

DISPERSED CITY AND SUSTAINABLE MOBILITY APPROACHES TO A SMART CITY

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ABSTRACT. The Metropolitan Area of Resistencia presents currently high dispersion and low density, with serious problems of vehicular congestion and vial accidents. Its public transportation is in critical condition, which has suffered during the last times the avatars of national economy, and partial and unfinished policies, and the improvement and cheapening or other urban transportation. This work aims, through documentary analysis, approach criteria which tend at sustainable mobility and urban accessibility of the population.

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Keywords: Accidents, Congestion, Dispersed City, Public Transportation, Sustainable Mobility.

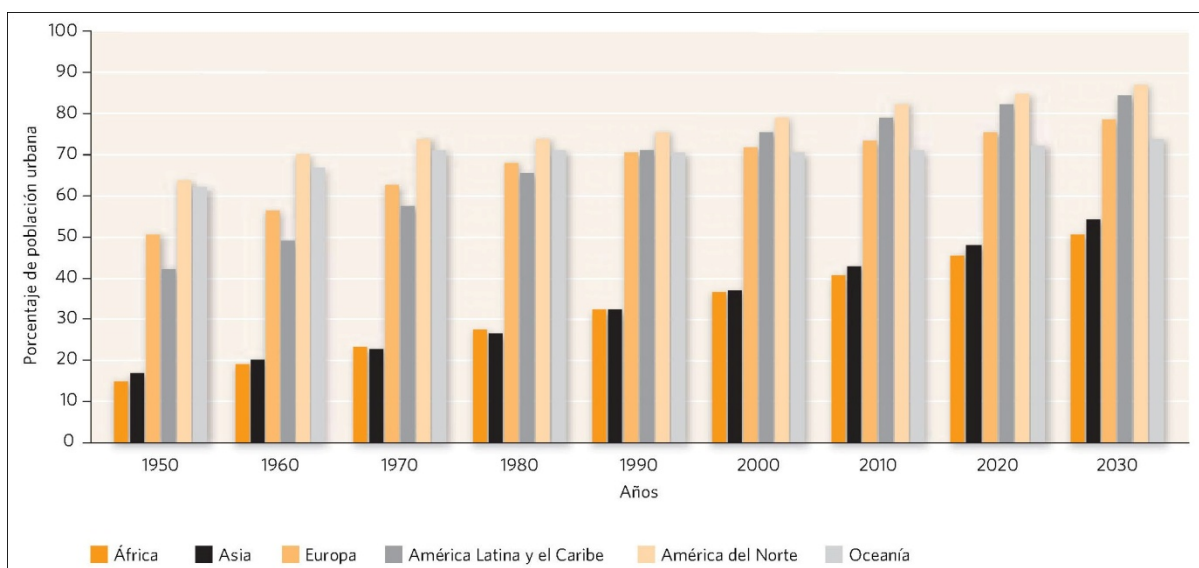
INTRODUCTION

In ancient times the limits of the city were well defined. In some cases, for religious beliefs, defensive walls, or both. Walls also had the function to separate the known from the unknown, the finite from the extensive, the order from the chaos, in order to contain the fear and to limit urban extension. City was contained and its growth was intramural, increasing density and compacting the urban net. The limited extension also solved the problems of population mobility and accessibility

This situation stayed with no variation until the industrial revolution. Since then, due to the technological advances and the cities have been adding benefits population was concentrating in them. In XX century the world urban population quickly increased (from 220 millions to 2.800 millions), and for 2008

represented the 50% of the total population of the planet [1]. But its distribution is not uniform and in some places like Latin America the current urban population reaches the 80% and in Argentina the 90%.

“Those artifacts which have the most artificial complexity degree in the planet, those masses bit formal of accumulated buildings with a variable cohesion degree, act like a first order engine in the evolution of the world, coordinated in a hierarchic relation or with benefits of a random synergy. They grow for increasing masses of people attracted for economic activities concentration that use more and more land as their qualities improve or as a consequence of the increment of the citizens’ wellness, which is satisfied with resources which involve the physical expansion.” [2]



Source: UNFPA (2007).

Figure 1: Resident Population Percentage in urban areas in the middle of the year, 1950-2030
The increment without precedents of urban population and the lack of limits or restrictions,

brought about the physical growth of cities. Even when the territory occupied by cities only covers the 2,8% of the terrestrial surface of the planet [3], the concentration in some cities results in a model which huge urban extensions, metropolitan areas and entire regions with low densities and dispersed occupancy. That is what some authors call diffuse city.

The development and improvement of transportation is one of the facts that have allowed this kind of urbanization. The increase of distances and the reduction of the needed time made possible the implantation of further activities in the space, for a higher economic performance or productive capacity, etc. Thus, urban densities, in average, decreased in the last two centuries. As the transportation improved, the tendency is that cities take over more and more territory per capita. [4]

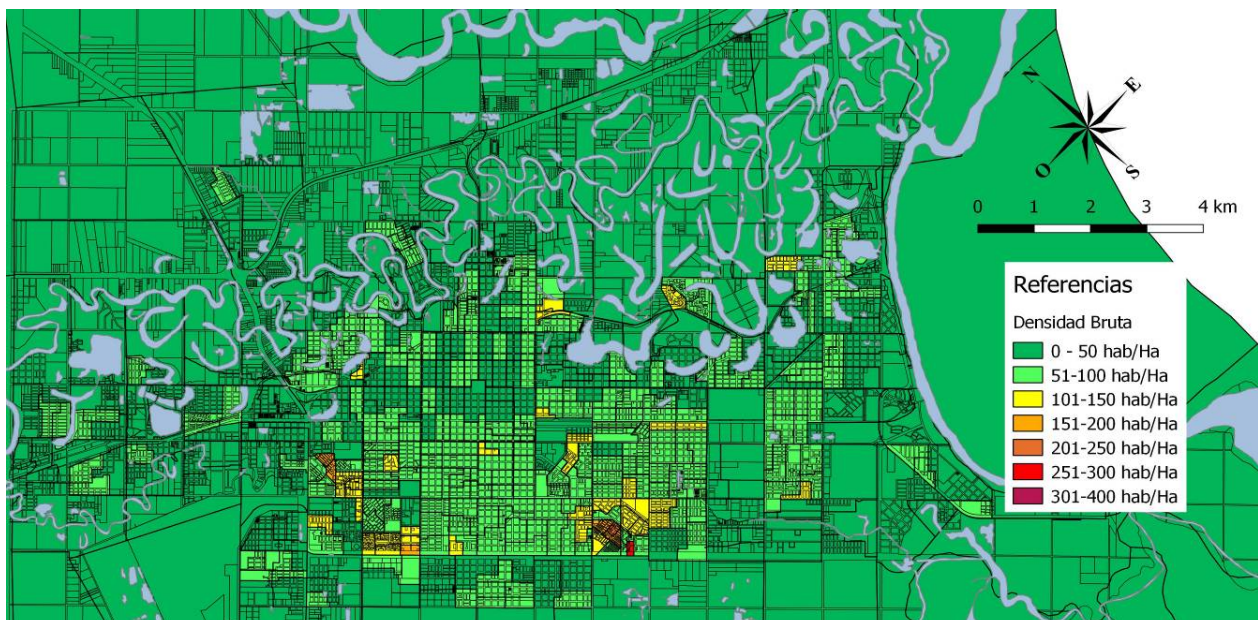
One of the last limits to the extension of urban was the mobility autonomy, which was overcome for the improvement of transportation and the needed infrastructure. The intensive use of transportation and specially the private ones in big cities made that new limitations arise due to the congestion.

“Resolution of transportation conflicts which come with the diffuse city, it can only be approached increasing the infrastructure to return the lost velocity or to solve the net saturation. This represents to occupy more space, consume more energy, and more

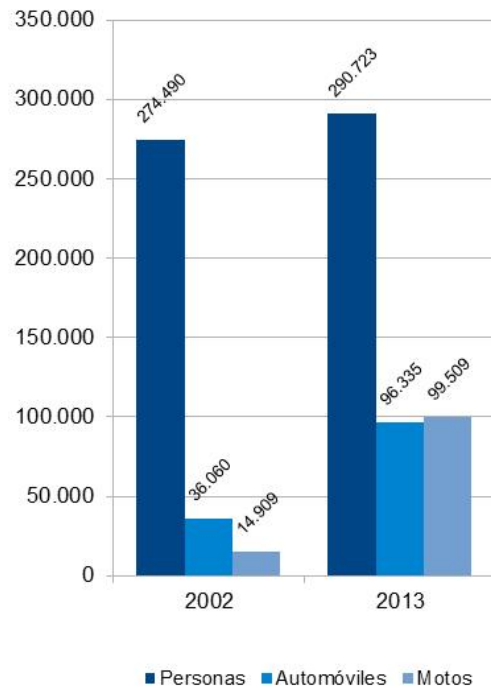
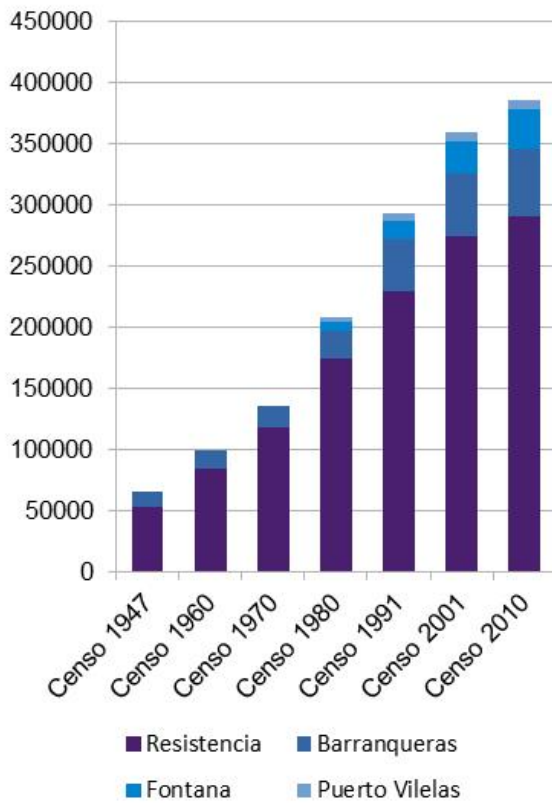
materials to end up daily doing the same. This dynamic process, it is also complementary and generally the precursor of new dispersed urban settlements, and so the enlargement of the net is not enough, because they will displace the congestion problem and the variables with it (contamination, noise, landscape contamination, higher energy consumption, space and time) to larger surfaces.” [5] y [6]

Like some other cities in the northeast region of Argentina (NEA), of the country and the continent, Resistencia city has considerably grew in population and size in the last decades, becoming the Metropolitan Area, along with Puerto Barranqueras, Puerto Vilelas, and Fontana. The metropolitan area of Resistencia (AMGR) concentrates the 40% of Chaco population and its extension didn't stop even with the imposed limits of the defenses against Rio Parana flood.

The extensive disperse and low density growth came with an important increase of the motorized mobility. Twenty years ago, streets were leisurely quiet during almost all day and the conflicts were not significant. The bicycle was one of the principal means of transportation for all social classes and the demand for parking spaces was scarce. Today the transit is chaotic during the peak times and maintains a high level of accidents, throwing the city to one of the first places in national statistics. There are few parking spaces for cars and motorcycles in the central part of the city.



Source: Own elaboration from INDEC data (2010)
 Figure 2: Densities AMGR plot-2010 census



Source: Own elaboration from INDEC data base don Population Census

Figure 3: Demographic evolution of Big Resistencia through National Census

Source: Patenting address, Resistencia Municipality (2014) Population Census 2001 and 2010 INDEC

Figure 4: Proportion of Patented vehicles between 2002-2013 respect to Resistencia city Population.

In the preceding graphics the significant difference between the rates of the population growth in Resistencia city and the rates of registered vehicles. In 2002 there approximately was one automobile for 7,5 persons and a motorcycle for 18 persons, and in 2013 there was one automobile for 3 persons and one motorcycle for 2,8 habitants. That is to say that while the population had an intercensal variation of 5,91% (7,27% in the entire AMGR, the quantity of automobiles per capita was duplicated and the quantity of motorcycles was six fold, representing in both mobility types a vehicle for 3 persons, all this without taking into account the other municipalities that are part of the AMGR.

In some other cities like Formosa, Corrientes, Posadas, Saeñz Peña, etc, which have a similar size to Resistencia or they even are smaller, the phenomenon acquires similar characteristics. One of the most important facts of this disproportionate increment or urban mobility is caused by the high concentration of varied equipments at the best consolidated places and with the most city infrastructure, its central areas or historic places.

In the case of AMGR, the central area of Resistencia city concentrates the most quantity and diverse administrative, financial, sanitary,

educative, cultural, recreative, commercial and professional services equipment, differentiating from residential peripheral areas, demanding the daily displacement of a large part of the population from its homes to the activities places.

Besides, at the AMGR the fast growth in the quantity of urban soil and mobility was not accompanied by the enough quantity of the needed vial infrastructure for the displacement of people to long distances. Only the 35% of the roads are paved (especially avenues and streets of the central part of the city), which generates a high vehicles concentration at a certain time of the day. This concentration produces congestion [7] and a higher quantity of conflicts, as well as accidents.

“The costs of the congestion in the traffic, (...) is a difficult topic to be quantified because the paths that are included in the calculus are extremely complex and varied. It is hard, then, to assign a real cost, with sense a base, to this kind of lateness which are so varied, but we can say that there is a lost of a huge quantity of time and money due to the serious interferences with the fast movement, and the fluidity of all vehicles.” [8]

LITERATURE REVIEW / METHODOLOGY / RESEARCH FOCUS

Since a long time and in different ways some European and Latin American countries are working, with these concepts about the city that have to do with the activities organization, and its infrastructure in an intelligent way.

Accessibility is a concept involved with places, to the possibility to obtain the goods, the service or the contact looked for from a specific space, y from there the term is used to point out the easiness to access clients and supplies to a particular place [9]. Sustainable accessibility refers to the decrease of the route distances, the proximity to urban activities, in such way that the people can access to them by walking, in a bicycle or without a motorized vehicle. This idea is also associated to the redistribution of uses in the urban space, it means, to a land-use mixing, the construction of neighborhood relations and the immediate social net.

Mobility is a concept related to people who want to travel, and goods that need to be displaced. Sustainable mobility, instead, is involved with the idea to palliate traffic disadvantage through the substitution of motorized transportation, private and of a great impact, for transportation with higher environmental and social effectiveness, particularly to the potentiation of bus transportation as an alternative to the private ones [10]. We have to keep in mind that public transportation uses a lot less soil for transported passenger and don't need a parking lot, and besides, consumption and emissions significantly decrease as well as the quantity of transported passengers. [11]

If we take into account what we exposed before in this paper, that any improvement made in the transportation system (possibility to travel larger distances, lower time, or in more efficient was) the problem goes to even greater areas, which make insufficient the initial improvement, so we can say that a sustainable accessibility is a deeper and a perdurable concept than the

sustainable mobility. However, it is also slower and harder to achieve, when working over the current consolidated urban nets, because they also depend on the private initiative. Thus, in the case of AMGR and due to the exposed vial emergency, it is important to work in the acquisition of both objectives:

- In sustainable mobility, as an aim easy to achieve in a short time, making suitable and promoting public transportation, facilitating an inter modality, creating safe urban cycle paths with an adequate urban infrastructure.
- In sustainable accessibility, as an aim in a long term, creating a promoting new centralities over the existent urban net, stimulating uses mixture (jobs, commerce, amusement, etc) and decentralization of equipments, facilitating the construction of infrastructures which allow pedestrian and cyclist mobility, etc.

In this work we will focus on taking the first step, in the possible ways of implementation of a sustainable mobility in the AMGR, replacing private mobility for a public one through the documental analysis of the existing information.

RESULT AND DISCUSSIONS

Even when motorized private mobility has significantly grown, other means of transportation like public transportation, bicycles, and taxis (remisses) kept stable or have notoriously decreased their quantity. This considerable disproportion between these two private motorized vehicles (automobiles and motorcycles) is because a confluence of economic-social facts, physic-territorial and normative-regulatory, which allow that in no more than a decade the quantity of registered motorcycles raised from 5, 4% to 33, 2% in the population. This type of vehicle was adopted for habitants of all ages and social classes for reasons that even when we discussed them in previous publication we will briefly mention them to have a better idea of the phenomena, and they are shown in the following chart.

Table 1: advantages and disadvantages in the use of motor vehicles in AMGR respect to other means of mobility

Source: Own elaboration based on surveys and previous analysis

This kind of vehicle presents a decrease of the physical effort and the rupture of the associated barriers (autonomy increment and urban accessibility) and is taken for these reasons for the lower social classes, as an ascent or a social vindication.

On the other side, if we take into account the economy, and if we consider the associated normal costs: combustible, maintenance and amortization in 5 years, this transport (if they travel as an average 20 to 25 km daily) it would approximately cost 1,2 and 1,5 dollars/day. Considering the same factors and the same distances, with a 10-year amortization, an automobile would cost around 10 dollars/day without parking costs. The current cost of the public transportation ticket is 0,37 dollars, representing an approximately family expense of 3 dollars/day.

The most significant advantage of private transportation against public transportation is the important improvement in accessibility, cause implies the possibility to adjust the journey, the considerable decrement of the journey time, and the deletion of the waiting time, which in some cases reaches an hour, due to the lack of available unities. [12]

Motorcycle, because of its small size can travel and maneuver between moving automobiles in congested areas, efficiently, which decrement even more the travel time. It doesn't even need a big parking space, which allows them to circulate looking for a parking place and get close to their destiny place. It doesn't pay for a parking place while automobiles do. These advantages are perceived for population to the point that,

"...persons with a great purchasing power had become a sector of a high demand: they can have two or three cars, but they buy motorcycles to make their daily transact, because it is almost impossible to transit in the city and the most parking places are reserved to motorcycles. Thus, they limit the use of the automobile to travel during weekends." [13]

If we take into account the negative impacts

which have arose in the city for the increment of private mobility, motorcycles stand out. As well as in any other means of transportation the habitual use of motor vehicles generates a certain confidence in the maneuvers they make. But, in this case, the power, the high capacity of the engine reaction, the great maneuver versatility, the reduced space to transit, etc lead to make a day to day a series of practices and a high risk behavior, with no respect for others rights.

Among some of the performed maneuvers and the most frequent habits we can mention: drive without a helmet, with no driving mirrors, or no lights, high velocities, to travel only in one wheel, to cross lines between automobiles, to go on ahead in a road cross without warning the other vehicles, to cross the red traffic light (habitual practice), take more than one passenger, to drive using the cell phone, to drive using headphones, and some other dangerous practices.

The exponential increment of the circulating vehicles and most of all the small size of vehicles lead to the impossibility to make the adequate controls and to sanction the violators. Transgressions and this kind of behavior are a lot frequent, when they see the impunity on the other drivers.

It is evident that the presence of municipality agents, or the assumption that can be presents make the vial users to avoid to commit infractions. But if police surveillance is intense and continuous they create in people certain habit that make them respect in a conscious or unconscious way the transit rules. That is the principal function of the coercive means.

In this way we observe a certain rigidity of administrative structures to adjust to the new conditions of urban mobility and to the exposed situations in the use of motorcycles as transportation means. The lack of qualified educated and trained personnel, and the lack of adequate equipment (cameras, vehicles, etc) to solve the different situations are problems that not have a solution in the short term.



Source: Chaqueña Supplement. Norte Newspaper. December, 11, 2012 and April, 12, 2015.
Figure 5: Motorcycles transit in the city

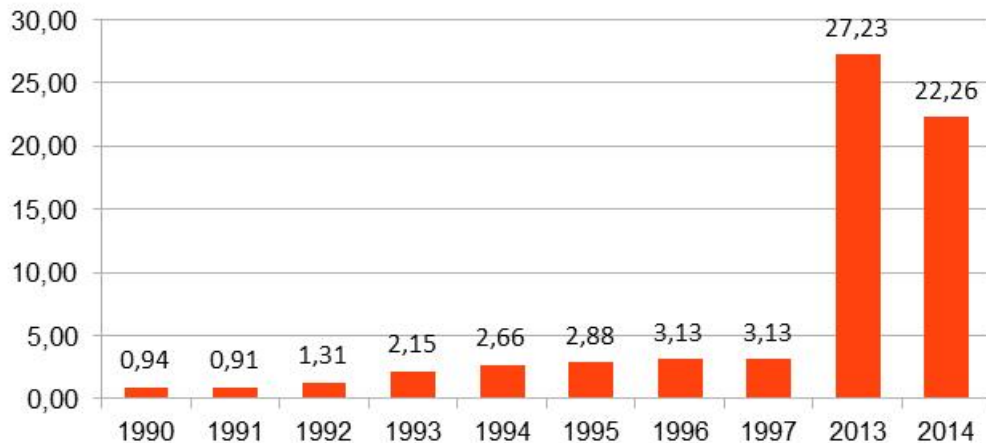
The consequences of these transgressions are reflected on accident statistics. In the following chart we can see the Province of Chaco compared to other provinces of the region, and it presents a high level of motorization and also a high level of vial accidents, which represents more than the double of the accidents of the province with the most motorization, Santa Fe. This case shows that motorization is not necessarily a synonymous of accidents and that

are other factors to take into account. Even when AMGR concentrates almost de 40% of the province habitants, the proportion of accidents is 75%. This means that around ¾ of the accidents f the whole province happens in a reduced urban area. At the same time the 90% of the accidents of the urban area happen between vehicles, but the kind of vehicles is not specified.

Table 2: Comparative table of vial accidents with other provinces of the region

	Santiago del Estero	Chaco	Misiones	Formosa	Corrientes	Santa Fe
Habitants	918.147	1.130.608	1.174.542	573.823	1.059.836	3.369.365
Registered automobile	145.769	314.561	256.396	101.027	273.075	1.544.712
Registered Motorcycles	166.726	286.130	159.357	129.987	181.867	748.281
Accidents with victims each 10000 registered vehicles	74,95	114,68	35,33	29,26	16,27	53,52
Habitants quantity for registered vehicle (automobile+motorcycles)	2,94	1,88	2,83	2,48	2,33	1,47

Source: Vial Security Observatory of National Vial Security Secretary (2014)



Sources: From 1990 to 1997, Norte Newspaper (1997). Statistics Direction of Chaco Highway police (2013 and 2014).
Figure 6: Daily average of transit accidents in AMGR

Beyond the intrinsic numbers, newspaper sources point out that “one of the most worrying impacts of the motorcycle invasion is the significant increment of accidents, in some cases with tragic results and in some others with permanent or transitory inabilities” [14]

In some local publications of the media, they say that in the year of 2014:

“the injured people who are derived to Perrando Hospital, around the 80% are accident victims produced between motorcycles. A huge percentage of people ended up with chronic inabilities (...) Costs are not only lives, legs, arms or fingers, but they imply a high cost to the State. To the hospital each person who is interned for a transit accident represents a cost of 20 to 30 thousand pesos by day. For 16 occupied beds, 12 belong to vial accidents.” [15]

In the same article, also says that at the Perrando Hospital around 700 persons get into emergency in a month, because of vial accidents, 23 in one day, and almost 1 by hour [16]. And this is only one of the biggest health care center available in the area. We don't take into account the Pedriatico Hospital, and private clinics which also take care of people from vial accidents. Like Norte newspaper said in a headline on January, 4th of 2015: “Pedriatico Hospital receives each month 60 kids (involved in preventable vial accidents), most of them by motorcycles. In this context it is necessary to take urgent and efficient actions in order to revert this current accident index, and to make people aware in the secure use of urban transportation, to improve urban life for the habitants of AMGR, and guarantee accessibility of all social classes to their activity places.

Public passenger transportation of Resistencia

city is characterized for being in a permanent agony, and only in some brief periods seemed to raise, but it went through different municipal managements as one of those problems that seem not to have solutions”. [17]

Public Passenger Transportation of AMGR actually has around 140 circulating units, distributed in 11 lines, and 23 branches, this give us an average of 6 units in each branch. This is that even when it offers a good urban coverage, it can't guarantee a good frequency. If we think that the path of each line last one hour, the waiting time between units would be 10 minutes, in case of having the 100% of functioning units. But reality is different because the complete travel can't be done in that time.

A good coverage of the service doesn't mean that the possibility to get closer to the destiny places exists, because each line has a fixed path, and in the total of cases goes through the central area of Resistencia city. So, here is where some connections with different lines can be carried on, but purchasing another ticket, and increasing the waiting time. Almost each line belongs to a different enterprise.

If we watch the following tables elaborated by the urban transportation Project in Metropolitan Areas of Argentina [18] from the Origen Address Mobility inquires-destiny for Metropolitan areas of Resistencia-Corrientes cities, we can see that in 2013 yet the ¼ of the enquired users out of the central area of the city where still using passengers' transportation and in briefly superiors' quantities motorcycles. It is also seen that the summation of private used vehicles outside of the central area is around 45% and in the center reach the 70%, and the users of this central area don't use much public transportation.

Table N°3: Percentages of Vehicles types used by families in their daily travel.

	tipo de medio													Total
	A pie	Bicicleta	Otro	Colectivo	Tren	Auto conductor	Auto acompañante	Moto/ciclomotor	Taxi	Remis autorizado	Remis no autorizado	Bus de la empresa	Transporte escolar	
CENTRAL AREA CORRIENTES	24,3%	4,3%	0,1%	17,6%	0,0%	23,8%	4,7%	16,7%	1,1%	6,2%	0,0%	0,0%	1,2%	100,0%
REST OF CORRIENTES	22,7%	3,2%	0,4%	35,0%	0,0%	11,1%	5,8%	19,0%	0,1%	1,9%	0,2%	0,3%	0,4%	100,0%
CENTRAL AREA RESISTENCIA	21,1%	0,6%	0,0%	6,7%	0,0%	37,7%	11,1%	16,6%	0,8%	4,6%	0,0%	0,3%	0,5%	100,0%
SUBURBAN AREAS RESISTENCIA	30,3%	4,9%	0,0%	24,0%	0,0%	6,0%	2,2%	31,7%	0,1%	0,6%	0,0%	0,1%	0,2%	100,0%
REST OF RESITENCIA	23,6%	5,4%	0,1%	25,2%	0,1%	11,0%	5,2%	26,7%	0,3%	1,6%	0,3%	0,4%	0,3%	100,0%
Total	212747	36872	1651	243248	224	108970	45764	204587	2208	18026	1605	2546	3294	881744
	24,1%	4,2%	0,2%	27,6%	0,0%	12,4%	5,2%	23,2%	0,3%	2,0%	0,2%	0,3%	0,4%	100,0%

Source: Inquieres of Origin Address(Domicile) Mobility-Destiny for metropolitan areas of Resistencia-Corrientes cities. Final Inform. Project of Urban Transportation in Metropolitan Areas of Argentina (PTUMA)Transportation and interior Ministry. December, 2013. Table 80.

Table N° 4: Table 218: reason for not using public transportation, for domain

	Reasons for not using public transportation												Total
	There is not a close public transportation	They don't pick me up	It is not comfortable	Other	It is expensive	Lasts more time	I don't know the service	Low frequency	There is no service on time	I don't need it	Not adequacy/inabilities	Unsafe	
REST OF RESITENCIA	17,9%	40,7%	68,3%	2,8%	24,1%	56,6%	17,2%	8,3%	6,9%	20,7%	10,3%	14,5%	100,0%
REST OF CORRIENTES	16,2%	23,9%	70,3%	6,3%	32,4%	52,7%	24,8%	7,2%	5,0%	18,5%	15,8%	14,9%	100,0%
CENTRAL AREA RESISTENCIA	12,9%	20,4%	52,9%	8,0%	29,8%	51,1%	20,4%	9,3%	9,8%	21,3%	3,1%	21,3%	100,0%
SUBURBAN AREAS RESISTENCIA	8,1%	19,5%	45,4%	11,4%	44,3%	55,7%	8,1%	10,3%	9,2%	20,5%	13,0%	4,9%	100,0%
REST OF RESITENCIA	24,7%	22,9%	45,8%	11,1%	30,3%	45,4%	11,1%	8,5%	5,9%	18,8%	6,6%	12,2%	100,0%
Total	16,5%	24,4%	55,5%	8,3%	32,3%	51,5%	16,3%	8,7%	7,3%	19,8%	9,4%	13,7%	100,0%

Source: Enquiries of origen Address Mobility-Destiny for metropolitan areas of Resistencia-Corrientes cities. Final Inform. Project of urban Transportation in metropolitan areas of Argentina (PTUMA), Transportation and Interior Ministry, December, 2013.

In the facts about not using public transportations becomes evident the time delay and the discomfort, although we have other facts like: they don't have close stops for public transportation, they don't pick them up, it is more expensive. We are not aware of the procedures or criteria used for the enquiry, but phrases like "they don't pick me up" or "it is not comfortable" can be associated to an accessibility fact and closeness to the path of the public transportation.

CONCLUSIONS

As we saw, the raise of this no precedents phenomena, in a short period of time, of a particular type of vehicles reflect a spontaneous

social expression which feeds from the necessity of equity in accessibility and the right to the city for its citizens. Also, as it is logic to suppose, in this current mobility in the Metropolitan Area of Resistencia, the principal characteristic is the economy for users, reduction of time, and physical effort at the time of taking decision about travels, and all other possibility that increment the accessibility to each citizen and its family.

Therefore, it is necessary to produce some changes to the public transportation of the city in order to reach these three basic needs. As any motorized transportation, the reduction of physical effort is implied. As to the reduction of time, the new municipal authorities, renewed in

December, 12, 2015, as well as the previous ones have been developing some proposals for the reactivation of public transportation which comprise the order of the central area of the city. The first option is the only one which is active after the authorities change.

The axis of this order vary between options of exclusive paths and preference paths over the first belt of avenues, having a better possibility the second alternative because it doesn't need big changes in the consolidated vial infrastructure. They haven't published yet the scope of the proposal and they haven't yet called for a public consulting. It is important to notice that the implement of preference paths will be a significant improvement to the efficiency of public transportation, because when it won't suffer interruptions related to the vehicles congestion, and it will be able to transit in a less time the most conflictive area. But this should be only the first step in the matter of circulation times of the public transportation. If we want the initiative to be valid and perdurable on time, parking and circulation of private vehicles have to be controlled strictly in those preference paths, demarcate stops, allow the green wave of the traffic lights and give physical security to the user.

It should also represent the first step to urban mobility of the AMGR, because if we want the public transportation to have a chance to replace the current private mobility has to have special characteristics to attract users: present efficient paths, frequencies according to the needs of populations, have schedule reliability, be economic, comfortable, and safe, allow the connection with other public transportation lines, enable the integration with other transportation means (train and bicycle). In other words, for a person, who gets out of its house for working use the public transportation, should walk 200 to 300 meters (with the adequate infrastructure) until it reaches the transportation stop, wait no longer than 10 minutes and be at its destiny on the same time as a private vehicle does, travelling comfortable and not worried about transit.

As to the third fact or the economic fact, in 2014 each bed at Perrando Hospital cost in average \$ 25.000 for a day, around U\$S 2047 at that moment and they received 23 people from vial accident in a day, this means the cost was U4S 55.367 in one day. If we consider the current cost of a public transportation ticket (U\$S 0.37) is valid to say that the Hospital spent in vial accident people, the equivalent of 149.640 tickets of an urban transport. if we divide 40 tickets/passengers for unit give us the possibility of 3.741 daily travels, and then divided by 23 branches gives 162 travels in each branch of AMGR transport. So, what the Hospital spends in vial accidents by day serves to sustain the entire Public Transportation of AMGR working 24 hours in a gratuitous way for population. And this happens without considering the people in intensive care, injured

kids at the Pediatrico Hospital, without considering death, legs and arms, the lost profits of persons and kids, the costs of interment, rehabilitation, state pensions for inability, material costs, lost of efficiency in the existent vial infrastructure, etc. If we consider all the aspects and involved costs the initial number will considerably increment. Only the costs for the state should be enough to improve and enlarge the free public transportation system of AMGR.

To provide a free public transportation or with a symbolic value to the AMGR will cost equal or less that the vial accidents that we have in the city. For this to happen, it is necessary to articulate national, provincial, and municipal jurisdictions, but there is no doubt that benefits can be even higher. To work in an intelligent way over the economy facts and time of the passengers' public transportation, will allow its use in a massive way, because it will offer comparative advantages respect to the risks and costs of using a private vehicle.

We can't forget t the work with urban mobility represents a low but constant process as a mode to palliate urban accessibility, and it should represent the final goal.

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