

Means of transportation choice for the residents of Villavicencio, Colombia: a quantitative analysis

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Abstract

This study describes the decision making process used by the residents of Villavicencio – department of Meta, central Colombia- to choose among different means of transport for their daily needs. This study constitutes an attempt to bring the attention to the traffic problem in Villavicencio, where the increase in the use of cars and motorcycles in the last decade has been exponential, with the result of generating a number of unresolved challenges -road accidents, traffic congestion, pollution and occupation of public space.

This study uses data from the survey '*Encuesta domiciliaria origen-destino*' conducted in the municipality of Villavicencio in 2008 and applies a multinomial logit model to establish the probability of choosing the mean of transport conditioned on a number of controls related to the individuals' socioeconomic characteristics, to the location of the work and that of the dwelling.

The results of both the descriptive statistics and the econometric model show that the variables related to the age of the resident, his/her socioeconomic level, time and cost of the journey are among the variables which mostly influence the resident decisions when choosing the mean of transport. In view of the constant increase in the traffic congestion and road related accidents recorded in the last decade in the area, the priority of the both the central and local Government should be the improvement of the public transport service –which is almost absent- and the creation of a safer environment to allow residents to cycle and to walk without impending danger.

Keywords:

Introduction

The statistics provided by the Department of Mobility suggest that in 2008 there were 61,279 vehicles daily circulating through the streets of Villavicencio, a city of approximately 387 thousand people and located right in the center of Colombia. Out of all the vehicles passing by the city streets, 52,735 vehicles belong to private citizens, 7,720 to the public service, 755 are official vehicles and the remaining, 69, are of unknown origin.¹ According to the Ministry of Transport, from 2006 to 2009 the department of Meta presented an average annual increase of 48% of the registered vehicles and from 2009 to 2013 the number of vehicles in Villavicencio has increased by 19,375. This last increase is explained by a rise of 85% in the number of motorcycles. This situation resulted in increased road accidents, traffic congestion, environmental pollution and increased competition for public space among pedestrians, cyclists, drivers and passengers (Universidad Nacional de Colombia, 2013).

The National Route 65, which passes through the city of Villavicencio, represents the road connecting the main oil production sites with the rest of the country. A number of heavy motorized vehicles, mainly trucks, day in and day out pass through the city to transport the hydrocarbons from the departments of the Llanos Orientales -Arauca, Casanare and Meta- where the oil is extracted to the departments of Meta and Putumayo where the refineries are located (Tasciotti et al., 2015). The discovery of oil wells in those three departments has resulted in an increase in the traffic congestion related problems, higher rate of road accidents, proliferation of parking areas in spaces otherwise destined to parks and in an increase of the barrier effect².

The constant expansion of the road infrastructures, theoretically created *ad-hoc* in order to reduce the traffic congestion and to accommodate the increasing number of vehicles, does not always represents the best option due to the process of suburbanization which causes

¹For more information please refer to the following website:

http://www.villavicencio.gov.co/index.php?option=com_content&view=article&id=5487:61279-vehiculos-es-el-parque-automotor-activo-de-villavicencio&catid=6:noticias-destacadas

² According to Stanley and Rattray (1978) the barrier effect -also referred to as severance- indicates the delays, the discomfort and the lack of access that road traffic imposes on non-motorized people as pedestrians and cyclists.

inefficiency in the delivery of public services (García Lopez, 2012). In addition, the improvements in the road infrastructures may generate the growth of the motorization level in the medium and long term and the return to the initial condition of traffic congestion. Furthermore, according to Vasconcellos (1999), all those roads' interventions have been made without taking into consideration other factors –e.g. the needs the pedestrians and the cyclists have as well as the role that environmental aspects may play- and they have increased the inequality in the use of public space and have produced exclusive urban environments.³ On the other hand, improvements in the systems of public transport, of the cycling and walking paths constitute a more consistent and efficient option even in view of the goals expressed by the Colombian State Law 1083, 2006, in relation to a more sustainable and cleaner mobility⁴.

This study represents a first step in understanding how individuals choose the transport mode in the area of urban Villavicencio and helps determining the link between the mean of transport chosen for everyday travel with the socioeconomic characteristics of the residents and the distance between residential areas and work areas. Understanding the determinants of the demand for transport is an important tool when there is the need of reducing traffic congestion and of strengthening the public transport in and around the city; furthermore it can help reducing the spillover effects related to the traffic congestion and it represents a valid tool that can be used by policy makers and Government representatives to propose and implement changes.

This study is organized as follows. Section 2 proposes a review of the existing literature on the demand for transport services and of the application of probabilistic models –e.g. the multinomial logit models- to explain the process of choosing the mean of transport for everyday travels. Section 3 illustrates the sources and the main features of the data used. Section 4 proposes some descriptive statistics; the results of the empirical analysis are presented in Section 5. Section 6 highlights the main implications of the results and Section 7 concludes.

³ Even though it refers to a different topic, the study made by Pellegrini and Tasciotti (2013) on the challenges faced by developing countries when trying to electrify the country highlights the fact that any attempt to improve the status quo never constitutes a smooth process and it has to be accompanied by a comprehensive portfolio of policies.

⁴ Article 1 of the cited law says that '[...] *all the municipalities and the districts should give priority to alternative modes of transport –e.g. use of bikes and other non-polluting vehicle [...]*'.

Review of literature on transport modal choice

The municipality of Villavicencio has experienced a significant population growth in the last 30 years; according to the National Administrative Department of Statistics (DANE), the number of people living in the urban area of Villavicencio grew from about 200 thousand to mid-1980 to 387 thousand in 2008⁵. This growth has been explained by the net migration process as a result of the local economy's growth and by the forced displacement as a consequence of the violence in rural areas (García Flórez, 2013). In addition to the increase in the population, which undoubtedly played a role in explaining the rise of traffic congestion problems, the choice of Villavicencio inhabitants of using motorized means of transport –e.g. cars and motorcycles- for their daily travel have exacerbated the traffic congestion problem, with consequences ranging from air pollution, inequality in the use of public space, higher rate of traffic accidents, presence of barrier effect and an increase in the demand of public and private resources to mitigate those problems (Acevedo et al, 2009).

Due to the extensive use of private and motorized vehicles, the city of Villavicencio is nowadays facing significant challenges in relation to the traffic volumes and the renovation of the current transport system has not been designed yet.⁶ A basic knowledge and application of the probabilistic demand for transport –modal choice models applied to the transport choice- would represent a major contribution for the planning of the transport system in the municipality as it will allow the municipality representatives to identify all those aggregates influencing the process of choosing the means of transport; *ad-hoc* policies could be then defined to encourage the use of public transport and to guarantee a more equal distribution of the public space among drivers, cyclists and those who choose to walk.

Modal choice models are classified into aggregate and disaggregated models; the first type of models are characterized by the information being based on zonal and inter-zonal levels while in the second type of model the data is disaggregated at the individual level. Predictive models of second generation, as the disaggregated models are also known (McNally, 2007), are useful as single individual data can be used to make predictions about the behavior and choices of a

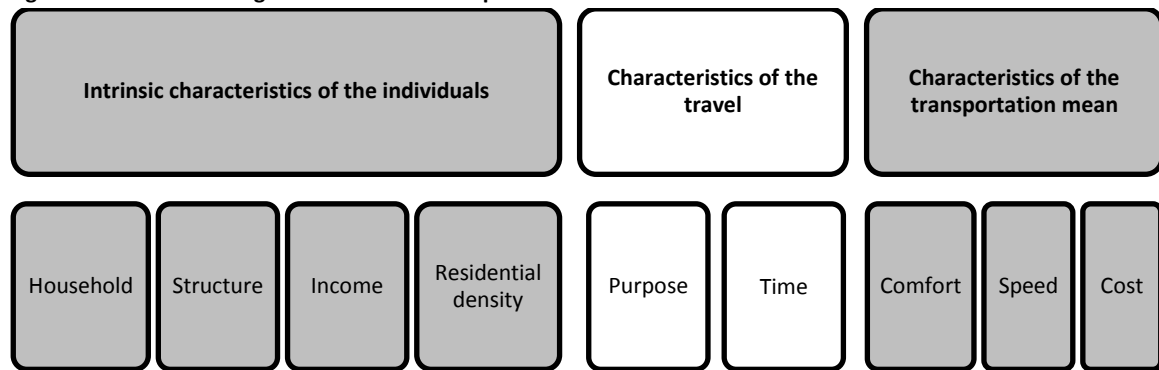
⁵ For more information, please refer to the following website <http://www.dane.gov.co/index.php/poblacion-y-demografia/censos> lastly accessed the 15/06/2016.

⁶ For more information, please refer to the following website: <http://www.eltiempo.com/colombia/otras-ciudades/problemas-de-movilidad-en-el-centro-de-villavicencio/14516337> lastly accessed the 15/06/2016.

community of individuals. On the other hand, even if disaggregated data are not available, it is sometimes possible to extrapolate disaggregated results using aggregate models (De Rus et al, 2003).

Urban travel demand is the result of the aggregation of individual travel demands, where each single member makes individual travel decisions based on a set of factors. These individual decisions are complex and sometimes extremely difficult to disentangle as they involve multiple decisions on trip purposes, frequencies and duration of the trip, the time of the day when the trip takes place, trip destination and mode of travel chosen. Furthermore, these choices should be analyzed in the context of simultaneous choices of automobile ownership, housing location, reason for the trip and end-of-trip activities (McFadden, 1974). Such a selection process modes of transport is determined by a number of factors directly and indirectly related to a number of individual's decisions which can be classified into three large groups: i. intrinsic characteristics of the individuals, ii. characteristics of the travel and iii. characteristics of the transportation mean (Ortúzar and Willumsen, 2011) (Figure 1).

Figure 1: Factors affecting the demand for transport



Source: Elaborated by the authors on the ideas originally developed by Ortúzar and Willumsen (2011).

The costs of different modes of transport has been considered to be one of the main determinants of the modal choice together with the intrinsic cost of everyone's time; transport demand varies according to the time of the day as there are significant differences between rush and non-rush hours (Ortúzar and Willumsen, 2011); during rush hours, traffic congestion is a factor that needs to be taken into account and fees are generally higher (de Rus *et al*, 2010). In addition to the monetary costs of the travel, aspects such as speed, privacy, personal taste, safety and flexibility may play a role in affecting the preferences of individuals (Bromberg, 2000).

The prediction of transport demand via the estimations of the modal choice models represents a significant advance for the planning of the transport services. While the transport supply is indivisible, not storable and fixed in the short term, transport demand can vary due to differences in intensity -peak and off-peak hour. The differences between the quantity supplied and quantity demanded can potentially generate a disparity which makes inefficient transportation system (Bull, 2003). As the provision of road infrastructure is costly, so an incorrect prediction of transport demand –i.e. the supply does not match the specific needs of the demand- can potentially generate losses of public resources. The underestimation of the current demand of public transport can be the trigger of traffic congestion and of negative externalities such as traffic accidents and spillover effects that can harm the society at different levels (IDB, 2011). To this concern, Ortúzar and Willumsen (2011) argue that, as a consequence of the indivisibility of transport services and the high sunk and maintenance costs of the infrastructures, demand forecasting constitutes an imperative aspect of providing an adequate transport supply.

To efficiently meet the demand for transport, an accurate plan is needed in both the short and long period; furthermore, a precise knowledge of the various attributes that determine transport choice is needed (Espino, 2003). Due to the multiplicity of factors influencing the choice of transport demand, it is possible to distinguish between the determinants of the aggregate demand determinants of individual demand.

Aggregate demand

Transport demand is a derived activity, meaning that transport demand is not a ‘per se’ activity but it is rather defined by the need individuals have when they decide to travel: work related purposes, to go to school/university, for personal reasons, etcetera. A larger population usually means a greater number of trips. Considering the fact that the share of the population living in urban areas is constantly increasing, it is becoming necessary to introduce public transport changes to encourage the uptake of mass transit as trams -the so called ‘Bus Rapid Transit’ (BRT) which are normally referred to as *Transmilenio* and mainly used in Bogota D.C.- and cable cars.⁷

⁷ Bus Rapid Transit (BRT) is a bus-based mass transit system, extremely common in Latin America. The BRTs often have dedicated lanes at the center of the roads, which make the service extremely fast and efficient.

The travel choice is strongly linked to the use of land, to the location of the house and of the work activity, to the time of the trip and the costs of everyone's time. This nexus between transportation and individual characteristics has been at the center of the urban economic theory ever since the theoretical models of urban land use have been formulated in the 1960s (Anas, 2012). The economic situation of the country –Colombia- or of the municipality – Villavicencio- as in this specific context, constitutes another aspect affecting the demand of transport; a rise in the number and size of the economic activities present there increases the transport demand in two distinct but correlated ways. Firstly, the increased flow of goods, which is a natural consequence of the increase in the economic activities, require more transport and, secondly, people have the tendency to travel more in times of economic boom (De Rus et al, 2003).

The locations of those urban facilities which are needed in every day's life –markets, shopping malls, parks- and that of the residential areas affect people's choice to use certain modes of transport: walking or using the bike, when applicable, would be used primarily for short distances while public transport and private vehicles would be preferred when the distance gets bigger. Another important issue to take into account is the orography of the territory surrounding the city; the presence of mountains can facilitate or impede the construction of certain infrastructures –e.g. highway, toll ways, bridges- enabling the supply of certain modes of transport and preventing the other. Also some terrain features such as slope, may impose a greater use of medium or large transport modes –such as buses and four wheels vehicles- and may prevent the use of scooters and bicycles.

Individual demand

In addition to determine the approach previously discussed in the aggregate demand, transport economics incorporates analysis tools of neoclassical microeconomics for individual approach (De Rus et al, 2003). Transport demand has some peculiarities that makes it different from the demand for other goods or services; some of these differences are represented by the choices dictated by the time use, by the importance this choice plays and by the discrete nature of the decisions of individuals in relation to transport services (Ortúzar y Willumsen, 2011).

The neoclassical theory of consumer behavior indicates that individuals make decisions in a rational way, comparing different baskets of goods and choose the basket which gives the

consumer the maximum profit or the maximum personal satisfaction, without forgetting that these choices are limited by the budgets of time and money (Varian, 2011). In this sense, individuals perform an evaluation of the available alternatives, which comprises a comparison between the prices of goods and the levels of satisfaction you get from the last consumed unit of goods. The final objective is of course to achieve a higher degree of satisfaction considered the restrictions imposed by time and money. The result of this process constitutes the individual demand function.

Data

The data used in this study comes from the '*Encuesta domiciliaria origen-destino*' conducted by the National Planning Department (DNP)⁸ in 2008 and which represented an attempt made by the Colombian government to better understand the traffic situation in the country⁹. The survey, which gathers data on a number of variables including the socioeconomic characteristics of the individuals, household demographics, the conditions of travel and a description of the vehicles used, aimed at getting a snapshot of the situation of the urban mobility in Villavicencio in order to optimize the transport system. For the implementation of the survey, following the recommendation of Ortuzar (2011), DNP used the 4% of the urban population of the town as recorded by the National Administrative Department of Statistics, which corresponds to 15,318 people¹⁰.

The survey instrument aimed at gathering information on the trips made the day before the interview by the interviewed residents. The days chosen for conducting the interviews went from Tuesday to Saturday in order to gather information on the daily trips done by Villavicencio citizens from Monday to Friday. The survey period went on for a 5-weeks period, from February the 11th and the March the 15th 2008. Interviews were directed to all the household's members in the selected households sample. The survey consists of four parts: i. in the first part, data on household characteristics were collected, ii. the second part provides information on type of

⁸For more information, see the following website: http://villavicencio.wikispaces.com/file/view/PlanMovilidad31-03-2010_17-48-34.pdf lastly accessed the 15/06/2016. .

⁹For more information, see the Decree 170 of 2001 on the following website:

<http://www.alcaldiabogota.gov.co/sisjur/normas/Norma1.jsp?i=6104> lastly accessed the 15/06/2016.

¹⁰ Even though the population of Villavicencio amounts to 387,232 people, only 382,967 people were considered in the sampling scheme; few city blocks were not considered in the survey as they have less than 20 people living there, which was the minimum threshold to be part of the survey.

vehicles owned by the household's members, iii. the third part gathers data on socio-economic characteristics of household's members and iv. the fourth part focuses on the main features of the trips made by the household's members, including the departure and destination place of each journey, the departure and ending time, the main purpose of the travel and the vehicle used.

The total number of trips recorded during the survey was 30,614, but only 81% of them - approximately 24,826- was used in this study, as the remaining part of the data presented some missing values and inaccuracies.

The variables on the monetary cost of each travel were built using the following assumptions:

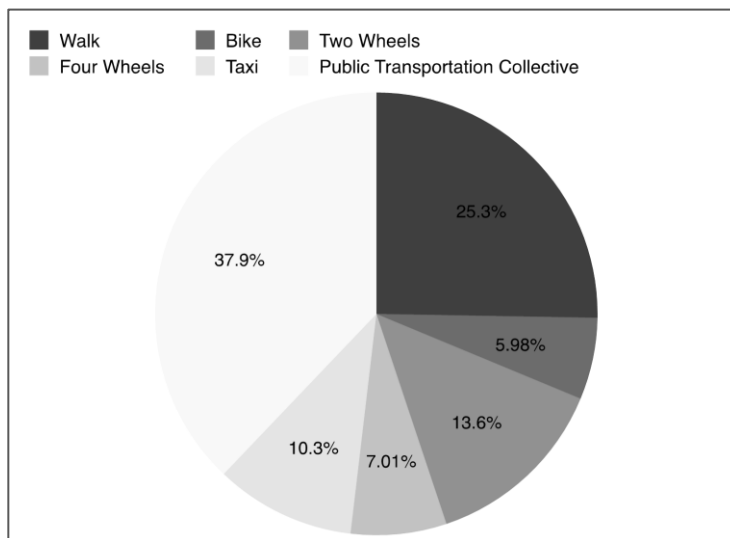
- i) the cost of bicycle journeys has been assumed to be equal to zero, even though there may be some costs related to the depreciation of the bike used –e.g. tires being consumed and bike getting older; with some degrees of approximations, these costs were considered to be negligible;
- ii) for those journeys made using either taxi or public transport, the average fee was used, which was US \$ 1.7 and US \$ 0.57 respectively. Although those travels outside the city perimeter have an additional charge, the average fee has been assigned to those taxi and public transport travels for which the cost was not reported. The assumption used can be considered reasonable as the surveyed population lives within the urban perimeter and the main markets and city malls as well as the main offices are located in the urban area. Thus, the share of travels done to reach locations outside the urban perimeters are negligible
- iii) In the case of travel by motorcycles and private cars, the cost of the travel has been calculated using the Monetary Average Cost per Kilometer Tour (MACKT). To this concerns, the MACKT price of those travels made using motorcycle (car) in 2008 was US\$ 0.0335 (0.144)¹¹. These values are multiplied by the distance in kilometers of each trip and take into account the the time spent on the trip and the average speed, which in the case of the motorcycle was 39.5 kilometers per hour km/h and 29.3 km/h for four wheels vehicles (Ivarsson & Asociados and Logitrans, 2008).

11 The cost of a single travel made by using either a motorcycle or a car has been computed by the authors using the methodology presented by (Chavarriaga, 2006).

Descriptive statistics

The citizens of Villavicencio, as those of many other cities, mainly travels for reasons related to their work; the decision regarding the type of vehicle used depend on their income level, their gender, age and family status. According to (Ivarsson & Asociados and Logitrans, 2008), about 80% of all the vehicles passing through the city of Villavicencio are either four or two wheels –i.e motorcycle- vehicles; despite this, the data of this study show that 70% of people still walk, use the bicycle or the public transport (Figure 2). A preliminary analysis of the data shows an inequitable use of road infrastructure of the city in favor of the four wheels and two wheels.

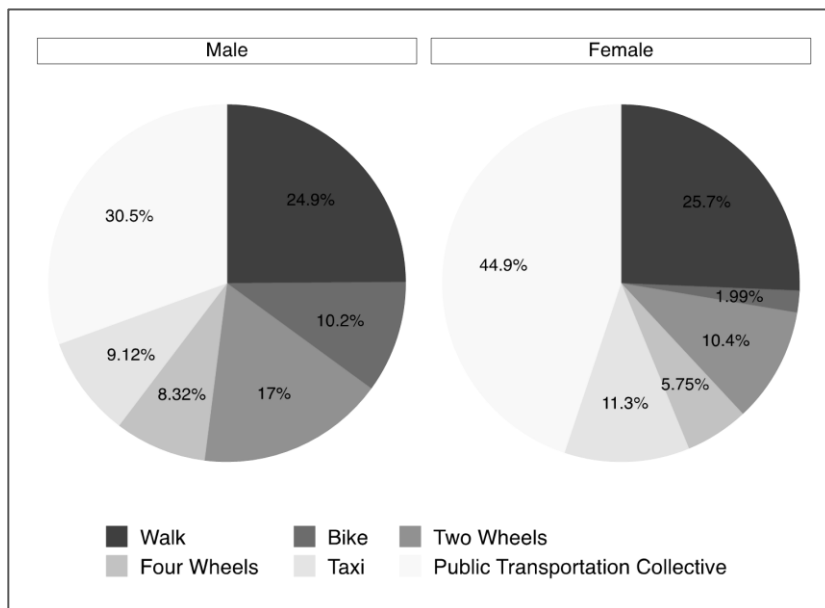
Figure 2: Daily use of different means of transportation in Villavicencio, 2008 (in %)



Source: Encuesta domiciliaria origen-destino, 2008.

The division of labor and duties within the household's members has an effect on the mobility pattern of men and women (Alcantara, 2010). Figure 3 shows that, on average, women walk more and use public transport more than men -70% of women's trips versus 55% for the male counterpart. Strangely enough, men seem to use the bike more than women -10% versus 2%. According to different studies, the cultural and the religious aspects may explain the low use of the bicycle by women (Alcantara, 2010) on the other hand, men seem to use private vehicles more than women.

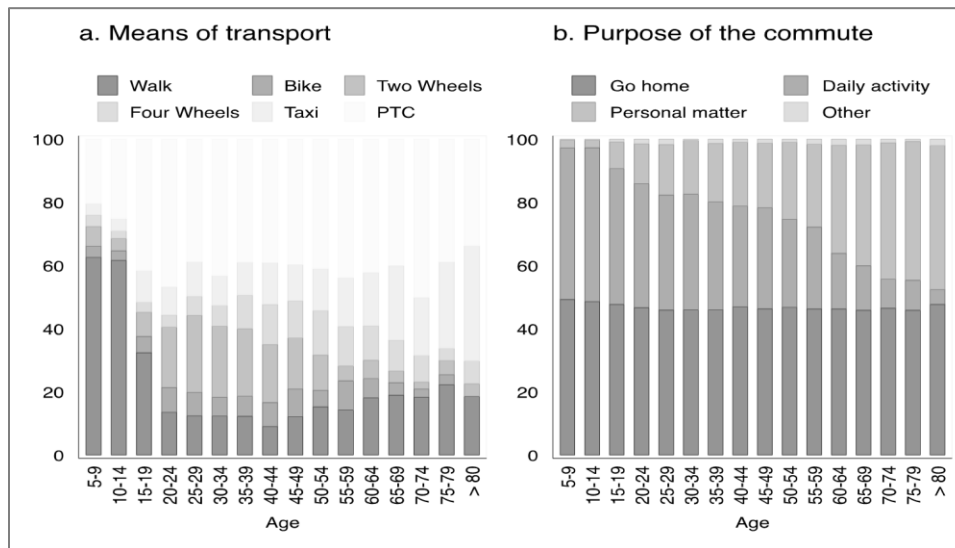
Figure 3: Daily use of different means of transportation in Villavicencio, 2008, disaggregated by gender (in %)



Source: Encuesta domiciliaria origen-destino, 2008.

The choice of the means of transport is influenced by the activities people perform and by the age people have. To this regard, children and teenager's principal activity is studying and going to school; half of the trips performed by people aged between 5 and 19 are related to their study (Figure 4). As in the municipality of Villavicencio the location of the residence is relatively close to schools –elementary, middle and high school- teenagers mainly walk there. Meanwhile, young adults perform more than one activity –they both study and work at the same time- and travel using mainly the PTC and the motorcycle. On the other hand, for those adults performing different activities -work, personal related businesses and also studying related activities - the choice of the means of transport varies. Finally, in the case of older adults –mainly retired people- the amount of activities to be done during a given day is reduced to personal chores, hence their mobility decreases as well and their favorite means of transport is the PTC, car and walking (Figure 4).

Figure 4. Daily use of different means of transportation and purpose of the trip in Villavicencio, 2008, disaggregated by age (in %)



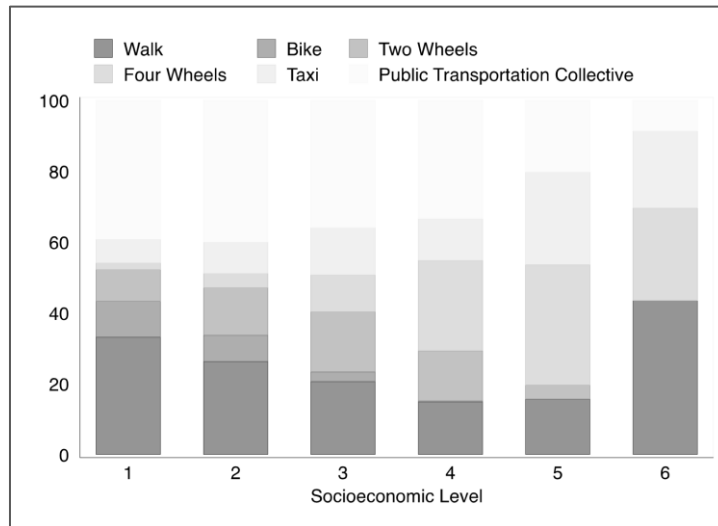
Source: Encuesta domiciliaria origen-destino, 2008.

Note: 'Daily activity' includes trips made for study, work and businesses reason; 'Personal matter' is constituted by all those trips related to shopping and other personal related trips. 'Other' refers to any other trip not in any of the above category.

The income level is a variable that can greatly affect the way people choose the transportation mode to use for their daily trip (Mendieta and Acevedo, 2008). The socio-economic level of the households, used as a proxy for the household's income, confirms that an increase in the household' wealth correspond a rise in the use of four-wheels vehicles and taxis (Acevedo et al., 2009) (Figure 5); less wealthy households, on the other hands, are more likely to walk or to use two wheels vehicles.¹² The statistic that wealthiest households walk more than any other households can be explained by the fact that, on average, they tend to live in houses located in better location of the city and, hence, they are closer to the city center, to the city services and to markets and shops (Frank et al., 2007).

¹² The DANE categorizes the dwellings where citizens live using a scale from 1 to 6; even though this variable does not indicate the household income, it can be considered a proxy for household's wealth.

Figure 5. Daily use of different means of transportation in Villavicencio, 2008, by socioeconomic level



Source: Encuesta domiciliaria origen-destino, 2008.

According to De Rus et al. (2010) people travel to access goods that enable them to meet their needs; in this regard the time spent on the trip do not generate any remarkable pleasure and, hence, individuals choose the fastest transportation.

Table 1 shows that the motorcycle constitutes the mean of motorized transport that, on average, requires less time in travel. This can be explained as motorcycles can overtake traffic congestion more easily than cars and it does not require waiting times as public transport¹³. On the other hand, public transportation is the mode of transport most used; the extremely high travel time needed by the public transport is explained by the long waiting times, the traffic congestion and the long routes, with the aggravating circumstance that public transportation vehicles all pass through the commercial and business center of the municipality which is an area with a very high traffic flow.

¹³ Until 2008, when data have been collected, in Villavicencio there were not bus stations nor bus stops in the strict sense. Most of what the local population refers to as 'bus stops' are places located next to traffic lights and roads'

Table 1. Time and cost of travel in the municipality of Villavicencio by means of transport

Mean of transport	Number of observations	Travel time (minutes)		Travel cost (Dollars)	
		Mean	Sd	Mean	Sd
Walk	6,282	20.30	11.55	0.00	0.00
Bike	1,501	26.04	14.99	0.00	0.00
Two Wheels	3,360	21.99	12.02	0.61	0.33
Four Wheels	1,731	24.39	14.83	2.08	1.26
Taxi	2,539	27.29	13.69	1.75	0.00
Public transportation Collective	9,413	40.39	17.04	0.58	0.00
Total	24,826	29.49	16.99	0.62	0.73

Source: Encuesta domiciliaria origen-destino, 2008.

intersection; those places did not report any sign indicating the presence of a bus stop (Ivarsson & Asociados and Logitrans, 2008). In addition, it is a very common habit to ask the bus driver to stop when and where the customer needs to get out. This current situation has clearly a number of negative spillover effects which ranges from a very slow public transport system –everyone gets on and out of the bus when and where needed- to the danger represented by fact of waiting in the middle of the roads. To date, bus stop are still non-existent in Villavicencio.

A very interesting feature is that the cost of travel of two wheels transport is very similar to the one of the public transport; however, it has to be noted that the cost of two wheels transport does not include the high risk of accidents or the cost for parking.¹⁴

Empirical analysis: modal choice specification

A discrete choice model -specifically a model of multimodal choice called unordered logit multinomial- will be used in what follows in order to determine the relationship between the choice of the mean of transport on one side and the characteristics of the trip and of the user on the other side. The choice of the model lays into the fact that it can predict, with a discrete level of accuracy, the probability that an individual chooses a mean of transport rather than another one conditioned on a set of explanatory variables –such as the cost and the duration of the travel, and some socio-demographic variables related to the person and to the household.

The multinomial logit is an advance in the process of specifying discrete choice models that have nonlinear relationships in the parameters. Some of the salient features of the multinomial logit model are that: i) the dependent variable is discrete, ii) the estimated Y_i is expressed relative to an alternative base, which indicates the probability of moving from a given option -0- to the next option -1- and iii) the functional form is the logistic one. Greene (1999) describes the multinomial logit model as: "(...) a set of probabilities for $j + 1$ alternatives to choose a person who has to make a decision and have X_i as individual characteristics".

Multinomial logit models are normally expressed as in formula (1):

¹⁴ Since 2015, the municipal government has implemented the payment of a fee for parking in some areas of the commercial and business center and in few surrounding areas –all of them referred to as "Blue Zones"; this imply that both motorcyclists and drivers of four-wheel vehicles have to pay this cost which was previously only charged in private parking. For more information about this change in policy, see the following website: <http://www.eltiempo.com/archivo/documento/CMS-13427256>. The results of multinomial logit model show the incidence each explanatory variable has on the probability that the inhabitants of Villavicencio substitute walking - chosen as the base option in the model- with the use of different transportation modes. The econometric results are presented in Table 3.

$$(1) Y_i = \frac{e^{\alpha + \beta_k X_{ki}}}{1 + e^{\alpha + \beta_k X_{ki}}} + u_i$$

The logit model used in this study is expressed logarithmically and it describes the probability of switching from walking to another mean of transport; the equation that will be used for estimation takes the following form:

$$(2) \ln\left(\frac{Y_i}{1-Y_i}\right) = \hat{\alpha} + \hat{\beta}_1(\text{gender}) + \hat{\beta}_2(\text{age}) + \hat{\beta}_3(\text{Education level}) + \hat{\beta}_4(\text{Purpose travel}) + \hat{\beta}_5(\text{Socioeconomic level}) + \hat{\beta}_6(\text{travel cost}) + \hat{\beta}_7(\text{travel time}) + e_i$$

The list of variables used and their meaning can be found in Table 2. The variables used in the model as control variables are the most recurrent in the literature; the only difference is represented by the omission of the variable referring to the quality of the service offered by public transport and taxi, as data on this aspect was not available.

Table 2: List of independent variables considered in the regression analysis

Variable	Description
<i>Gender</i>	It assumes values '1' if the respondent is male, '2' if the respondent is female
<i>Age</i>	It indicates the age of the respondent
<i>Education level</i>	It refers to the last approved educational level of the respondent; it has 7 categories: 1) Preschool and Elementary school; 2) High school diploma; 3) Technical/technological diploma; 4) University degree; 5) Post graduate certificate; 6) Other; 7) None
<i>Purpose travel</i>	It indicates the purpose of the journey: 1) Return back home; 2) Daily business activity; 3) Personal matter; 4) Other
<i>Socioeconomic level</i>	It is a proxy for the socioeconomic status of the household and it assumes values from 1 to 6. Since 1994, the government made the strata divisions of the population official and strata are now used to determine how much each individual pays for utilities, in university fees, healthcare services and other services
<i>Travel cost</i>	It indicates the monetary costs, expressed in US dollars, of a specific mean of transport. For the pesos/US dollar conversion, we used the 2000 pesos per US dollar ¹⁵
<i>Travel time</i>	Time in minutes of the journey taken; it is computed as the difference between the time of arrival at place destination and departure time at place origin. It hence includes waiting time and access to transportation

15 For more information about the exchange of Colombia, see: <http://www.banrep.gov.co/es/trm> , lastly accessed the 15/06/2016.

Discussions

The results of multinomial logit model show the incidence each explanatory variable has on the probability that the inhabitants of Villavicencio substitute walking -chosen as the base option in the model- with the use of different transportation modes. The econometric results are presented in Table 3.

It is important to highlight the fact that this study constitutes the very first attempt to study the choice of the transport mode in Villavicencio. Previous studies focusing on the modes of transport in Villavicencio have analyzed the transport infrastructure, the number and typology of vehicles passing through the city and how the whole transport industry had been organized (Ivarsson & Associates and Logitrans, 2008; Gleave and Akiris, 2009; National University of Colombia, 2013); in other words, the accent had been on objects rather than on people. In this study we use the characteristics of transport users too; we try to link the individuals' characteristics to the transport mode used. Among the individual variables used, age is statistically significant with a positive coefficient for all the transport modes; this means that the older people get, the more likely they choose means of transport –especially taxi and four wheels vehicles- other than walking; this choice would be associated with factors related to greater comfort and safety of the journey. This finding represent an important aspect of the transport choice as it shows that people of younger ages tend to primarily walk; this choice, combined with the poor level of infrastructure¹⁶ for pedestrians explains the death of under 14 years old teenagers killed in traffic accidents.

The second result worth of mentioning is that women are significantly more likely to walk and to use collective public transportation in their daily trips. This is an important finding as it shows the result of intra-household negotiations about which person will use motor vehicles –mostly the male part of the household- and which person -mostly women- has to either walk or use public transport. The allocation of vehicles among household members as previously described may occur for two reasons: i. sexist stereotypes may still exist and/or ii. men may have a prioritized access over the female counterpart on the use of motor vehicle as a faster transportation mode for getting to work. This findings have a gender component too; the

16 For more information about the death of Young pedestrian in Villavicencio, please refer to the following website: <http://www.eltiempo.com/archivo/documento/CMS-4798840> lastly accessed the 15/06/2016.

precariousness and the lack of quality of the BRT and the absence of infrastructure for pedestrians exposes women to a number of risks and discomforts which the municipality of Villavicencio may think of reducing if not eliminating.

The educational level is statistically significant and positive for all modes indicating that individuals having higher educational level have a higher likelihood of switching from walking to different modes. This result suggests that the probability of walking decreases with higher educational level as more years of schooling may mean more economic activities and faster transportation modes.

The socioeconomic status is not significant for any transportation mode except for the collective public transportation; as individuals becomes richer they prefer to use motorcycles, private cars and taxis with this behavior that can be explained by the fact that higher income level allows them to use more comfortable and faster modes, even though those modes are more expensive (Acevedo et al, 2009). The lack of significance of the socioeconomic status for the use of bicycles is related to the heterogeneity of the bicycle users and to the purpose of using the bicycles. Those users in the lower socioeconomic strata may use the bicycle as it is a cheap option to travel and allows you to travel longer distances compared to walking. On the other side, people on the higher socioeconomic strata may use the bicycle for sport reason, because it is a fashionable option or as a mode for exercising with other people (Jaffe, 2016; Litman, 2013). An increase or a decrease in the socioeconomic status of a given household, then, does not necessary imply a change in the use of the bicycle.

Travel time is statistically significant in four out of the five modes and the coefficients are positive for what concern the public transportation collective, the two wheels and four wheels – including taxi- vehicles. These results highlight the fact that when the travel time increases, the likelihood of using these modes of transport goes up as well, as those transport modes are considered faster than walking.

The variable 'travel cost' is significant for all modes. PTC, taxi and two wheels have positive coefficients; the cost of travel using those three modes is greater if compared to using the bike or walking, with these last two modes having zero monetary cost. According to (Azan et al, 2012) and (Vasconcellos, 2010) both public transport and motorcycle behave like an inferior good, whose consumption increases when their prices go up. This explanation couples with the fact that the expenditure for transportation represents an important share of the household

budget - about 10% of the total monthly expenditure; furthermore, in some areas of the city there may be a limitation in the availability of the other means of transport, which leaves the users with very little choice apart from public transport.

For what concerns the taxi option, this transport mode is mainly used by those users in the higher socioeconomic strata (see Figure 5); hence, those users are less willing to change their transport mode as soon as the price goes up (Fravel and Gilbert, 1978).

In addition, the model results highlight the fact that people are willing to pay an increase in the monetary cost of the travel provided the fact that the time of the travel reduces, which is what happens when users take PTC, taxi and two wheels vehicles. In the case of four wheels vehicles, the coefficient is negative, meaning that when there is an increase in the travel cost -i.e. an increase in the price of petrol- there is a higher chance of seeing the use of cars decreasing.

Table 3: Regression results

Transportation means	Bike	Public Transportation Collective	Taxi	Two wheels	Four wheels
Age	0.02*** (0.002)	0.02*** (0.001)	0.04*** (0.001)	0.03*** (0.001)	0.04*** (0.002)
Gender	-1.57*** (0.083)	0.24*** (0.040)	-0.01 (0.060)	-0.56*** (0.047)	-0.53*** (0.072)
Education level					
Preschool and Elementary school	0.15 (0.230)	0.07 (0.136)	0.34 (0.233)	0.69*** (0.237)	0.02 (0.252)
High school	0.61*** (0.234)	0.78*** (0.138)	1.17*** (0.235)	2.08*** (0.237)	1.00*** (0.253)
Technical/technological	0.48 (0.307)	1.08*** (0.168)	1.78*** (0.262)	2.86*** (0.255)	1.62*** (0.282)
University	-0.46 (0.361)	1.14*** (0.167)	1.66*** (0.261)	2.62*** (0.256)	2.38*** (0.272)
Post graduate	-46.3 (12.59)	6.63 (5.92)	7.36 (5.937)	8.18 (5.930)	9.33 (5.933)
Other	0.37 (1.178)	0.27 (0.845)	-3.35 (7.171)	-3.17 (7.894)	1.27 (1.180)
Purpose of travel					
Go home	0.37 (1.178)	-0.43** (0.196)	-0.05 (0.290)	0.16 (0.255)	-0.24 (0.334)
Daily activity	0.12 (0.357)	-0.30 (0.197)	-0.26 (0.292)	0.32 (0.256)	-0.01 (0.334)
Personal matter	0.35 (0.357)	0.01 (0.201)	0.37 (0.295)	0.05 (0.262)	-0.41 (0.343)
Socioeconomic level					
Socioeconomic status 1	2.63 (9.440)	1.36 (0.972)	-1.11 (0.809)	1.67 (1.739)	-0.87 (1.739)
Socioeconomic status 2	2.40 (9.440)	1.73* (0.972)	-0.84 (0.808)	2.07 (1.739)	-0.18 (1.738)
Socioeconomic status 3	1.58 (9.440)	2.07** (0.972)	-0.30 (0.808)	2.30 (1.739)	0.65 (1.737)
Socioeconomic status 4	-0.64 (9.456)	2.06** (0.977)	-0.35 (0.821)	2.19 (1.743)	1.35 (1.741)
Socioeconomic status 5	-3.20 (11.19)	1.43 (1.022)	0.58 (0.871)	1.12 (1.803)	1.84 (1.775)
Travel time	0.01 (0.002)	0.09*** (0.001)	0.03*** (0.002)	0.01*** (0.002)	0.01*** (0.003)
Travel cost	-0.004*** (0.001)	0.01*** (0.001)	0.01*** (0.001)	0.01*** (0.001)	-0.01*** (0.001)
Constant	-1.14 (9.451)	-5.25*** (1.00)	-5.14*** (0.885)	-4.80*** (1.774)	-1.35 (1.793)
<i>Observation</i>	24.826	24.826	24.826	24.826	24.826
<i>R-squared or R-squared adj.</i>	36				

Notes: ***, ** and * mean significance at 1, 5 and 10%.

Source: Encuesta domiciliaria origen-destino, 2008.

After analyzing the results of the regression and the measures of the goodness of fit, we can assume that the independent variables considered in the model explain relatively well the choice of transport modes of the residents of Villavicencio. The pseudo R squared of 36%

indicates that the independent variables used in the model explains a little more than one third of the variance of the dependent variables. On a different level, the Likelihood Ratio test rejects the null hypothesis that all coefficients are equal to zero, with a confidence level of 99%.

Conclusion

In the last decade, the city of Villavicencio has experienced a significant growth in both the population and in the income level which, combined to the lack of appropriate urban planning, has resulted in spontaneous urbanization processes and in substantial and non-controlled increase in the motorization level –with the number of motorcycles having rapidly rising in the last decade. All those factors have been responsible of a series of spillovers effects such as traffic congestion, road accidents, increased in the number of road deaths and occupation of public spaces otherwise used as parks.

This study constitutes an effort to understand the process underlying the choice of the means of transport used for every day's life by those living in the municipality of Villavicencio and it aims at guiding the local and central Government to better manage the transport demand and supply and to improve the still lacking public transport and cycling paths, which are known to generate less negative impacts if any. The quantitative and qualitative lack of public infrastructures for pedestrians has been compromised by the streets' occupation of illegal street vendors, cars and motorcycles which greatly discourage people to walk. Similarly, bicycle users face discomforts and dangers because of the poor infrastructure present and because of such an aggressive behavior of drivers.

The citizens of Villavicencio, mainly travels for reasons related their job. About 70% of people walk, use their bicycles or the public transport. The last one still constitutes the mode of transport mostly used; however the travel time needed by the public transport is extremely high. Motorcycles, on the other hand, represent the mean of transport requiring less time as they can overtake traffic congestion more easily than cars and they do not require waiting times as public transports do.

Women walk more and use public transport more than men; men seem to use the bike more than women. The socio-economic level of the households confirms that an increase in the

household' wealth generates a rise in the use of four-wheels vehicles and taxis. The statistic that wealthiest households walk more than any other households can be explained by the fact that, on average, they tend to live in houses located in better location of the city and, hence, they are closer to the city center, to the city services and to markets and shops.

Regressions results evidenced that travel time and travel cost are among the main determinants of the choice of the means of transport; to this regard, we found that both two wheels and four wheels vehicles had significantly lower travel times to public transport bus and taxi. Lower travel time, coupled with the poor control put in place by municipal authority for parking in public spaces, has created incentives for an exponential increase in the use of these modes of transport.

A forward-looking public policy interested in making mobility a sustainable phenomenon should discourage the use of four and two wheels vehicles –especially if parking spaces are not sufficient- and encourage the citizens to walk, cycle and/or use the public transport mode. As an example, the Villavicencio municipality should better control the parking situation in and around the city; in addition, imposing fees for parking on public streets and in shopping malls would create dis-incentives for use of private vehicles and, at the same time, it would improve the travel conditions for pedestrians (Litman, 2013). In addition, the municipality should strongly consider to put in place exclusive road lanes for public transport as well as pedestrian areas, as already done in other major cities (Steer Davies Gleave and Akiris, 2009). These policies would very likely increase travel times for four wheels and two wheels while improving the conditions of travel for pedestrians, cyclists and public transport users.

To this regard, an increase in demand for public transport will require significant changes in the modalities this service has been delivered as, on one side, there is an excess in the competition –problem known as the '*Guerra del centavo*'- while, on the other side, each public vehicle operates in a completely disjointed way (Chaparro, 2002). The municipal government has tried to change the way public transport was provided but with limited results. In the last attempt, dated 2009, the municipal government proposed the so-called '*Sistema Estratégico de Transporte Público*' (SETP; Strategic Public Transportation System) which generated a strong rejection by several groups of bus owners, drivers and users; several bus drivers and public transport companies perceived this public transport re-organization as a threat to their work

and business (Steer Davies Gleave y AKIRIS, 2009). At the current state of the affairs, the SETP - despite being an innovative plan- is not applicable anymore without further updates needed to avoid that a situation of monopoly of the public transportation is generated.

Changing the provision of the public transportation system is still long way to be done as, on top of everything, the implementation of indicators to measure the quality of the service of public transport would be needed.

It has to be noted though, that the very low population density in the periphery of the municipality of Villavicencio raises the costs of the public transportation provision which have to be transmitted to the users in higher prices and/or higher time per each travel. The changes in the provisions of public transport should then be accompanied by a better tailored expansion of the city in those residential areas located in the outskirts of the city, which is where the majority of industries are located.

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