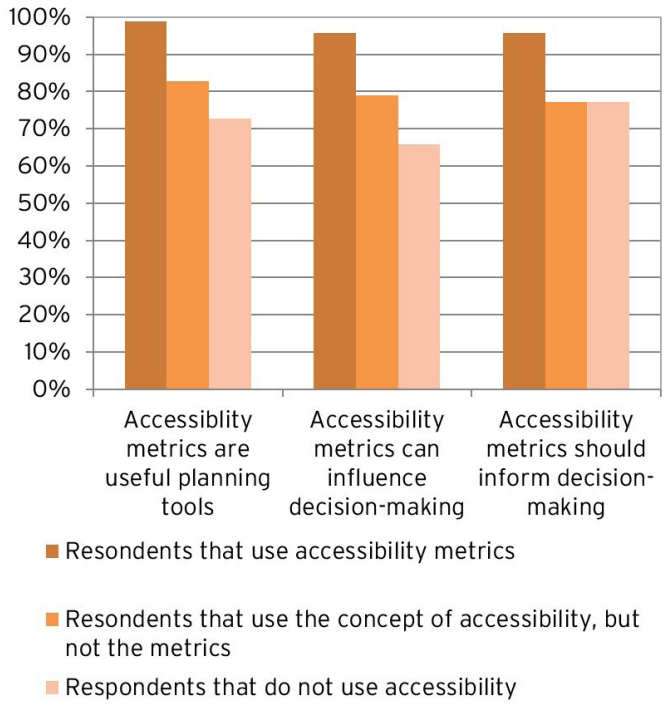
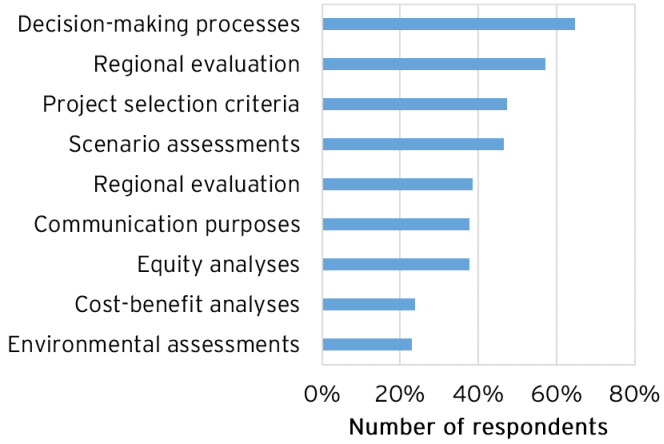


Figure 17: Different uses of accessibility metrics



Furthermore, regional evaluation, project selection criteria, and scenario assessments were the most common uses after decision-making (Figure 17). These findings are in line with the assessment of the plans presented within Findings A through C. Also similar to the assessment of metropolitan transportation plans, fiscal analyses based on accessibility do not appear to be present. Cost-benefit analysis was the least commonly cited use of accessibility metrics (by 24 percent of the respondents), together with environmental assessments. This further supports that accessibility analysis are not integrated into fiscal analyses.

6 Implications and Policy Recommendations

Based on the assessment of over 30 metropolitan transportation plans and direct survey of over 300 related professionals, there is little question that the accessibility concept is now firmly rooted within transportation and land use planning. However, these results also find considerable barriers to transforming such demonstrated interest with accessibility concepts into formal policy.

Reviewing metropolitan transportation plans reveals a promising trend to integrate accessibility objectives into conceptual frameworks, a major evolution beyond the formerly strict use of the mobility paradigm. Most plans also emphasize the need to improve accessibility, and oftentimes the more specific goal of greater access

to destinations.[56] However, the transition towards accessibility-based planning is far from complete. Practically speaking, few plans employ accessibility-based indicators to guide their decision-making processes. There is often a discrepancy between plans' stated accessibility objectives and the performance indicators used to make decisions. Mobility approaches, which have dominated transportation planning since the widespread use of the car in the 1950s, are still strongly rooted in practice.

The results of the practitioner survey demonstrated an important gap between the knowledge of the concept of accessibility and its implementation into accessibility metrics. While most practitioners surveyed are familiar with the concept of accessibility, a much lower proportion of respondents (55 percent) stated that they use accessibility metrics in their work. Furthermore, only 43 percent of the respondents actually used accessibility metrics that reflect the ease of reaching destinations. In contrast, access to public transit and travel time proxies were most commonly used by practitioners. This aligns with the transportation plan assessment, where access to transit and travel times proxies were the most commonly used metrics.

Based on the findings from this research, more concerted efforts are needed to effectively implement accessibility-based approaches. Whereas lack of support and interest does not appear to be a major obstacle to implementing accessibility metrics, lack of knowledge and data is highlighted as the main barriers among practitioners. Planners must often take the initiative to implement metrics in their regular routines, suggesting a lack of knowledge or support for formal accessibility policies from their superiors.

These findings suggest that working directly with practitioners and supervisors can effectively foster the use of accessibility metrics in practice. More specifically, such efforts can contribute to the implementation of metrics in practice by: i) providing practitioners with a greater understanding of various types of metrics, ii) improving their knowledge on how to generate such metrics, and iii) highlighting the value of using these metrics for land use and transportation planning.

Furthermore, greater collaboration between researchers and practitioners can help align academic pursuits with practical challenges and needs. Given that accessibility is now a mature field of research, there is a potential to strengthen the links between the different actors and to increase collaboration between academics and practitioners. In fact, previous research has shown that an improved dialogue between researchers, practitioners, and software and tool developers can better support the use of planning tools, and more specifically accessibility planning tools, in practice.[57]

In the European context, the Cost Project on accessibility instruments that brought together developers, researchers and academics, found positive results that suggested that workshops can contribute to promoting the use of accessibility instruments in practice. Namely, the authors reported that participants were satisfied with the workshops and intended to use the insights gained from the workshop in their work, and share them within their organizations.[58] This study highlights the need for similar projects, especially in North America. These workshops could be delivered in various forms. Firstly, an open workshop could be organized as part of global conferences, such as the annual Transportation Research Board meetings. Secondly, independent workshops could be organized in various cities. Thirdly, open online webinars could be conducted to reach a greater number of practitioners.

In addition to working closely with practitioners, practitioners stated that the presence of clear accessibility indicators is a key motivation to implement accessibility metrics. Yet most respondents, especially those that do not use accessibility metrics, indicated that their local region's planning documents do not include clear accessibility indicators. Similarly, the plans assessed in this report revealed that few have accessibility indicators guiding their decision-making processes. To foster the generation of accessibility metrics, it is essential to ensure that clear accessibility guidelines are included in planning documents.

While this report uncovers distinct barriers to implementation, it also points to successes with advancing accessibility theory into formal practice. Those can be grouped into six distinct recommendations, plus an additional group of next steps.

Accessibility goals and objectives

Goals and objectives are key elements of any transportation plan, as they guide the specific planning targets.[59] The same applies to accessibility concepts, as regions like London with more specific goals related to accessing key destinations created a stronger foundation for practitioners to develop actionable metrics. In contrast, broad accessibility goals can be misinterpreted and do not necessarily address access to destinations.[60] For example, the US federal government defines six planning factors that guide the development of regional transportation plans, one of which is to "increase the accessibility and mobility of people and for freight." 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.

Distinction between accessibility and mobility

Another best practice is to have distinct mobility and accessibility goals. As accessibility objectives are often translated into mobility indicators (see Finding A, Table 3), the definition of two distinct objectives can prevent such practices as seen in the Baltimore plan. In its multi-criteria analysis, the Baltimore plan defines six distinct goals, one of which is accessibility and one of which is mobility. As a result, the indicators falling under the accessibility goal are specific to accessibility and reflect the ease of reaching destinations. Furthermore, a clear distinction should be made between access to mobility, access to destinations[61] and universal accessibility. This can be encouraged by the clear definition of objectives, as highlighted in the first recommendation.

Multi-criteria analysis including accessibility indicators

To further foster accessibility-based planning approaches, accessibility indicators should systematically be included in multi-criteria analyses as in the case of London, Baltimore and Puget Sound. Although this does not ensure that decisions will be made based on the accessibility analysis, it offers an alternative to mobility-based decisions and potentially provide greater transparency in the decision-making process.[62] 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, as done by Baltimore. Another approach is by defining guiding factors on which projects should be analyzed, as done by the St-Paul Regional Council. This encourages the integration of accessibility-based indicators, but might not be as efficient as a systematic multi-criteria analyses conducted to select projects.

Access to destinations metrics

The use of access to destinations metrics such as cumulative-opportunity metrics provide indicators that typically reflect the ease of reaching destinations. We encourage regional planners to use such measures. More specifically, we recommend the use of cumulative-opportunities measures to jobs by public transport and car. These measures provide adequate indicators of the regional patterns of accessibility, and are easy to generate, to interpret, and to communicate.[63]

Yet, while accessibility to jobs by automobile or transit provides a good assessment of land uses and the transportation system, they do not fully address broader planning goals, such as increasing social inclusion and population health. However, these are key planning issues to which land use and transportation planning can contribute. For example, access to health care facilities, green amenities and sport and leisure center provides greater health benefits. Similarly, access to education facilities and social and cultural amenities reduces the risk of social exclusion. Accordingly, accessibility analyses will need to include diverse destinations if they are to address the full range of issues related to geographic access.

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.

Multiple modes

Including active transportation modes can also contribute to achieve a wider range of objectives. Greater walkability is associated with positive health outcomes. Moreover, increasing active transportation can contribute to reduce car dependency, and the associated social and environmental impacts. Finally, neighborhoods that support active transportation can support local economic development. Along the same line, tracking multiple travel modes can motivate the inclusion of pricing and, eventually, deeper fiscal and financial data. One of the most important ways to gauge accessibility competitiveness across modes is to compare user pricing alongside the share of destinations reachable in a given time.

Visualization tools

Visualization tools are an important asset when communicating accessibility metrics, especially since many non-practitioners may not have experience with accessibility metrics like they may traditional mobility measures like congestion scores. 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. A key example is the London plan which provides before and after maps of accessibility to highlight the impacts of the transportation plan. Isochronic heat maps—or bands of travel time reach—are especially valuable since many commercial applications, including many smartphone applications with location services, use similar techniques.

Next steps

While the plan assessment and survey did uncover successful implementation of accessibility metrics in certain places and among certain practitioners, two additional barriers must still be addressed.

The first concerns education. To develop comprehensive accessibility analyses that reflect the needs of a specific region, broad knowledge of the various measures of accessibility, and their limitations, is required. Accordingly, training and educating is a key component for promoting appropriate accessibility-based planning approaches. However, the knowledge gaps demonstrated by the plan assessment and survey crystallize the expansive need. This creates an enormous opportunity for the civic community and peer public agencies to develop accessibility curricula. If more practitioners—especially high-ranking officials—can use that curricula to improve their knowledgebase, this research confirms more metro areas will begin to formally implement accessibility metrics.

The second barrier involves the use of fiscal and

Table 8: 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

financial components within accessibility metrics, and vice-versa. Since accessibility analyses are not often integrated into fiscal analyses or other financial assessments, it can be difficult for planners to clearly quantify effects across individual projects or broader development efforts. In the plans assessed here, for instance, accessibility indicators are not included in financial analyses, such as cost-benefit analyses. However, it is crucial that planners, finance professionals, and a wide range of practitioners begin to more consistently quantify the benefits and costs of accessibility, while trying to better incorporate it into future decision-making processes.

7 Conclusion

This study investigated the design and implementation of accessibility metrics by land use and transportation practitioners and in metropolitan transportation plans. While most transport plans include accessibility goals and objectives, few of them have clearly defined access-to-destinations indicators that support decision-making. Furthermore, the survey revealed that although most practitioners are familiar with the concept of accessibility, a much lower proportion generate accessibility metrics. Knowledge factors are identified as a major barrier to the implementation of accessibility metrics, while the inclusion of clear accessibility indicators in planning documents represent a significant motivation.

Overall, this research illustrates the need to bridge the gap between accessibility research and practice. To support the implementation of accessibility metrics in policy and practice, educating practitioners and setting clear accessibility performance measures in planning documents are essential. With respect to planning documents, specific recommendations are presented in Table 8 based on the assessments of the metropolitan transportation plans. The main recommendations include the definition of distinct mobility and accessibility indicators and the inclusion of accessibility indicators in multi-criteria analysis. With respect to accessibility training, this report highlights the potential benefits of organizing accessibility workshops with transportation practitioners.

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Appendix A: Accessibility-related objectives and indicators from selected metropolitan transportation plans

Plan	Accessibility-related vision, goals and objectives	Indicators	Comments
Transport 2025 (Transport for London, 2006)	**Social goal:** To improve London's accessibility (p.10) **Objectives:** Economic development: Improvement in employment accessibility, Social inclusion: Improved access to employment from deprived areas (p.25)	• The change in the number of jobs accessible by public transport within 45 minutes travel time – indicators + maps • Percentage of population in the 10 percent most deprived areas of London within 45 minutes travel time of international and metropolitan centers (p.25) • Bus accessibility index – maps (p.94-95)	Accessibility metrics are used as performance indicators to evaluate the effectiveness of various scenarios. No weight is given to the different criteria, and the accessibility metrics are not present in the final scenario assessment table (p.130-131). Some results are stated in the plan (e.g.: An increase of almost 25 percent in employment accessibility) Bus accessibility index is used to present a regional evaluation of the bus service.
Plan de déplacements urbains Île-de-France (Conseil régional d'Île-de-France, 2014)	**Objectives:** Ensure access to mobility for all, Ensure spatial equity in access to mobility, Improve access to jobs and economic centres. (p.53)*	• Number of jobs accessible within 60 minutes of public transport – map (p.36) *	Accessibility maps are presented but they are not discussed in the plan.
Urban Transportation Development Plan 2025 (Senate Department for Urban Development and the Environment of the State of Berlin, 2014)	**Goals:** Improve accessibility in all outer city areas. (p.12) **Objectives:** Further improving links between Berlin and the housing areas along the axes radiating from the city. Strengthening the polycentric city structure through improved accessibility to urban neighborhoods and between districts and the main downtown centers. (p.5)	Accessibility to both the main centers and district centers	This indicator was included in a scenario assessment (not available in English)
Plan de mobilité régionale (Iris II) (Bruxelles Mobilité, 2011)	**Goal:** Improve regional accessibility with the most appropriate modes, to support economic and social dynamism (p.4)*	None	The plan states that an accessibility map should be generated in the near future, but no such map was found.
Local Transport Plan 3 (Greater Manchester Combined Authority, 2011)	**Objectives:** To support economic growth across the subregion and improve access to jobs for all. (Integrated Assessments Report p.19)	Will the LTP improve access to jobs, particularly for people who suffer income or employment deprivation? Will the LTP reduce journey times and improve accessibility for local businesses? Will the LTP improve or reduce accessibility to health care facilities, particularly for those who need the most health services e.g. the elderly, people with disabilities and those without a car? Will the LTP encourage healthier lifestyles by promoting the use of walking, cycling and public transport and increase accessibility to open greenspace and sports facilities particularly for the most deprived communities and sections of the community whose access needs are often not catered for? Will the LTP help improve accessibility through integrated spatial planning? (Integrated Assessments Report p.16-19)	Questions addressing accessibility were included in the integrated assessments report of the Local Transport Plan 3.
Plan de déplacements urbains 2010-2020 (Lille Métropole Communauté Urbaine, 2011)	None	None	
Local Transport Plan 3 (West Midlands CEPOG, 2010)	**Goals:** To tackle deprivation and worklessness, so enhancing equality of opportunity and social inclusion for all age groups, through improved access to services and other desired destinations within and adjacent to the West Midlands Metropolitan Area. (p.32)	None	An accessibility analysis was conducted in 2006, prior to the elaboration of this plan. Accessibility is very present throughout the document, but not quantified in this plan.
Urban Mobility Strategy (City of Stockholm, 2010)	**Objectives:** Accessibility in the road and street network is to be enhanced by increasing speeds for high-capacity transportation means and raising travel-time reliability for all road users (p.31)	None	The plan focuses on accessibility and proximity but no quantified metrics are available.
Land Transport Master Plan (Singapore Land Transport Authority (LTA), 2013)	**Vision:** We see a future where we all can get to more places faster and in greater comfort as we enhance our rail, bus, cycling and sheltered walkway networks, take steps to improve the quality of our public transport services and support new options such as car sharing. (p.51)	Vision: 8/10 households living within a 10-minute walk from a train station	Access to public transport indicator is used to set the vision.

Transport Strategy 2012 - Planning for growth (City of Melbourne, 2012)	**Objectives:** Making our public transport system more effective: Accessibility (p.64)	Accessibility provided by the public transport network. (p.85)	The plan indicates that an extensive accessibility by public transport assessment was conducted. This is reflected in the justification of the measures (increased tram running speed and increased service frequency). The accessibility indicator is however not detailed in the plan itself.
Sydney Long Term Transport Master Plan (NSW Government, 2012)	**Goals:** Support economic growth and productivity - by [...] improving accessibility of people to other people, opportunities, goods and services. Support regional development - by improving accessibility to jobs, services and people, [...]. Reduce social disadvantage - by improving access to goods, services and employment and education opportunities for people across all parts of the State. (p.22) **Objectives:** Jobs and services need to be more accessible (p.120)	Proportion of metropolitan jobs accessible within 30 minutes by public transport and private vehicle - map (p.120)	A regional evaluation is conducted to identify the gaps in accessibility to jobs.
Vancouver Transportation Investment (Mayor's Council on Regional Transportation, 2014)	None	Access to potential workers, jobs, and markets. (p.28)	The plan states that the projects were assessed based on these accessibility indicators.
Transportation Plan (Ville de Montréal, 2008)	None	None	Improving accessibility to employment clusters is discussed in the text as a benefit of various transportation projects, but only in general terms. There is no objective or indicators related to accessibility.
The Big Move - Toronto (Metrolinx, 2008)	**Objectives:** Increased transportation options for accessing a range of destinations, Improved accessibility for seniors, children and individuals with special needs and at all income levels. (p.15)	• Percent of people who live within two km of rapid transit, from 42 percent to 81 percent. (p.58)	An access to public transport indicator shows the results of the modelling forecast, and is used to highlight the benefits provided by The Big Move.
The Atlanta Region's Plan – Transportation (Atlanta Regional Commission, 2016)	None	• Number of low-wage jobs within 60 minutes by transit from equitable target areas. • Transit (60 minutes) and walking (0.5 miles) travel sheds from i) libraries, ii) school, ii) grocery stores, iii) major hospitals, and iv) public parks, located in equitable target areas. • Areas within 0.5 miles of a transit station (Appendix J)	Accessibility metrics are used to conduct an EJ** assessment. It provides diagnosis of accessibility to various destinations for deprived areas.
Maximize 2040 (Baltimore Regional Transportation Board, 2016)	**Goals:** Improve Accessibility: Help people of all ages and abilities to access specific destinations. (p.S-2)	None • Access to Job/Activity Centers (Highway): Degree to which project improves infrastructure enabling access to and supporting major Job/Activity Centers (1/2 mile buffer analysis - per mile benefits) • Transit station/stops: Degree to which project supports access to specific destinations (EJ population - 1/4 mile buffer analysis • Access to Job/Activity Centers (Transit): Degree to which project improves infrastructure enabling access to and supporting major Job/Activity Centers (1/4 mile buffer analysis - per mile benefits) (p.F-2)	With respect to the accessibility goal, no accessibility indicators are used. Rather, it is mobility indicators. Accessibility indicators are used in a multi-criteria assessment of projects submitted to Maximize 2040 by local jurisdictions. A score is given based on specified criteria.
Long Range Transportation Plan 2040 (Boston Region Metropolitan Planning Organization, 2015)	**Vision:** A modern transportation system that is safe, uses new technologies, and provides equitable access, excellent mobility, and varied transportation options... (p.ES1) **Objectives:** Increase percentage of population and places of employment within one-quarter mile of transit stations and stops. Increase percentage of population and places of employment with access to bicycle facilities (p.ES3)	None • Number of industrial, retail, and service jobs within a 40-minute transit trip and a 20-minute auto trip • Number of hospitals, weighted by number of beds, within a 40 minute transit trip and a 20 minute auto trip • Number of two- and four-year institutions of higher education, weighted by enrollment, within a 40-minute transit trip and a 20-minute auto trip	Clear accessibility objectives are stated, but they are not discussed in the plan. An EJ assessment is conducted and analyzes the different in accessibility from equity and non-equity zones.

Connections 2040 (Delaware Valley Regional Planning Commission, 2013)	Goals: Increase accessibility and mobility (p.4) Objectives: Provide access to key employment, commercial, institutional, and tourism centers in the region (p.78)	None	There are no accessibility indicators although there are clear accessibility objectives and goals.
Bridging Our Communities (Houston-Galveston Area Council, 2016)	Vision: In the year 2040, our region will have a multimodal transportation system through coordinated investments that supports a desirable quality of life, enhanced economic vitality and increased safety, access and mobility. (p.5)	None	There are no accessibility objectives among the set of objectives or goals.
Regional Transportation Plan – Phoenix (Maricopa Association of Governments, 2006)	Vision: To enable people in Maricopa County to travel with ease using safe, accessible, efficient, dependable and integrated public transportation services. (p.3)	None	There are no accessibility objectives among the set of objectives or goals.
2040 Transportation Policy Plan (Metropolitan Council - St-Paul, 2015)	Goals: Access to Destinations: People and businesses prosper by using a reliable, affordable, and efficient multimodal transportation system that connects them to destinations throughout the region and beyond. (p.62)	None Access to jobs and activities (p.6-55) • Increase in job accessibility on the transit system within 45 min. • Number of regional job concentrations served Equity (p.6-55) • Opportunity access for low-income population and people of color • Number of jobs reachable within 30 min. by car/public transport (p.10-13)	Performance measures related to Access to Destinations goal are not accessibility metrics. Accessibility-based measures are defined as potential indicators for setting regional transitway priorities. These measures are presented as potential indicators. An comparative accessibility analysis is conducted for people of color, the general population and people with low incomes, as part of the EJ assessment
Bay Area Plan – San Francisco (Metropolitan Transportation Commission, 2013)	None	None	Two accessibility performance measures are defined. However, the related indicators do not reflect accessibility.
Financially Constrained Long-Range Transportation Plan for the National Capital Region (National Capital Region Transportation Planning Board, 2015)	Goals: Provide reasonable access at reasonable cost to everyone (p.12)	• The change in the number of jobs accessible by public transport and automobile within 45 minutes travel time between 2015 and 2040 – indicators + maps (p.30)	Accessibility metrics are used to evaluate the performance of the transportation plan. They are, however, not included in the summary performance analysis.
Plan 2040 (New York Metropolitan Transportation Council, 2013)	None	None	The plan states that the New York metropolitan transit authority is conducting an equity analysis based on public transport access. This analysis is however not readily available.
Mobility 2040 (North Central Texas Council of Governments, 2016)	Goals: Ensure all communities are provided access to the regional transportation system and planning process. (p.14)	• Population within 15 minutes to hospitals • Number of jobs accessible within 30, 60 and 90 minutes by auto/transit and within biking/walking distance (2 miles) (p.B-28)	A detailed EJ assessment is presented and included under the main accessibility goal. The accessibility indicators are generated for various socio-economic groups.
Plan 2040 (North Jersey Transportation Planning Authority, 2013)	None	None	There is no accessibility objectives among the set of objectives or goals
Transportation 2040 Plan Update 2014 – Seattle (Puget Sound Regional Council, 2014)	None	• How well does the project improve access to areas of opportunity? • How well does the project support job retention or expansion by improving access? • How well does the project provide access to job-related training or educational opportunities? (p.D-19 in Appendix P)	Accessibility indicators are used in a multi-criteria prioritization framework. Scores from 1 to 4 are given for each indicator based on specific conditions.
2050 Regional Transportation Plan (San Diego Association of Governments, 2011)	Goals: Better link jobs, homes, and major activity centers by enabling more people to use transit and to walk and bike. (p.1-3) Social equity goal: Ensure access to jobs, services, and recreation for populations with fewer transportation choices. (p.4-4)	• Access to transit: percentage of homes within half a mile of a transit stop, including Trolley and light rail stations, bus stops, etc. • Access to Amenities (auto and transit): Percentage of Population within: 30 minutes of education institutions/of the airport and 15 minutes of healthcare/of parks or beaches (p.4-16)	A social equity analysis was conducted for all scenarios to make sure they were consistent with EJ assessment. A broad variety of destinations is included.

Regional Transportation Plan 2040 (Southeast Michigan Council of Governments, 2013)	**Vision:** [The plan should contribute to] access to services, jobs, markets, and amenities (p.3) **Objective:** Increasing the percentage of households with access to jobs, services and recreational opportunities. (p.46)	•Percent of households with access to jobs/to amenities/to services (p.4) • Percent of the region's population/elderly population/low-income households/jobs is within 1/4 mile/1/2 mile of an existing bus route. (p.65) • Average number of job/shopping opportunities from traffic analysis zone (25 minutes by transit, 50 minutes by car) • Percent of population close to a hospital/a college/a major retail center (25 minutes by transit, 50 minutes by car) (EJ: p.10-11)	Specific accessibility metrics are defined as potential indicators to measure progress towards achieving desired outcomes. A broad variety of destinations is included. Yet, the current plan does not include these performance indicators. Indicators of access to transport are included in the plan to describe the public transport service coverage. A detailed accessibility analysis is conducted to assess the differentiated impacts on various demographic groups in the region (p.24).
Regional Transportation Plan 2040 – Los Angeles (Southern California Association of Governments, 2016)	**Goals:** Maximize mobility and accessibility for all people and goods in the region. (p.64)	None • Share of employment and shopping destinations within a one- and two-mile travel buffer from each neighborhood; within 30 minutes by auto or 45 minutes by bus or all transit modes during the evening peak period. • Share of population within a one- and two-mile travel buffer from a regional park or school; also, share of park acreage that can be reached within 30 minutes by auto or 45 minutes by bus or all transit modes during the evening peak period. (p.167)	There is no accessibility indicators related to the main accessibility goal. Accessibility indicators are used to conduct the EJ assessment.
The Southwestern PA plan – Pittsburgh (Southwestern Pennsylvania Commission, 2014)	None	• Proximity to transit: Housing units within 0.5 miles of a transit stop • Proximity to parks and trails: Proximity to parks and trails (0.5 miles) (p.5-7)	These indicators are identified as relevant performance measures for land use and transportation projects, but are not included in the current plan.
Go To 2040 Update (The Chicago Metropolitan Agency for Planning (CMAP), 2014)	None	• Percentage of jobs and population within at least moderate access to transit, based on: (1) weekly frequency of transit service, (2) activities that can be reached via a single direct transit route, (3) proximity to a transit stop or station measured over the network, and (4) the pedestrian friendliness of the surrounding area. (p.19)	An interesting composite index of access to transit is included in the plan. There is however no indicators of access to destinations.

*** These quotes were translated from French to English by the authors**

** EJ stands for environmental justice assessment

Appendix B: Selected information and questions from the survey

Advanced Question Structure
Throughout the survey, agreement questions used a 5-point Likert scale (1-"strongly disagree", 2-"disagree", 3-"neither agree nor disagree", 4-"agree", 5-"strongly agree"). In the analysis of the results, respondents that selected "agree" and "strongly agree" were aggregated together as "agree", and respondents that selected "disagree" and "strongly disagree" were aggregated together as "disagree". Respondents who selected "neither agree nor disagree" were considered as "neutral".

Personal information
In which sector do you work?
What best describes your organization/company?
Which best describes your job title?

Accessibility concept
In this survey, the concept of accessibility refers to the geographic access to opportunities by walking, cycling, public transit or car. In other words, accessibility is the ease of reaching desired destinations in a region. Please note that we do not refer to the principle of universal accessibility for people with a disability in this survey.

To what extent do you agree with the following statement? I am familiar with the concept of accessibility defined above.

Accessibility metrics
Accessibility metrics quantify the ease of reaching various destinations using a specific mode, based on travel costs, distance and/or time. There are many ways to measure accessibility. For example, an accessibility metrics is the number of jobs that can be reached from a specific location within 45 minutes using public transport. Other locations commonly used in accessibility metrics include retail stores, hospitals, parks and transportation amenities (highways, public transit bus stop, etc.).

To what extent do you agree with the following statement? I am familiar with accessibility metrics.

Use of concepts and metrics
To what extent do you agree with the following statements?
I use the CONCEPT of accessibility in my work.
I use accessibility METRICS in my work.

Use of accessibility metrics
What types of accessibility metrics have you used?
Which of the following metrics have you used?
For which modes have you used accessibility metrics?
What do you use accessibility metrics for?
The generation of accessibility metrics was: (my own initiative, a request from a superior, a requirement from a planning document, was present as a tool prior to my arrival in my current job, a request from client, other)

Use of the concept of accessibility
Which concepts of accessibility do you or have you used?
What do you use the concept of accessibility for?
For which reasons do you not use accessibility metrics?

Accessibility in plans
To what extent do you agree with the following statements:
The concept of accessibility is included in the planning documents of the region I work in.
Accessibility is stated as a main goal in the planning documents of the region I work in.
Clearly defined accessibility indicators are included in the planning documents of the region I work in.

Relevance of accessibility metrics
To what extent do you agree with the following statements:
Accessibility metrics are useful tools for land-use and transportation planners.
Accessibility metrics have the potential to influence decision-making processes.

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Credits

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