RELATIONSHIP BETWEEN PUBLIC POLICIES, LAND USE AND CARSHARING SYSTEMS

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ABSTRACT

This paper addresses the issue of carsharing, public policies relating to vehicle parking systems and land-use and occupation theories. The paper aims to identify the practices that contribute for a better performance of carsharing systems, taking into account land use and occupation practices and car parking policies adopted in several cities. The work is based on carsharing case studies literature and practices adopted in municipalities in Brazil and abroad. The data collected in municipalities' websites, articles and publications related to the topic is presented through examples and topics with the perspective of sustainable urban mobility. The conclusions point the best practices and alternatives for implementing and integrating a carsharing system within public transport networks.

1. INTRODUCTION

The transportation sector, and particularly individual motorized transportation, is a major cause for greenhouse gas emissions (IPCC, 2004), though they carry less than 25% of the world's passengers, with occupation rates varying 1,0 and 1,4 and knowing that most private vehicles are parked 23 hours each day. Moreover, and according to a survey conducted by the Ministry of Cities in Brazil together with the National Department (National Traffic Department) in the year of 2005 traffic accidents costs in Brazilian roads were twenty-two billion R$, which represented 12% of the Brazilian GDP.

Despite this reality, during the last decades, Brazilian authorities have based the national transportation policy on individual motorized transport models by creating incentives for car supply, reducing automotive taxes (IPI), and attracting automotive factories to set up in Brazil through tax incentives. One of such programs is the Inovar-Auto that promotes a tiered tax program for vehicle manufacturers (law 12/175/2012).

Brazilian reality is now changing with the creation in 2012 of an urban planning politic tool named National Policy of Urban Mobility, which aims the integration of the different transportation modes and the improvement of accessibility, and mobility for people and cargo. Present urban mobility principles suggest the need to reduce motorized individual travel in order to mitigate environmental impacts. In this context, theories regarding collaborative use of vehicles have been gaining space as a hybrid public and private transportation alternative or complement.

This work addresses the issue of carsharing and how public policies related to vehicle parking systems and land-use theories may be used to promote it. Specifically, it aims to

identify the practices that contribute for a better performance of carsharing systems, taking into account land use and occupation practices and car parking policies adopted in several cities looked as benchmarks around the world. The data collected is presented through examples and topics with the perspective of sustainable urban mobility.

The analysis concludes carsharing operations are successful especially in cities characterized by high-density occupation models, as it allows a greater share of the population to have at their disposal a vehicle network for occasional trips or to complement a certain section of the trip. Despite high-density areas may favor the use of a public collective transportation, opting by carsharing systems seems to be dependent on the users' life style. The option to use carsharing systems may be much more attractive for the user, considering the financial point of view, in relation to the car property, where insurance, maintenance, taxes are always present. The examples show that the integration of carsharing with public transportation systems favors the success of the former. The implementation of parking policies to restrain the use of private vehicles and protect carsharing systems in city centers is seen as a sustainable urban mobility strategy. Public parking policies also help to make the system more legible and usable.

2. PARKING POLICIES FOR CARSHARING SYSTEMS

The access to a parking space, as well as its cost are key features upon the choice to use an individual motorized transport, especially in an urban context. The role of the municipalities is to calculate the rates and legislate about the use of soil in areas designated for parking lots in public ways or in commercial and residential enterprises. Besides an infrastructure necessary for circulation, a car needs two parking spaces, one at its origin and another at destination, creating a demand for parking lots, which may be divided in three categories (MTI REPORT, 2012):

1. Parking areas outside public ways: parking lots where a fee is charged for the limit of permanency. The management of these areas may be public or private.
2. Nonresidential private parking lots out of the public ways: parking lots for commercial buildings or trade centers, where the access is only allowed for proprietors or building employees.
3. Residential parking lots: parking lots attached to residential buildings, where the access is allowed only for dwellers.

A new approach suggests that public transportation policies, especially the ones concerning parking, must be implemented such that the city and its streets are returned to the inhabitants. Such trends pursuit the following objectives (Moore *et al.*, 1994):

- Make the urban centers attractive for commercial activities.
- Reduce the individual motorized transportation.
- Develop the integration of different public transportation systems.
- Reduce the environmental impacts produced by individual motorized transportation.
- Guarantee the access to public transportation for all social levels.
- Improve the cities' walkability.

This approach led to the creation of new parking policies articulated with sustainable urban mobility strategies:

- Park sharing: Under the optics of shared consumption, the parking places reach the maximum usage index.
- Higher parking fees in downtown areas: It promotes the use of public transportation as it becomes more attractive. Parking fee collection is used for the maintenance and investment in public transportation.
- Use of management technology and supervision of parking areas: Present technology enables to record vehicle data, orient the search for parking lots, identify regulation violations inside parking areas and provide real time orientation system. In some cities in Europe, this system is already being used for parking spaces on the streets.
- Demand monitoring: When demand begins to exceed the offer in a certain street, the parking may be forbidden and the offer of parking spaces may be changed.
- New land occupation and use legislation: These new laws extinguish the need for minimum parking lots in residential enterprises. The advantage of this procedure is the reduction of the enterprise cost, with a better use of the land and the induction to the use of public transportation.
- Carsharing: The reduction in the possession of vehicles reduces the demand for parking lots.

The regulation of parking lots for carsharing system are important since they define the organization of the network and define its visibility to the public, operating like asset that the cities may offer to the operators to reduce the costs and help to increase the operations. Some legal or institutional barriers may come up along the development of the parking policies. As a general view inside North America, some elements were identified as fundamental (MTI REPORT, 2010):

- Allocation of parking spaces to operators made through a combination of formal and informal processes by the public agents.
- Limit of parking spaces for each operator.
- An annual or monthly license determining the quantity of hours that each operator may use each parking area.
- Horizontal and/or vertical signaling to identify the space as well as the responsibility of maintenance from each operator, to guarantee the conformity with the local legislation.
- Supervision and operation controls, such as tickets or towing, to guarantee that vehicles out of the system cannot have access to the parking spaces.
- Documentation of social and environmental impacts by the operator.

2.1 Parking policies – city benchmarks

Table 01 shows some examples of cities around the world where carsharing systems were implemented as part of the local transport policy requiring legal subsidies and urban infrastructure and the goals pursued. The cities mentioned have different characteristics regarding to population, geography and location, but they all seek for one or more of the following four goals: reduce the CO_2 levels, reduce the vehicle property, prioritize public transportation and reduce private parking areas. Based on the data supplied by these city municipalities, three tables were prepared with examples for understanding the support policies regarding parking spaces for carsharing systems. To wit:

- Integration with public transportation (Table 02)
- Documentation for system monitoring (Table 03)
- Support actions provided by local authorities (Table 04)

Table 01: Goals pursued by carsharing systems around the world

	Goals			
	Reduction of CO^2	**Reduction of vehicle ownership**	**Prioritize public transport**	**Reduze Parking**
Bremem	Yes	Yes	Yes	No
Freemantle	No	No	No	No
Port Phillip	Yes	Yes	No	No
Stonnigton	No	Yes	No	No
Sidney	No	No	Yes	Yes
Flanders	No	Yes	Yes	Yes
São Paulo	Yes	Yes	Yes	No
Madrid	Yes	Yes	No	No
Toronto	No	No	Yes	Yes
Pasadena	No	No	Yes	No
Portland	Yes	Yes	Yes	Yes
São Francisco	No	Yes	Yes	No
Washington	No	No	No	No
Paris	Yes	Yes	Yes	Yes
Amsterdam	Yes	Yes	Yes	---

Table 02: Integration with public transport.

	Integration with public transport			
	Tickets and combined rates	**Carsharing stations may issue tickets for the public transport**	**Acess to modal**	**Carsharing as part of the public transport system**
Bremem	**Yes**	**Yes**	**Yes**	**Yes**
Freemantle	**No**	**No**	**No**	**No**
Port Phillip	**No**	**No**	**No**	**No**
Stonnigton	**No**	**No**	**No**	**Yes**
Sidney	**No**	**No**	**Yes**	**Yes**
Flanders	**No**	**No**	**Yes**	**Yes**
São Paulo	**No**	**No**	**Yes**	**No**
Madrid	**No**	**No**	**Yes**	**Yes**
Toronto	**No**	**No**	**Yes**	**Yes**
Pasadena	**No**	**No**	**No**	**No**
Portland	**No**	**No**	**Yes**	**Yes**
São Francisco	**No**	**No**	**Yes**	**Yes**
Washington	**No**	**No**	**Yes**	**Yes**
Paris	**Yes**	**Yes**	**Yes**	**Yes**
Amsterdam	**Yes**	**Yes**	**Yes**	**Yes**

Integration with modal systems as part of public transport is a premise found in 80% of the cities. The evolution of this concept for sustainable urban mobility can be seen in cities like Bremen, Paris and Amsterdam where tickets and fares can be removed in carsharing stations with rates combined offering greater convenience to the users. Meira *et al.* (2010) argues that integrating carsharing-parking locations with the possibility to transship to other transportation public modals is essential.

Table 03: Documentation for monitoring system usage

	Documentation for monitoring				
	Documentation about the use of parking spaces	**Vehicles documentation**	**Documention about the emissions**	**Environmental certifications**	**Public participation**
Bremem	Yes	Yes	Yes	Yes	No
Freemantle	No	Yes	Yes	No	Yes
Port Phillip	No	No	Yes	No	No
Stonnigton	No	No	Yes	Yes	No
Sidney	No	Yes	Yes	Yes	No
Flanders	No	No	Yes	No	No
São Paulo	No	No	No	No	No
Madrid	No	No	Yes	No	No
Toronto	No	No	Yes	No	No
Pasadena	Yes	Yes	Yes	No	Yes
Portland	Yes	No	No	No	Yes
São Francisco	No	No	Yes	Yes	Yes
Washington	Yes	Yes	No	No	Yes
Paris	Yes	Yes	Yes	Yes	No
Amsterdam	Yes	Yes	Yes	Yes	No

Integrating carsharing with urban planning is a relatively new concept. Studies in Europe have concluded that there is no reason to prevent local governments to incorporate the system as a tool to promote sustainable urban mobility (Solman *et al.*, 2005). Rydén *et al.* (2005) report that the use of carsharing decreases the rate of emission of a single driver from 39% to 54%.

Table 04: Supporting actions

	Supporting actions			
	Street parking concession	**Parking provided in the city´s low for commercial and residential building**	**Facilities to approved new parking**	**Marketing support**
Bremem	Yes	No	----------	Yes
Freemantle	Yes	No	----------	Yes
Port Phillip	Yes	No	No	No
Stonnigton	Yes	Yes	Yes	No
Sidney	Yes	Yes	Yes	Yes
Flanders	Yes	No	No	Yes
São Paulo	Yes	No	No	No
Madrid	Yes	No	No	Yes
Toronto	Yes	Yes	Yes	Yes
Pasadena	Yes	No	Yes	Yes
Portland	Yes	No	Yes	Yes
São Francisco	Yes	No	Yes	Yes
Washington	Yes	No	Yes	No
Paris	Yes	No	----------	Yes
Amsterdam	Yes	No	----------	Yes

The provision of parking dedicated to the system is an essential supporting action to the success of carsharing operations, 100% of the mentioned cities have adopted this policy.

3. TRANSPORT SYSTEMS AND THE THEORIES OF USE AND OCCUPATION OF THE LAND

Vasconcelos (1983) states that the need for displacement generates transportation demand, which may be provided by different systems (bus, train, metro, ferryboat) and, as consequence, a higher offer for transportation produces a higher accessibility for the urban space.

New Technologies, such as carsharing are capable to support the demand mentioned by Vasconcelos, where users may obtain the benefits of using a private car without the costs and responsibilities by having it as a fixed asset. This is possible through the logic of shored economy. As a fact, carsharing offers different decisions in the way inhabitants of an urban Center move around. These decisions may produce a change in behavior and a more selective use of a private car, combined with a public transportation network.

The relations between the urban soil uses together with the different transportation systems define an important relation in the study of the spatial organization of the city. The soil and transportation use and occupation are components of an ample process which will make viable the access to the work site, study housing, leisure services and social-spatial interactions, where the motorized displacements have the support of parking policies.

A series of classic conceptual models, such as the Concentric Model from Burgess, The model of sectors and the Urban Multi-polarities Model was created, however these models were created to describe North American cities and cannot be applied to the Latin America urban reality. Borsdorf (2003) developed a scheme (Figure 01) that shows urban structures of Latin American cities.

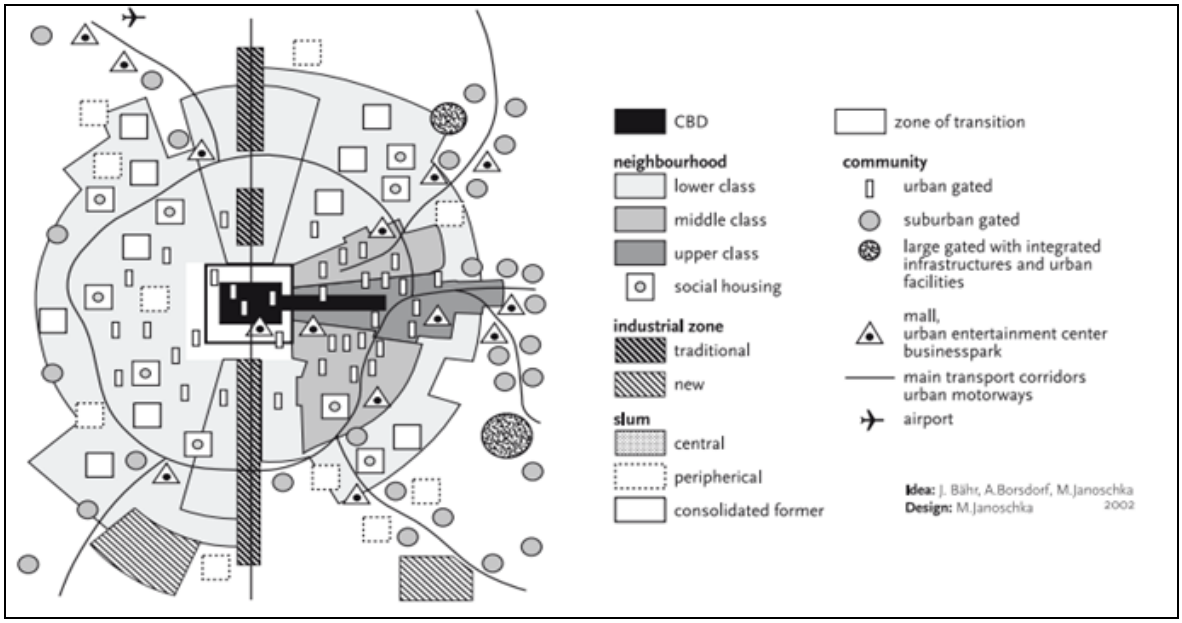

Figure 01: Latin American Cities (Borsdorf)

Borsdorf (2003) argues That urban network is not anymore capable to absorb the existing traffic, new intra-urban speedways are built and the peripheral areas become attractive for the high class. Urban models in the form of mega-enterprises arrive, such as Alphaville, in São Paulo state, in Brazil. This type of fragmentation is a marker of a new spatial structure

in the Latin American cities, here the city of rich people and city poor people do not exist anymore.

The central areas of the modern cities have a major importance in the theoretical context. Silva (2007) says that central areas are constituted with base on the flow of people, cars, capital, decisions, and information and, above all merchandizes and inputs. Corrêa (2000) goes further stating that central areas have double importance; besides concentrating the main commercial and services activities related to the public and private, they concentrate intra-urban and intra-regional transportation terminals. The central areas present two sectors: the central core or Central Business District (CBD) and the peripheral area around the center (a transition or obsolescence zone). The central core in present cities may be characterized as follows:

- Intensive soil use with a major concentration of the economic activities
- High level of vertical density
- Limited horizontal growth
- Diurnal concentration related to the working hours, and night emptying due to the predominance of the commercial use
- High concentration of intra-urban transportation.
- The peripheral zone is characterized in following form:
- Disordered soil use, with abandoned terrains and predominant activities of bulk trade, storage, and light industries
- Low buildings
- Residential area with multi-familiar dwellings inhabited by persons from class C

In Brazil, Villaça (2001) developed a model (figure 02) to represent the use of soil and occupation. The model proposed by the author proposes three development city types according to the directions it is done.

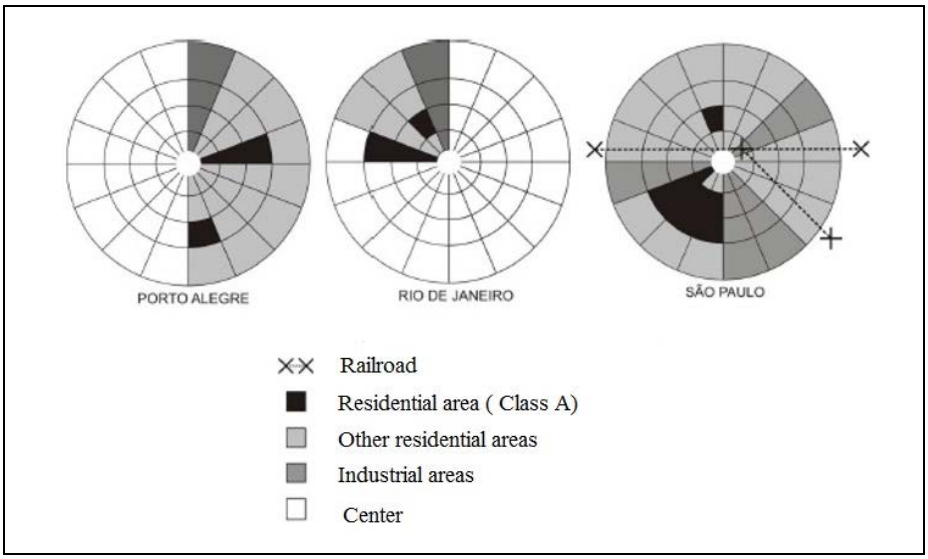

Figure 02 - Brazilian Cities (Villaça)

1. 360° cities - São Paulo, Belo Horizonte and Curitiba;
2. 180° cities with (Recife, Fortaleza and Porto Alegre);
3. 90° cities - Rio de Janeiro and Salvador. Coastal cities, in general, have their origin connected with the introduction of a port, being classified as 180° and 90° cities.

Villaça (2001) states that the intra-urban space is the study of the arrangements of the urban spaces and that this space is fundamentally structured by the displacement conditions of the human being, either as carrying a merchandize, consumer or as a displacement house-worksite/house school.

The author defends that the XIX century was the transition period of the urban space for the Brazilian cities, where the segregation of the soil use followed the same segregation logic of the social classes. The class with the best acquisition power is concentrated in one only intra-urban structure sector, allowing optimizing the displacement times, mainly to the urban center. Class C searches the urban centers for services diversity that they may offer, thus compensating the displacement time spend (Figure 03).

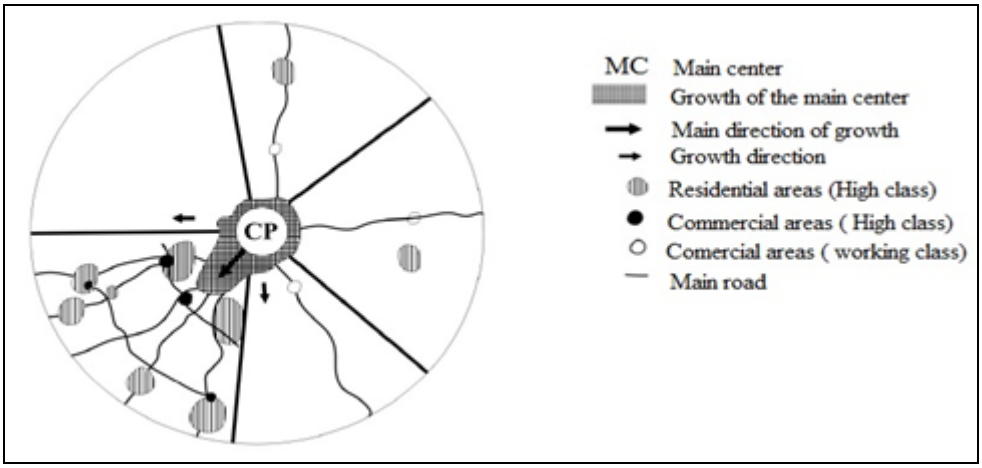

Figure 03: Intra urban space in Brazil for Villaça

Villaça (2001) argues that Residential areas for class A emerge far from the center, when interconnected by expressways, proper for individual transportation supplied by fossil fuels. The Brazilian intra-urban space has an organization that is a mix of concentric circles and of circle sectors.

The models presented before promote the spreading of the soil use. These models of occupation promote on the one hand the extinction of natural and forest landscapes, and on the other hand urban dispersion. The latter imposes an elevated level of individual, collective or merchandizes motorization, increasing the energy consumption and, as consequence, a higher rate of residuals, particularly in the transportation sector. Another consequence ascribed to the high rate of vehicle property is the soil impermeability. In order to create roadways for vehicle circulation urban soil gets a high percentage of impermeable layer area that unbalances the microclimate and the hydrologic cycle of the cities.

Beginning with these questions about the new model of soil occupation and use, they propose the urban compaction, taking into consideration the environmental needs and the social needs. Urbanism understands that the problems of the cities are related in one sphere, to where the human relations are the main catchword.
Rogers (2001) maintains that the urban compaction bring dwellings, service renderers and leisure equipment nearer, reducing the need for displacements. It also optimizes the use of soil, liberating areas for agriculture, environmental reserves, energy resources and the

urban network infrastructure. Rogers' model is illustrated in figure 04. The urban compaction proposes the decentralization of services from the nucleus to the periphery, ending segregation and making the urban network more equalitarian. The concept of compact cities according to Newman is:

- High residential and commercial densities.
- Diversity of the soil use, so that the basic needs of the population may be accessed on foot or by bicycles.
- Division of the soil use in little areas, in order to guarantee the diversity, avoiding big dormitories and the single function spaces.
- Increase of the social and economic interactions, through a good arrangement of the public spaces.
- Continuous development, where abandoned buildings are rehabilitated in order to avoid desertification of the centers.
- Urban development contained and delimited by visible limits, in order to avoid that the city increases its perimeter.
- Multimodal transportation system, privileging the use of non-motorized transportation and with investment in public transportation agencies.
- High-level accessibility, at regional and local levels.
- Sidewalks with high connectivity (large sidewalks and bikeways) encourage the population to circulate on foot or in non-motorized transportation.
- Few functional spaces, in order to optimize the urban capacity and avoiding expansion beyond limits.
- Control of the urban development.

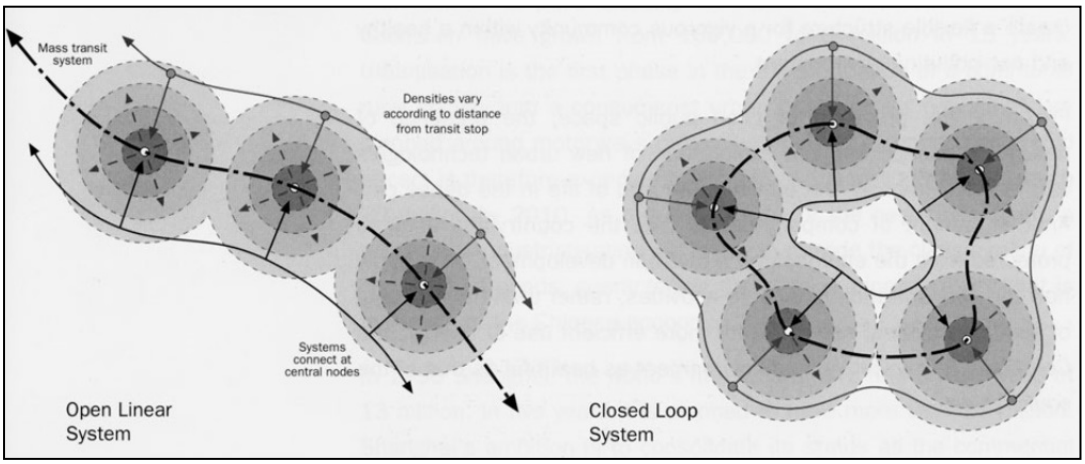

Figure 04: Model for compaction cities by Rogers

4. THEORIES ABOUT THE THE THEORIES OF USE AND OCCUPATION OF THE LAND COMBINED WITH SUPPORT POLICIES FOR CARSHARING SYSTENS

The model presented by Villaça characterizes Latin America cities as sprawled, as they are susceptible to create high far-income households cores of urban centers and consequently large urban voids. The challenge in these cities is to discourage the use of individual vehicles and create an efficient, reliable and sustainable public transport network.

Initiatives between the public and private sectors can be created so that the carsharing is seen as part of the modal city and therefore as part of the public transport system.

Litman (1999) states that for the carsharing market, a minimum number of users at a convenient distance from the vehicle locations is necessary. This distance may be covered on foot or with bicycle. One of the biggest barriers for the carsharing operators is to maintain a critical mass, or in other words, a minimum number of users. In low-density districts, the kick-off of carsharing operation is the critical stage and needs an extensive marketing and communication network with the local community. Litman (1999) argues that the integration between the parking policies and the soil use may be reached with high densities, mixed occupation and multimodal systems, inducing the use of carsharing, and reducing the need to purchase a private vehicle. The table 05 shows the different theories of occupation and land use and how they can be used as carsharing supporting policies.

Table 05: Land use and parking policies for carsharing

	Compact Cities	Villaça model for Brazilian cities
Land Use	• Model -based range of occupations with a wide network of trade and buildings in each core. Ideal for carsharing systems.	• The model has a dispersed occupation, but may be susceptible to creating new canters. The creation of these new centers is positive for carsharing operations.
Population density	• Model -based medium and high densities, ideal for carsharing operations.	• Model can create urban voids for having large residential or commercial sectors and make unsuccessful carsharing operations.
Integration with modal systems	• The model of compact cities makes the public transport most efficient carsharing operations must be integrated into the modal system.	• The model creates long trips in the urban perimeter, he ideal is that these trips can be made by public transport and supplemented by carsharing.
Parking policies	• Parking policies are a factor to the decision by consumers to access carsharing vehicles, they should be encouraged.	• Parking policies are a factor to the decision by consumers to access carsharing vehicles, they should be encouraged.
System location	• The areas around each core may be ideal to locate the systems stations.	• Areas near the traffic -generating poles are more suitable for the location of stations.

5. CONCLUSIONS

The growing of the carsharing operations is highly connected to cities characterized by a high-density occupation model, as seen in Table 05. Carsharing systems allow people that live in urban centers to have at their disposal a versatile vehicle fleet for occasional trips or

to complement certain trip sections. Table 02 shows that some municipalities understand that carsharing systems are part of the public transportation network, but the impact of the sustainable urban mobility system must be monitored and checked, as indicated in Table 03.

However, high-density areas may favor the use of a public collective transportation. This type of decision, made by the consumer, will depend on his life style and in the way he prefers to access his destination. The option to access some destinations using the carsharing systems may be connected with the financial option, as commented, because the system is much more attractive for the user, considering the financial point of view, in relation to the car property, where insurance, maintenance, taxes are always present. The integration of the carsharing operations with the public transportation system allows them to operate in a complementary form. Policies for the support to carsharing systems, as demonstrated in Table 04 may offer new options to reach a destination for the consumer.

New urban planning trends have long realized that car traffic should not be prioritized. As demonstrated in Table 01, principles of moderation and security to ensure better traffic conditions for pedestrians and urban life should be introduced. The analyses of mobility issues in urban areas cannot follow a fragmented logic. The different existing systems, land use, public transport, circulation of private vehicles, bike lanes, sidewalks and parking lots must have a systemic approach. Present urban and environmental planning has as one of its objectives the integration with sustainable mobility, where people of different social classes may have the possibility of choices in relation to their paths through the city.

The search for a sustainable urban mobility should be the goal not only of architects, engineers and designers but also of public administration. The latter should pursuit measures to review land use and occupation rules, laws and the demand for parking to discourage the use of private car and invest in public transport quality and accessibility to all sectors of the population. The growing discussion about the reduction of CO2 levels by the automotive industry should incorporate the use of carsharing in Brazil collaborating with new trends in the automotive sector and with the marking new studies about location and information technology.

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