PEAK VISION N°6

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SUSTAINABLE MOBILITY

How far do the cyclists travel regularly by bicycle in Medellin city?

PEAK URBAN CONTRIBUTES

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Highlights

1.

In many cities around the world, cycling has become the mechanism to promote sustainable mobility. The challenge is to prioritize the provision of adequate infrastructure and increase its usability.

2.

During the last decade, cycling has become a priority in addressing the air quality challenges in Medellín. Bicycle trips currently account for 1% of the modal share, and the city expects to increase this level to 10% of all trips by 2030.

3.

The distance traveled by bicycle may differ due to various urban settings, ranging from planned neighborhoods to informal settlements. The streets of Medellín negotiate with the steep topography, giving rise to street patterns with organic shapes.

The use of the bicycle as a mode of transport is increasingly recognized in many cities worldwide. Medellin is no exception. The city faces air quality challenges by encouraging the use of bicycles as a transportation mode, among other actions. According to the 2015 report of the Metropolitan Area of the Aburrá Valley, bicycle trips represent only 1% of the modal share, and it expects to increase this number to 10% by 2030. However, despite the efforts to build close to 120 kilometers of bicycle paths and a shared bicycle system, the city faces a more significant challenge, the lack of connectivity and quality of the infrastructure, which represents a critical factor in people's decision to use the bicycle as a mode of transportation in Medellin.

This research is based upon cyclists' routes collected in Medellín (Colombia), a heterogeneous city in terms of topography and urban structure. This study aims to understand how natural factors, the urban context of origin, destination, and route, affect the travel distance in cycling.

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The use of the Bicycle and Sustainable Mobility

Current global urbanization trends involve significant challenges for urban planning. High levels of energy consumption and greenhouse gas emissions, in addition to equitable access to opportunities, represent some of the challenges that current urban sustainability agendas seek to address. According to the United Nations, these challenges are fundamental for countries in constant development, mainly because they face rapid urbanization processes, ranging from 50% in 2005 to 68% projected in 2050.

The use of bicycles has become an essential mechanism for promoting sustainable mobility in many cities. The challenge is to prioritize the provision of adequate infrastructure and increase its usability.

Policy makers in many cities worldwide seek to improve infrastructure for cyclists and make cycling a more attractive and safer mode of transportation. These actions are challenging in contexts such as those of the global south, where resources are limited and urban planners must prioritize the provision of cycle-infrastructure to obtain the maximum impact. A more precise estimate of the behavior of bicycle users, especially travel distances in developing cities, will aid in the formulation of policies and plans in at least three aspects:

1. To increase and better allocate the resources to develop the infrastructure for cycling
2. To improve the design and layout of the new bike paths within the city
3. To increase the usability of the dedicated cycling infrastructure

Where was the study done?

The study was accomplished in Medellín, the second-largest city in Colombia, with about 2.6 million inhabitants. The city is located in the western region of Colombia (Fig. 1), with altitudes ranging from 1,500 to 2,500 meters above mean sea level. The average relative humidity is 67%, lower than that of other cities in humid subtropical zones, and temperatures fluctuate from 17 to 28 ° C with an annual average of 22 ° C.

Fig. 1. Location of the metropolitan area of Valle de Aburrá and the city of Medellín.

On the other hand, three aspects make Medellín a case in which the factors determine the distance traveled by bicycle by the inhabitants, some of these are:

1.
The presence of diverse urban environments, ranging from planned neighborhoods to informal settlements

2.
The high levels of socioeconomic inequality and a pattern of spatial segregation that divides the city into two halves

3.
The variable topography with gradients ranging from 0% to 6% in the flatter areas of the city and with 20% in the hilly ones

The distance traveled by cyclists may differ due to various urban characteristics, ranging from planned neighborhoods to informal settlements. Much of Medellín's streets negotiate steep topography, giving rise to organic-shaped street patterns.

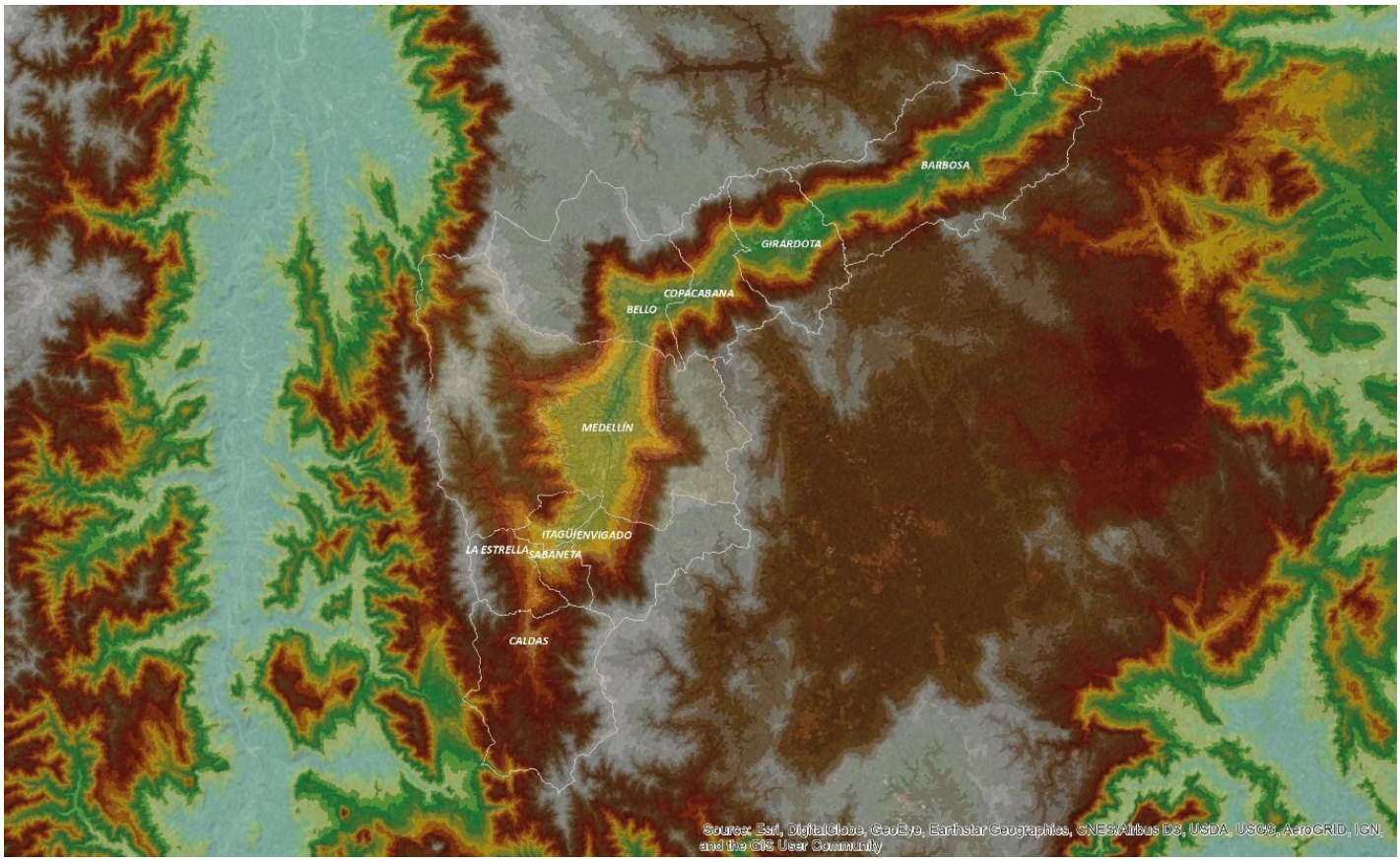

Fig. 2. Perimeter of the city of Medellín and topography of the Metropolitan Area of the Aburrá Valley.

And the data, where did it come from?

For the present research, the cycling routes were obtained from a survey carried out in Medellín in 2017. The survey was distributed online, by telephone, and in the streets of the city. The survey allowed collecting data related to the sociodemographic characteristics of cyclists and the routes they take to get to their study or work destinations.

The questionnaires included three sections: the first section discriminated current bicycle users from those who used other modes of transport. The second, related to active cyclists, focused on their individual sociodemographic characteristics. The third section concerned the origins, destinations, and routes of the most recent bicycle trips made by the respondents.

The survey allowed researchers to know that cyclists commute by bicycle 4.15 times per week on average. In addition, in terms of income groups, 17% of the cyclists were low-income residents, 61% were middle-income residents, and 22% were high-income residents.

The survey involved 810 cyclists coming from different socioeconomic backgrounds and city areas. 70% of respondents were men and 30% were women, and the average age was 29 years.

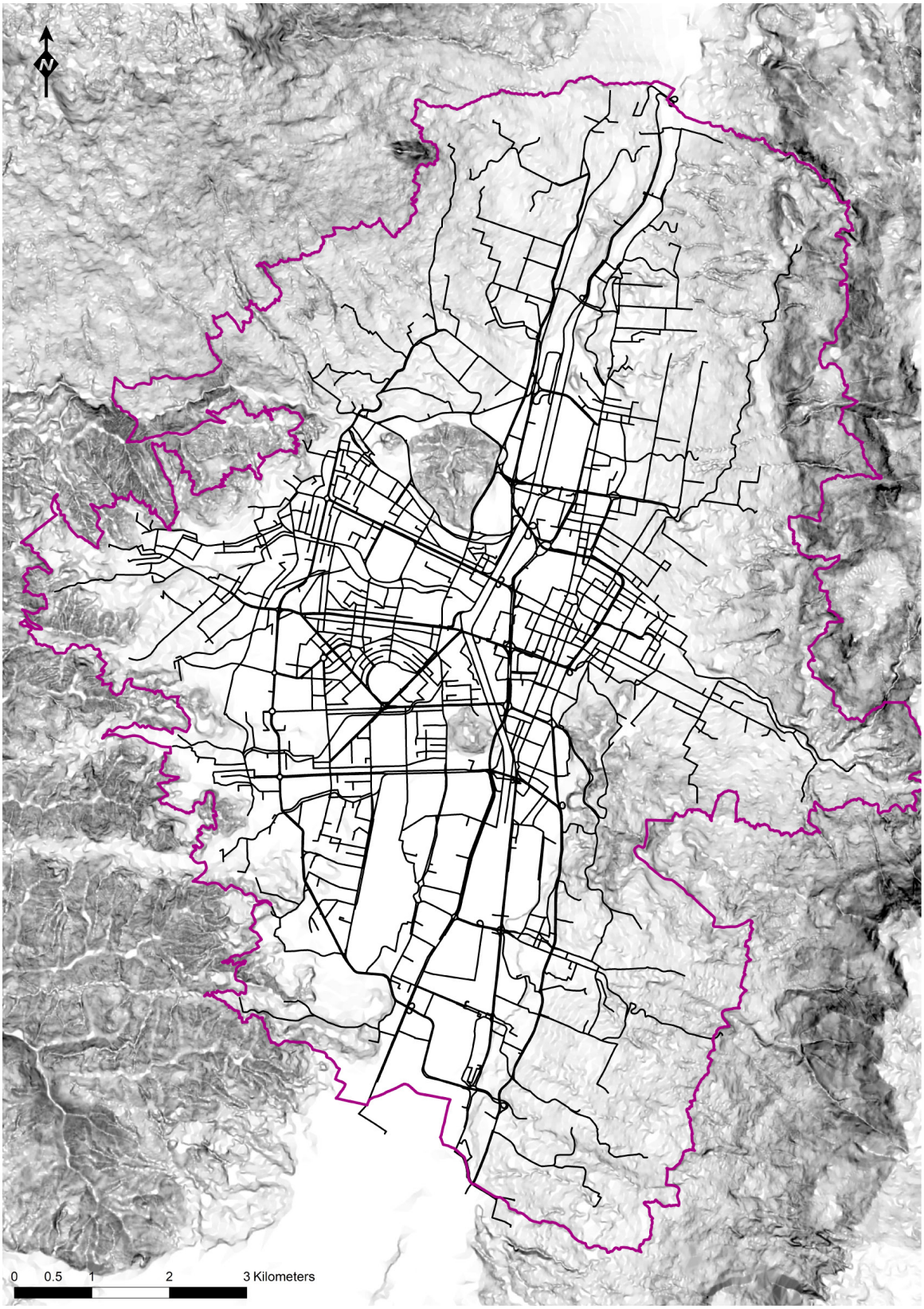

Fig. 3. Spatial distribution of the 810 cycling routes in the city of Medellín. (2020).

The metric used

Each route derived from [dataset] Ospina et al. (2018) was geocoded using street network information taken from Open Street Maps (OSM). Due to the metrics associated with each route, the geocoding process involved a careful revision of geometric properties and attributes associated with each link of a route, e.g., directionality and connectivity and attributes such as speed, the number of lanes, and the presence of bike paths. As some of the metrics are calculated within a buffer along a given route, the revision of the street network also involved accounting for street segments positioned within buffers.

It is important to note that in a few cases we had to deviate from the common practices in the literature when producing the metrics for our paper. The contribution of empirical evidence from cities in developing countries comes with many challenges including data availability. Therefore, for each case, we seek to make the best use of the official information and each variable was approved for inclusion only if the resulting spatial patterns make sense to the eyes of a team with a deep knowledge of the city of Medellin.

How was it made and what was found?

Using a mathematical model, the researchers estimated the impact of the individual, trip, and built and natural environment characteristics on cycling travel distances.

In this process, they found that variables such as the density of streets and the density of intersections along the route are highly correlated and cannot be included together in the same specification. In the same way, the street density and the length of major and minor roads at the origin and destination are highly associated. This can be attributed to the fact that these variables capture the same type of information: the density in the first case and the length of the infrastructure in the second.

The research model included three collections of variables corresponding to each of the dimensions examined:

1. The socioeconomic and travel dimension

2. The built environment at the origin and destination

3. The built and natural enviroment along the route, two determinig factors to identify the research problem

Regarding the routes employed by cyclists, these contained on average 45% of cycle-infrastructure, 49% of major roads, and 5.7% of minor roads. On average, the routes have 13 intersections per kilometer, of which a little more than four intersections include traffic lights.

Regarding the travel distance, it was found that cyclists travel 4.17 km on average on each trip they make by bicycle in Medellin city. This is a statistically equivalent value to the 4.20 km travel distance estimated by the metropolitan Origin and Destination Survey (2012). Likewise, it was found that 50% of cyclists are willing to travel up to 4 km, and only 5% would travel beyond 8 km, as shown in figure 4.

According to the results, there is an interaction between the detour and the dedicated cycling infrastructure. In this direction, cyclists are willing to deviate from their most direct route to use the cycle infrastructure available in the city and complete their trip. However, as the detour gets larger, cyclists lose interest in deviating. For instance, a detour greater than 2.69 would imply that cyclists decide not to make the bicycle trip. Likewise, the results suggest that cyclists are willing to make an effort to overcome some of the slopes they find along the route. However, they would not climb more than 350m of elevation between their place of origin and their destination.

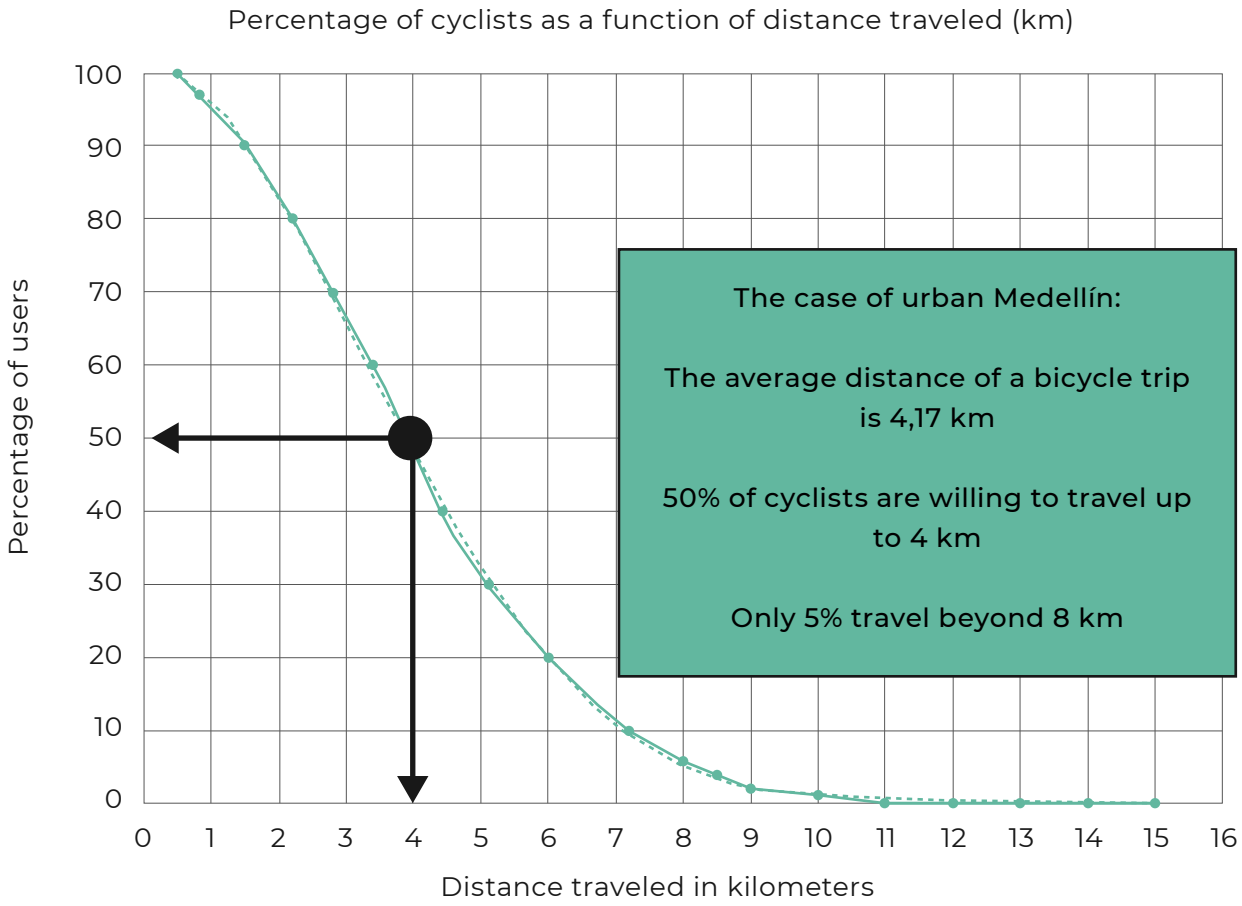

Fig. 4. Cumulative percentage of cyclists according to average distance traveled.

What can be concluded, and what should follow?

This article reveals the importance of built and natural features along the routes in explaining bicycle travel distances while controlling for socio-economic and built environment measures at origins and destinations.

In the case of Medellin, the demographic characteristics do not show significant effects on the cyclists' travel distance, which is opposed to the existing literature. However, the relationships between the natural and built environment, the trip characteristics, and the cyclists' travel behavior are coherent with previous findings. Especially, despite cyclists prefer direct routes, they are willing to deviate to find comfortable and safe roads. However, excessive deviation can lead cyclists to avoid making their

trip by bicycle.

Finally, the methodological contribution goes beyond supporting previous findings and highlighting the importance of the route's characteristics. This research shows the relevance of including the interaction and the quadratic effects of some variables to achieve a much more robust model.

It is recommended to visit https://bit.ly/3gTdaMj this link to get deep into the investigation.

References

Área Metropolitana del Valle de Aburrá, 2015. Plan Maestro Metropolitano de la Bicicleta del Valle de Aburrá. Medellín.

Broach, J., Dill, J., Gliebe, J., 2012. Where do cyclists ride? A route choice model developed with revealed preference GPS data. Transp. Res. Part A Policy Pract. 46, 1730–1740. https://doi.org/10.1016/j.tra.2012.07.005

Cervero, R., Kockelman, K., 1997. Travel demand and the 3Ds : Density, design and diversity. Transp. Res. Part D Transp. Environ. 2, 199–219.

Cervero, R., Sarmiento, O.L., Jacoby, E., Gomez, L.F., Neiman, A., 2009. Influences of built environments on walking and cycling: Lessons from Bogotá. Int. J. Sustain. Transp. 3, 203–226. https://doi.org/10.1080/15568310802178314

Duque, J.C., Lozano-Gracia, N., Patino, J.E., Restrepo, P., Velasquez, W.A., 2019. Spatiotemporal dynamics of urban growth in Latin American cities: An analysis using nighttime light imagery. Landsc. Urban Plan. 191, 103640. https://doi.org/10.1016/j.landurbplan.2019.103640

Faghih-Imani, A., Eluru, N., El-geneidy, A.M., Rabbat, M., Haq, U., 2014. How land-use and urban form impact bicycle flows: Evidence from the bicycle-sharing system (BIXI) in Montreal. J. Transp. Geogr. 41, 306–314. https://doi.org/10.1016/j.jtrangeo.2014.01.013

Garrard, J., Rose, G., Lo, S.K., 2008. Promoting transportation cycling for women: the role of bicycle infrastructure. Prev. Med. (Baltim). 46, 55–9. https://doi.org/10.1016/j.ypmed.2007.07.010

Handy, S., van Wee, B., Kroesen, M., 2014. Promoting Cycling for Transport: Research Needs and Challenges. Transp. Rev. 34, 4–24. https://doi.org/10.1080/01441647.2013.860204

Heinen, E., Van Wee, B., Maat, K., 2010. Commuting by Bicycle: An Overview of the Literature. Transp. Rev. 30, 59–96. https://doi.org/10.1080/01441640903187001

Iacono, M., Krizek, K., El-Geneidy, A., 2008. Access to Destinations: How Close is Close Enough? Estimating Accurate Distance Decay Functions for Multiple Modes and Different Purposes.

Larsen, J., El-Geneidy, A., Yasmin, F., 2010. Beyond the Quarter Mile : Examining Travel Distances by Walking and Cycling, Montréal, Canada. Can. J. Urban Res. Can. Plan. Policy 19, 70–88.

Ortúzar, J.D.D., Willumsen, L.G., Ortuzar, J. de D., Willumsen, L.G., 2011. Modelling Transport, Fourth. ed. John Wiley & Sons, London. https://doi.org/10.1002/9781119993308

Páez, A., Scott, D., Morency, C., 2012. Measuring Accessibility: Positive and Normative Implementation of Various Accessibility Indicators. J. Transp. Geogr. 25, 141–153.

Pucher, J., Buehler, R., 2008. Making Cycling Irresistible: Lessons from The Netherlands, Denmark and Germany. Transp. Rev. 28, 495–528. https://doi.org/10.1080/01441640701806612

Saelens, B.E., Sallis, J.F., Frank, L.D., 2003. Environmental Correlates of Walking and Cycling : Findings From the Transportation , Urban Design , and Planning Literatures. Behav. Med. 25, 80–91.

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