FACTORS IN THE DESIGN OF A BIKEWAY NETWORK IN A MEDIUM-SIZED CITY: THE CASE OF TULUÁ IN COLOMBIA

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SUMMARY

This article presents a guideline for designing a bikeway network in a medium-sized city, taking into account key factors such as modal split, corridors along desire lines of travel connecting points of interest, the available public space, the investment possibilities of the city in the short term, and the benefit from segregating the bicycles from others vehicles. The guidelines are practical rules to define the shape of the network and the location of the bicycle lanes among different possible streets. Those guidelines were applied to Tuluá, a medium-sized city in Colombia (133.500 inhabitants in the urban zone) with 19% of trips by bicycle in 1997. A bikeway network was designed in the Master Plan of Highways and Transport 2000-2015 for the city, demonstrating that the bikeways could be a solution to mobility problems in medium-sized cities with appropriate conditions for the use of bicycles. A characterization of the main factors influencing the use of bicycle and the role of cycling in the total modal split are presented for this particular case.

1. INTRODUCTION

Many cities in Colombia have certain favorable characteristics for bicycle use such as a great number of bicycles, some topographic features, and a substantial percentage of young people that would use the bicycle if current conditions were improved, but these opportunities have not been used appropriately. Very few studies has been accomplished in this sense. This work is an effort to promote the bicycle as a regular transportation mode for various trip purposes, because there exists in Colombia the wrong idea that the bicycle is only a vehicle for recreational trips in weekends. In Colombia, for example, for several decades, large cities like Bogotá or Cali have promoted the bikeway on Sundays, closing some streets to motor traffic and encouraging recreational cycling.

In recent years the environmental and energy problems caused by traffic congestion have shown the importance the bicycle mode has as an alternative for certain type of trips in congested areas. The alternative must be investigated and promoted to create conditions for its development.

Studies performed in small and medium-sized cities with a tropical climate and a flat topography have shown that the bicycle provides a good choice for improving mobility. A few principles for designing bikeway networks are presented below and applied to one of those cities: Tuluá in south-eastern Colombia.

2. KEY FACTORS FOR A BIKEWAY NETWORK DESIGN

Useful factors to guide a design of a bikeway network in a medium-sized city are: modal split, identification of corridors connecting the main trip generators, space availability in the streets, and cost and benefits of the network implementation.

2.1. Modal split

It is necessary to undertake a mobility study in order to know how many people use the bicycle currently. The mobility study helps to know the magnitude of the bicycle travel demand, the desire lines of travel among different zones, distances, travel times, schedules and purposes. A sample of between 2 and 6 percent of the population could be taken in cities around 100.000 inhabitants. The greater the use of bicycle, the greater will be the possibility of justifying a network of bicycle lanes. Percentages of trips by bicycle between 15% and 30% are significant and could reach a critical mass of users to initiate the development of a network.

2.2. Identification of corridors

To identify the corridors for bicycles, a trip origin-destination matrix for the cycling mode could be build. This matrix allows to draw on a map of the city main desire lines of travel. By the width or color of those lines it is possible to visualize the main flows and the natural corridors that they would use. In a second step, the desire lines with origin and destination near each other can be consolidated through the same highway facility. It is important to locate the points of great production and attractions of trips by bicycle. The production points are residential areas with a great potential of bicycle trips. The points of attraction include schools, universities, industrial zones and other particular sites such as recreational areas. The optimal network could be defined by the minimum path between locations of origins and destination, for connecting the main points of productions and attraction, avoiding extra travel distances and treating to channelize important flows through few corridors forming a continuous network.

Also, it is recommended to have a volume count of vehicles (cars, buses, trucks, motorcycles and bicycles) at several points in the city. These data are useful to determine the allocation of the street space among different modes.

2.3. Space availability

The capacity of the highway network to serve the future flows of motor vehicles and the availability of extra space to accommodate bikeways must be estimated. One of the criteria to define a bikeway network is to place the bikeways at street with light traffic. Nevertheless, the space availability at the street becomes a critical factor because in many cases the right of way is not wide enough to satisfy the demand of space from pedestrians, cyclists and motor vehicles. Generally each of the two sidewalks in a street must be wider than 1.5 meters, and the minimum width of two lanes should be between 5 and 6 meters. For this reason a bicycle lane two meters wide should be only installed at streets with right of ways of more than 10 meters wide. On the other hand, the city may have arterials with more lanes than those required by motor vehicle traffic or lanes that are too wide (for example, 3,5 meters wide or wider). In theses cases the number and/or the width of the lanes could be reduced in order to create space for the bicycle lane. If there is a wide median in the street or a wide green zone close to the sidewalk, it may be possible to build a bicycle path on it. In other cases, if the desire lines are along a natural corridor such as a river, it is possible to give landscape treatment to the mobility solution.

2.4. Cost and benefits of implementation

Finally, it is important to analyze the city investment possibilities in the short term and the benefits in reduction of travel time and accidents, obtained from segregating the bicycle flows from the motor vehicle flows. Generally, the investment required is relatively low and the network can be implemented in the first phase of two or three years of a City Plan.

3. THE CASE OF TULUÁ IN COLOMBIA

3.1. Description of the city and its mobility

The city of Tuluá has a population of 133.500 inhabitants in its urban zone and 16.500 inhabitants in its rural zone (Data of 1997). It is located in south-eastern Colombia, near Cali (an important city of two million people, capital of the Valle Department). Tuluá has a favorable flat topography, an average temperature of 27 °C and it is crossed by the Tuluá River from South to North with a distance of 5 km. The population density is near to 200 inhabitants/Ha in the residential zones. The traditional vocation of the city is commercial.

The street network of the city measures 160 km, of which 13,6% are arterial streets, 14,7% collectors and the rest local streets. There are 25 signalized intersections in the downtown area. The urban structure of Tuluá is illustrated in Figure 1.

The motorization index is near 170 vehicles per 1.000 inhabitants, with 9.500 cars and 13.000 motorcycles registered in 1996. The administration do not register bicycles. Nevertheless the mobility study accomplished in 1997 revealed that bicycles constitute the majority of vehicles in Tuluá with 25.000 bicycles (near 190 bicycles per 1.000 inhabitants).

According to the mobility study in the year 1997 based on a sample of 2,2% of the population, the total trip generation index was 1,8 trips per inhabitant. There are 240.000 trips per day, from which 94% are home based, namely, with origin or destination at home. The centre of the city has the greater attraction of trips with 40% of them. The modal split is the following: 30% by motorcycle, 19% by bicycle, 13,5% by bus, 7% by car, 5% by taxi, 25% on foot and 0,5% by others. Bus service is provided by one private company that operates a network of 7 routes, with a total 78 buses carrying an average of 31.500 passengers per day.

3.2. The Master Plan of Highways and Transport of Tuluá

In 1997 a Master Plan of Highways and Transport of Tuluá was developed. This study, was conducted in two phases.

In the first phase, an inventory was taken and an estimate of the transportation supply and demand was made. The hierarchy and function of the highways facilities was identified. Its geometric characteristics and pavement conditions were recorded. The conflict points at intersections were also analyzed. The land use was characterized classifying the zones that have been defined according to the predominant activity developed in each one (residential, commercial, institutional and industrial). The transportation demand was analyzed based on the results of the mobility study. A trip matrix by mode and purposes of travel was built.

Furthermore the operation of public transportation and the causes of its low use were analyzed as well as the difficulties for travelling by pedestrians and cyclists.

In the second phase, several alternatives to satisfy travel demand were analyzed, such as giving priority and encouraging the use of the public transportation, improving the network configuration and operation. Also, because motorcycles do not demand much space in the street, emphasis was placed on the pedestrian and cyclist who had been forgotten until then and did not have enough space for developing their mobility. The solution presented consisted in a new road hierarchy which satisfy the mobility of public and private transportation assigning large areas for pedestrians at city center and space for implementing a bikeway network which segregates the cyclists from the motorized traffic. The Tuluá river is used as a landscaped corridor to carry the main flows of cyclists who travel from the north of the city to the university zone at the south. Two arterial alternatives are considered along the river. The first one would have a one way at each bank with its respective sidewalk for pedestrians and a bikeway at the east of the river. The other alternative would have the complete arterial at the east bank in order to use the west bank for building a landscaped facility consisting of a narrow roadway for slow moving motor traffic, ample sidewalks for pedestrians and a wider bicycle path. This alternative uses the river as a barrier to separate the motor traffic from the pedestrian and cyclist along the main axis of the city. The cost of implementing each alternative was estimated and finally the second one was selected but introducing some projects of the first alternative.

The plan was finalized in 1998 and it will be incorporated in the Master Plan of Tuluá 2001-2009 in order to have the funds for its implementation.

3.3. Key factors for the bicycle network of Tuluá

3.3.1. Modal split

Some relevant aspects of the modal split are the following:

- The motorcycle is the vehicle more used (30%). This type of vehicle offers advantages like a relative low cost and flexibility to park and move through the streets. Nevertheless, in the future it is possible that many of these users change their motorcycles by cars with the consequent problem of congestion and space requirements.
- Walking is the second mode in the city (25%), which is desirable for the city and must be promoted.
- Cycling is the third transportation mode in number of people, transporting more people than public transportation

3.3.2. Corridors along desire lines of travel connecting points of interest

The trips on bicycle are attracted by certain specific zones such as schools, Policy school, the city center and the Victoria sector where some primary and secondary school are located. From certain residential areas to those points of attractions there are flows of 300 to 500 bicycles per day (see Figure 1). With other minor flows, in total there are near 45.000 trips by bicycle per day that do not have appropriate safety or available infrastructure for travelling.

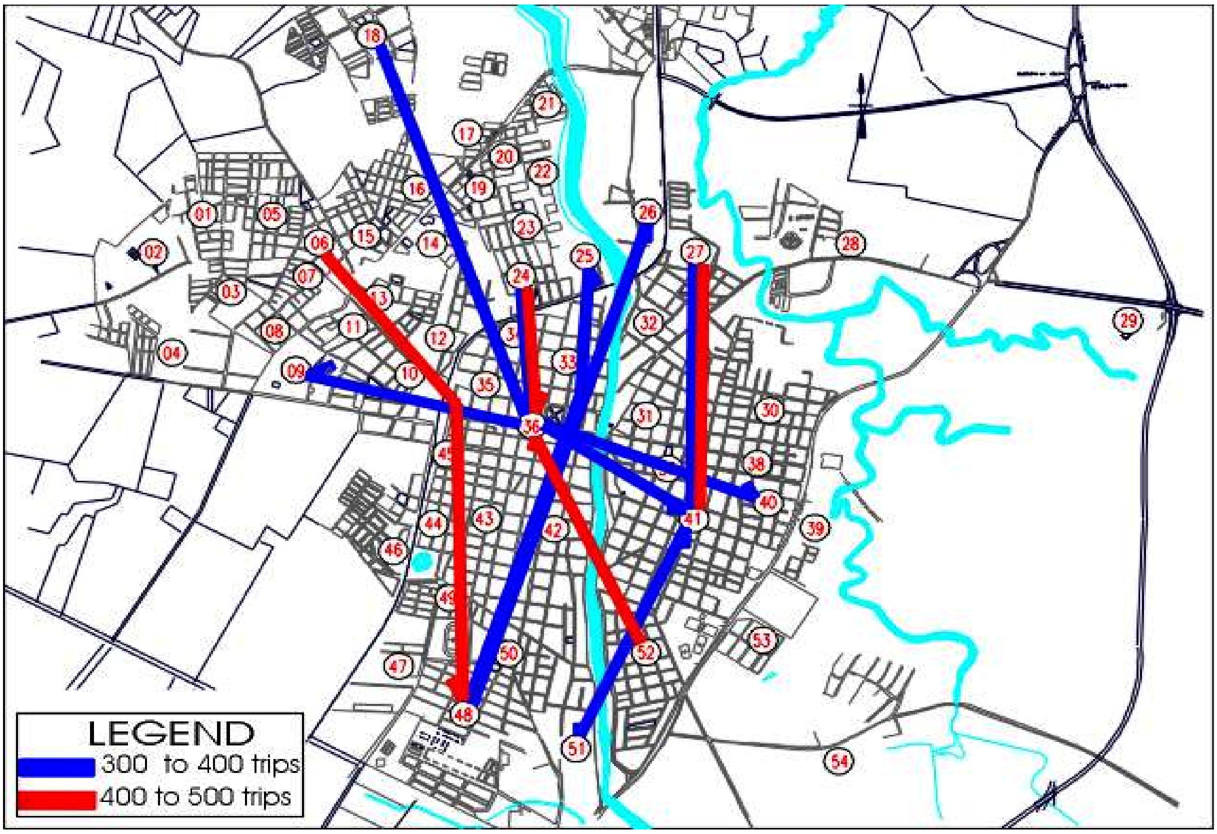

Figure 1. Desire lines of travel by bicycle in Tuluá-Colombia.

Using desire line of travel showed in Figure 1 and analyzing the space availability, the bikeway network was defined as presented in Figure 2.

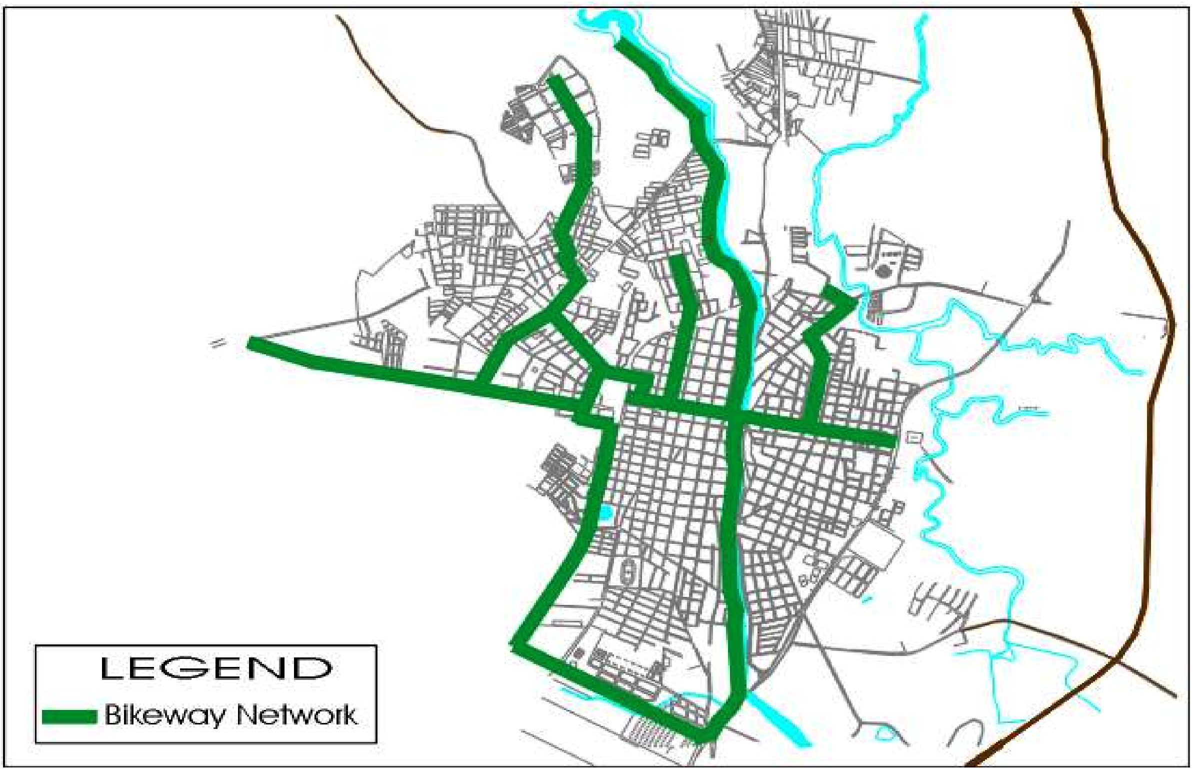

Figure 2. Bikeway Network in Tuluá-Colombia

3.3.3. The available public space

The demand for the peak hour (10% of the average daily traffic) was estimated for the year 2015 and the private traffic was assigned to a proposed highway network with a preliminary capacity assuming the same modal split. The designed bikeway network was overlaid on the highway network competing for the available space, although, generally the bicycle lanes could be installed on streets with light traffic and space availability. When this decision generated extra travel distances for the cyclists, the option was to reduce capacity to the motorized vehicle and expect a modal shift or a change in trip schedule. Nevertheless, for a medium city like Tuluá the motor vehicles can usually find other paths for their trips.

Two situation were analyzed: one with bikeways and the other without them (mixture of traffic like in the present). The first was always the best both bicycles and motor vehicles, demonstrating the advantages of segregating bicycles from motorized vehicles.

3.3.4. Investment possibilities of the city and benefit from bikeways

The benefit/cost ratio of the bikeways is high. For this reason they must be built as a short term activity. Revenues from gas tax were estimated and compared with the estimated cost of the network. This comparison led to recommend building the bikeway network in the first two year of the plan. The network planned has 17,4 km of bicycle lanes with a cost of 350.000 USD which is a 1,6% of the budget of the plan which is about 21,8 millions of dollars.The cost of the bikeways did not include the cost of some special traffic signals for cyclists.

3.4.Characterization of the main factors influencing the use of bicycles

The flat topography, the warm climate, the average trip length under 5 km and the regional habit bicycle riding are natural conditions of Tuluá that favor cycling, which added to poor bus service produce a high percentage of bicycle use (19%). Nevertheless, if the local government do not take advantage of the favorable conditions bicycle use could be reduced. And, if public transportation is improved by the implementation of the Plan, bicycle use should not decline, but the percentage of trips in both modes should increase.

4. CONCLUSIONS

Medium-sized cities with favorable natural conditions such as flat topography, average trip length under 5 km and a great potential for economical and cultural development should make decisions to take advantages of these conditions to properly address the need for better mobility in a sustainable form. Some key factors for designing a bike way network have been mentioned in this work and illustrated for the city of Tuluá. They show that a bicycle modal split of 19% is enough to justify the development of a network segregated from the one for motorized vehicles, at a very low cost in comparison with the cost other infrastructures which serve less people than bicycle lanes and paths.

REFERENCES

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