Effects of the Proposed Cable Cars System in the Accessibility of Pereira, Colombia

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Abstract

Accessibility studies allow us to see the easiness of connection between the different geographical places in a region, either current or proposed in a new project. City planners propose new infrastructure plans that focus primarily on increasing mobility but they affect accessibility. This paper shows the influence that the new cable cars system will have in the global accessibility of Pereira (Colombia) and it highlights the neighborhood Villa Santana. These results were obtained through a geostatistical analysis of the travel time variable and shows that Villa Santana inhabitants will experience a reduction between 4% and 24% in their travel times.

Keywords: Accessibility analysis, cable cars, geostatistics, fairness.

1 Introduction

Accessibility, defined as the potential for interaction between different geographic locations [1] or ease of access to opportunities [2], implies how a group...
of people, considering their own limitations, can be included in the different urban activities, like jobs, education, recreation, medical services, or others. From the point of view of transport, accessibility becomes a cost distribution [3] represented by distances between areas of interest, or preferably, by travel times in the transport network [4]. Integral accessibility is the cost distribution from all nodes to a single one [5] and global accessibility is a representation of all the integral accessibilities in the network within the same graph.

This measure of accessibility, based on the infrastructure and represented by the travel times between each node, does not comply with the theoretical concept of accessibility [6] [7], since it does not include the travel choice of each person, age, disability, race, among others variables [8] [9]. However, Miller [10] defines that accessibility is directly related to the benefits that transport infrastructure offers to individuals, therefore these analyses become an easy and quick way to present information on the current or future behavior of the transport network to city planners [6].

Global accessibility studies, have been presented as a tool in the planning of territory [11] [12]. These studies show the reachability of any node in a region, given the conditions of the network and taking into account the mode of transport for the analysis [13]. These studies suggest a mitigation of social exclusion as long as the financial and time cost in the transport network, are the lowest possible [2].

Geographic information systems (GIS) are an easy-to-use tool that allows accessibility studies to be carried out on a transport network and the evaluation of the new infrastructure projects [14]. GIS enable a friendly visualization of distances or cost between given nodes [15] [10]. The results are presented with isochrone curves representing the travel times needed to reach an area in the city.

Most Colombian cities have a mono-centric structure, a great quantity of jobs and services are concentrated in the same area. The city of Pereira plans to construct a cable cars system (Fig. 1) that connects the city core, the bus station, the Universidad Tegnológica de Pereira (UTP), and the community of Villa Santana (south east). It is expected that this project will generate more participation of Villa Santana neighbors in the city jobs. Although, a greater accessibility to the different centers of activity does not imply, in this case, the creation of more jobs, it is necessary, in search of fairness, facilitate the access to them [16] [6].

2 Methodology

The development of this article follows the methodology proposed by Miller [10], whose procedure is clearly shown in [17] and [12]; Figure 2 exhibit the process followed in this paper. The basis of these analyses is to present, with
the help of GIS tools, isochrone curves that symbolize the mean travel times with which every node is reached in a transport network from all nodes (global accessibility). The speed values assigned to each edge of the network are taken from real data, measured with GPS devices in the city of Pereira all along the month of February 2017 by the Universidad Tegnológica de Pereira for the CIDT (Centro de Innovación y Desarrollo Tecnológico) project.

Initially, a GPS data processing was performed in order to calculate the operational speed in all edges between 5:00 a.m. and 10:00 p.m. on Tuesdays, Wednesdays and Thursdays of February. Using the equation 1, where \( v_i^a \) represents the operational speed \( i \) of the edge \( a \) in km/h, \( l_a \) the edge length and \( t \) the time when the start and end node of the edge is reached; the operational speed was computed as the mean of the \( n \) speeds calculated, as shown in equation 2.

\[
\begin{align*}
\hat{v}_i^a &= 3.6 \times \frac{l_a}{t_2 - t_1} \\
\bar{v}_a &= \frac{\sum_{i=1}^{n} v_i^a}{n}
\end{align*}
\]
Once the travel times were obtained, based on the edges operational speeds computed with equation 2 and the edge lengths, the structure of the road network was implemented in the GIS tool, the calculation of minimum travel
times from each node to every other nodes in the network was performed using a Dijkstra algorithm [18] [19]. Also, a comparison was made against results of a new network with some edges representing the cable cars system. The speed assigned to the new edges was 21 km/h ².

With the purpose of performing a spatial interpolation of the travel time vector (TT) in the urban area of the city, with and without the cable cars system, the normality, stationarity, which states that the mean of the TT should be constant with respect to the geographical location; and the finite variance of the TT, was verified [20] [21]. The calculation of spatial interpolation was performed by the ordinary Kriging method, the results were corroborated by cross-validation (resemblance between the observed and computed TT) and plotted using a GIS tool.

3 Results

The mean travel times with which each of the nodes can be reached, from every other, in the current network of the city of Pereira can be seen in (Fig. 3). The isochrone curves exhibit a behavior that favors the central zone of the city by its own geographical location. The results demonstrate that the community of Villa Santana, located in the south east of the city, is the zone with the greater difficulty of access with travel times between 37 and 50 minutes.

Figure 5(a) shows the relation between the coverage of the isochrone curves, population and area of the city ³. The results indicate that 96.5% of population (94.5% of urban area) reach their destinations with travel times equal or less than 37 minutes. This results demonstrate that the Villa Santana inhabitants are in the remaining 3.5% of the population that experience the greatest difficulties in accessibility.

When the MEGACABLE (name assigned to the cable cars system) is included in the transport network of the city, a significant variation is obtained for the community of Villa Santana, their travel times change from 37 and 50 minutes (without cable cars system) to 32 and 42 minutes (with cable cars system). These results show a reduction, from 6 to 10 minutes. Figure 4 exhibit the isochrone curves of these times over the whole city.

²the speed of the cable cars is equal to reported by one of the bidders. URL = http://newsroom.doppelmayr.com/es/doppelmayr/prensa/8-seater-gondola-grasjoch-with-world-novelty-2-2-2/
³The distribution of population in the city area was provided by the metropolitan administration for the CIDT project
Figure 3: Isochrone curves for the city network without cable cars system, values in minutes

Figure 4: Isochrone curves for the city network with cable cars system, values in minutes
Carrying out a similar analysis to the one showed in figure 5(a) with respect to the coverage of isochrone curves, the population and area of the city when the cable cars system is included in the city network (Fig.5(b)); we can see that 96.6% of the population (94.8% of the urban area), will be covered by travel times equal to or less than 36 minutes, so that we can infer a positive impact of the new cable cars system in the city.

A comparison between the figures obtained with (Fig. 4) and without the cable cars system (Fig. 3) shows that, in total, the cable cars project will represent a saving in travel times between 1 and 2 minutes for 44.7% of the population (44.3% of urban area) and 6 to 10 minutes for 0.76% of the population (percentage corresponding to the community of Villa Santana). Figure 5(c) and figure 6, shows that the cable cars project will produce savings of 2% in the actual travel times of 75% of the population and between 4% and 24% for the Villa Santana neighbors.
4 Conclusion

The cable cars project in the city of Pereira proposes an increase in the accessibility as it will reduce the travel times for an extensive part of the population, specially, for the inhabitants of Villa Santana who will benefit the most from this intervention. Although, the concept of accessibility here is based on ease of connection between places, a deeper analysis should be carried out assessing the individual connection needs, their preferences, and travel choices [22]. This suggests moving from place-based to people-based accessibility [23] without reject the ability of integral and global accessibility analyses to facilitate the research of the complex travel choice of inhabitants, considering their desire to reduce the time expended on each displacement; and the easiness to present to city planners the changes in the accessibility of the city with a given project. The present research should be considered as a part of a deeper analysis in which it can be determined what will be the advantages of these inhabitants to whom his travel time is been reduced.

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