Sustainable Metropolitan Transportation: Characterization of the Metropolitan Region of Baixada Santista

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Abstract: For transportation planning it is important to the realization of a transport characterization that observes the context of the region and the modalities that best suit that scenario. The scenario under analysis is the Metropolitan Region of Baixada Santista, one of the metropolitan regions of the State of São Paulo. In order to accomplish this brief characterization, a flowchart developed by the authors was used which aggregates the principles of sustainability in transportation and the modalities of metropolitan transport. As elements of analysis, we observed two origin-destination matrices elaborated for the region under study, in 2007 and 2012, review of research on mobility of the region and aspects of system governance, that is, how the various actors develop the planning of the transport. The result showed that the flowchart is an important tool to help planners in the characterization phase of transport in relation to sustainability principles.

Key words: Metropolitan transport, transportation planning, sustainability.

1. Introduction

According to Pedroso and Neto [1], among metropolitan areas, metropolitan regions concentrate the development of the country, which is reflected in gross domestic product (GDP), vehicle fleet and population displacements. Although they share daily the flows of goods and people of the metropolitan agglomerate, in general, the member municipalities that are part of a metropolitan region do not act in a collaborative and shared way. Transport in metropolitan areas presents systemic operational problems due to planning difficulties, such as the lack of tariff and operational integration within the metropolitan scope, competition between metropolitan and municipal systems, the equation of revenue distribution and cross subsidy in integrated environments, besides the strong competition of individual private modes.

In the Metropolitan Region of Baixada Santista (RMBS) these problems also occur. On the one hand, there is a strong growth of the fleet of vehicles and the presence of cargo and passenger transport in the same way, in view of the increase of cargoes to the Port of Santos; on the other hand, it can be noted a small use of other forms of transport, in addition to road transport.

The scenario becomes even more critical with the large number of commuting and the high population growth rates of some municipalities in the region [2]. To mitigate these external effects, Quereschi [3] proposes the use of the principles of sustainable development in transport. Sustainable transport requires a dynamic balance between the main pillars of sustainable development, that is, environmental protection, social equity and economic efficiency.

The objective of this article is to characterize the requirements of sustainability, through a model proposed by the authors, of the modalities of transportation of the Metropolitan Region of Baixada Santista and to carry out an analysis in relation to the

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necessary points for a sustainable transport. In the Methodology next item, the theoretical foundations of sustainable transport will be presented. The following is a flowchart to support the characterization process, and, finally, the application in the Metropolitan Region of Baixada Santista.

2. Methodology

2.1 Sustainable Metropolitan Transportation

According to Litman [4], the term sustainable transport is a logical continuation of the theme sustainable development and is used to describe transport modes and planning systems that are coherent with broader sustainability concerns.

TAC [5], Ferreira, Silva and Bastos Silva [6], Shiftan, Kaplan and Hakkert [7] and Litman [8] define the objectives of environmentally, socially and economically sustainable transport, if:

- Environmental: to clean energy, reduce waste, preserve free areas, prevent and mitigate climate change, save energy resources and recycle resources;
- Social: to allow equality of access, provide improvement in population health, assist economic development, be safe, preserve cultural heritage and improve the quality of life of the population;
- Economic: to be financeable, efficient, require reduced costs for deployment and operation and induce economic development.

Other authors, such as Nijkamp [9], Greene and Wegener [10], Geurs and Van Wee [11], Shiftan, Kaplan and Hakkert [12] and Steg and Gifford [13], note the importance of sustainable transport, such as:

- Technological: zero emission vehicles such as electric cars, systems based on light vehicles on rails, meters or buses, and real-time traffic information;
- Physical and spatial planning: regions of automobile restriction, regulation of land use, and high density regions close to transport corridors;
- Behavioral: fuel taxes and vehicle use, traffic education programs, availability of travel planning information, and traffic education programs;

- Government measures: operation of public transport on a daily basis and for 24 hours a day, limitation of parking spaces in regions provided by public transport, and concession of license for transport services;

- Economic measures: taxes on more than one vehicle per family, subsidies for public transportation, and charging for high-congestion roadways;

- Quality of life measures: discouragement of car ownership, measures to restrict vehicle traffic, improvements in public transport, and expansion of road infrastructure;

Traditional transportation planning defines and measures transportation in terms of travel, uses the criterion of maximizing capacity to meet demand, has little public involvement in decisions, does not consider vehicle ownership costs, considers only the costs of local pollution and a small range of equity-related issues.

Sustainable transport planning contrasts with the traditional planning model as:

- defines and measures transport in terms of access;
- enables high popular participation in the planning process;
- uses economic analysis to determine policies and investment ideas;
- considers the user time, operational and ownership costs of vehicles;
- prices roads and parking lots to recover investment costs;
- considers the impacts of transport decisions on land use;
- favors transport policies that improve access for non-drivers and disadvantaged populations.

Litman [8] highlights the importance of population participation in decisions for two reasons. First, because the principles of sustainable development reflect the values of a community; and second, because sustainable transport involves changes in the behavior of communities and, therefore, depends on

the participation of individuals.

Regarding the modal of passenger transport, Vasconcellos [14] classifies them as follows: motorized modal and non-motorized modal. Motorized modalities can be classified, as regards nature, in public and private and, in terms of use, in individual and collective. Due to its greater comprehensiveness, the use classification will be used.

2.1.1 Flowchart for Characterization Support

A support to support transport planning, considering the characteristics of sustainability, must be based on two pillars: the requirements of sustainable transport and the modalities of metropolitan transport, according to Fig. 1. As a result of a review of the literature on the subject, a flowchart was developed to support the planning of sustainable metropolitan transport.

The flowchart aims to provide support in planning, considering that it is in opposition to the traditional model of transportation planning based on technical-economic criteria, since, in addition to the objectives for a sustainable transport, which involve besides environmental issues, environmental aspects and social, is also based on the participation of the public and on measures, both public policies and planning.

To perform the characterization, the last two origin-destination matrices of the region will be used, as well as articles published by researchers. In this article, it is not intended to exhaust the entire

characterization, but to verify the feasibility of using the proposed support flowchart as part of a transportation planning process.

2.2 Application in the Metropolitan Region of Baixada Santista

According to Zündt [15], a Metropolitan Region of Baixada Santista is formed by nine municipalities with a population of 1,781,620 inhabitants (IBGE, 2014) that is distributed in insular and continental areas. The Ilha de São Vicente Island is the seat of two municipalities of Santos and São Vicente, and Ilha de Santo Amaro is the municipal seat of Guarujá. In addition to the resident population, there is the possibility of increasing the order by 3 times, due to the peaks of tourist seasonality. The Metropolitan Region of Baixada Santista was created by State Complementary Law No. 815 of July 30, 1996, and was the second metropolitan region of the State of São Paulo. It is located on the central coast of the state, bordering the north with the Metropolitan Region of São Paulo, to the south with the Vale do Ribeira, to the east with the Metropolitan Region of the Vale do Paraíba and North Coast (Fig. 2).

The urban spot is continuous and with a high degree of conurbation. In addition, it presents a longilinear, narrow, confined form between the Atlantic Ocean and the Serra do Mar, with wide mangroves, restinga and hills vegetation. The region also has the largest port, petrochemical and steel pole in Latin America [16]. Cunha et al. [17] emphasize the

Fig. 1 Flowchart to support the planning of sustainable metropolitan transport.

Fig. 2 Metropolitan Region of Baixada Santista.

Source: Ref. [20].

importance of pendular mobility, which means the daily mobility of individuals for their work or study activities within the RMBS, which occurs by dissociation between “places of residence” and “places of work”. Fig. 3 represents the commuting movements between the municipalities of Baixada Santista in the year 2000.

Vasques and Sena de Oliveira [18] observe that in the pendular mobility for work and/or study within the RMBS, the first is preponderant over the second. For a more accurate analysis, it is important to understand the division of the pendulum motions. According to POLIS [19], there is a predominance of jobs in the municipalities of Santos, Guarujá, Cubatão, Praia Grande and São Vicente. Santos is the center of commerce and services of the region and Cubatão presents a differentiated profile, with companies of the petrochemical pole, representing the high entrance rates in the two municipalities. According to EMTU [22], based on data from the Origin-Destination Matrix 2012, in addition to travel for work, travel is also important for education, health, shopping and leisure reasons. It is important to note that the last source-destination matrices available for the

Metropolitan Region of Baixada Santista are from the years of 2007 (Matrix Base) and 2012 (Point Matrix Update from 2007).

2.2.1 RMBS Transportation Modes

With the publication of the 2007 Origin-Destination Matrix [23], a more detailed study on transport in RMBS was started. According to the data presented, 54% of the displacements were carried out in motorized modalities, the municipalities of Santos (333,378 trips) and the municipality of São Vicente (231,739 trips) the two with the greatest use of these modalities in the region. Around 46% of the trips were performed in non-motorized modes, with the municipality of Guarujá (80,022 trips), with greater use of the bicycle, and the municipalities of Santos (218,935 trips) and São Vicente (145,835 trips) transport on foot. The large number of non-motorized journeys, including the bicycle, motivated the metropolitan agency to develop a Metropolitan Cycle Plan, AGEM [24]. In that plan, the main cycle routes of the RMBS were determined with the focus on the integration between existing bicycle paths and greater safety for cyclists. The goal of the Metropolitan Cycle Plan is that, by 2026, the RMBS will have about 518 km

Fig. 3 Pendular mobility—Metropolitan Region of Baixada Santista 1995-2000.

Source: Ref. [21].

Table 1 Division of the use of modalities in RMBS—OD Matrix 2007 and 2012.

Modal		OD Matrix	
		2007	2012
		(%)	(%)
Non-motorized	Walking	32	26
	Bicycle	15	11
Motorized	Individual	21	26
	Collective	32	37

Source: Origin-Destination Matrix 2012 [22].

of bicycle paths, in an integrated way, adding up all nine municipalities, in addition to investments to expand the number of public bicycle rentals.

With the publication of the Destination-Origin Matrix 2012, also known as Mini OD 2012, considering that it only updated some data from the Source-Destination 2007 Matrix, it was possible to identify the evolution of the quantitative ones in relation to the Origin-Destination 2007 [22]. Table 1 shows the modal split used for about 2.2 million daily trips that take place in the RMBS, where one can observe the growth in the use of collective motorized modes from 32 to 37%, and from 21% to 26%, and on the other hand, a decrease in the use of non-motorized transport, from 32% to 26% in the case of a bicycle, and from 15% to 11% for walking.

Another relevant datum from the Origin-Destination Matrix 2012 is the average travel time by modal. The study compares the results with the Origin-Destination Matrix 2007, revealing an increase in the average travel time of the buses, from 47 minutes to 53 minutes, 12.7%. This fact demonstrates the impact on the metropolitan transit of the increase of the use of the individual motorized modality, considering that both use the same road infrastructure. It is important to point out that the data referring to the travel time of the modal bus are a weighted average, relative to the number of passengers, of the travel time for municipal and intercity buses. According to the OD 2007, the average travel time on municipal buses was 43 minutes while in the intercity buses 60 minutes.

As shown in Table 1, 26% of the trips made in the region occur with the use of the car or the motorcycle. According to data from the Origin-Destination Matrix 2012, in relation to data from the Origin-Destination 2007 Matrix, there was an average growth of 5.2% per year in the number of cars in the RMBS (198,904 automobiles in 2007 to 256,844 in 2012), resulting in a rate of 148 automobiles per thousand inhabitants. In terms of motorcycles, growth was also significant, with an average rate of 8.2% per year (71,683 motorcycles in 2007 to 106,383 in 2012) [22].

In relation to collective motorized transport, the main modal of the region is the bus. Based on data from the Origin-Destination Matrix 2007, considering RMBS, 8% of all trips were made by intermunicipal bus [23]. In municipalities such as Cubatão (13%) and São Vicente (17%), the proportion of journeys is above the average of the region. In addition to the intermunicipal bus, another important motorized mode for the region is the waterway. Between the municipalities of Santos and Guarujá (both for the county seat and for the district of Vicente de Carvalho) and between the municipalities of Guarujá and Bertioga, the modal is responsible for almost 7 million passengers per year, according to data from [25].

According to the PMDE [26]—Strategic Development Plan of the Baixada Santista, one of the objectives is to implement a metropolitan waterway system for freight and passengers by 2030, expanding the supply of this modal, and integrating it with other existing ones in the region. Partially deployed, the VLT—light vehicles on rails will link the municipalities of Santos and São Vicente. According to the PMDE [27], the VLT system will modify the current structure of medium capacity modes between the two municipalities, with a repercussion throughout the region. According to Alouche [28], VLT systems have four times the capacity of buses, besides their adaptability to the urban environment, greater comfort, low noise and use of clean energy (electrical).

With regard to non-motorized transport, data from

the target origin matrix for 2012 show that 26% of the displacements in the region are carried out on foot. In addition to the importance of walking, bicycle trips account for 11% of all trips. Observing the Origin-Destination Matrix 2012 [22], there is an increase in the number of bicycles for each group of 1,000 inhabitants, between 2007 and 2012. According to the latest survey, the RMBS has an average of 330 bicycles for each group of 1,000 inhabitants.

2.2.2 Governance of the Baixada Santista Transportation System

The Metropolitan Agency of Baixada Santista is the organ where the transport discussions in the region are carried out. The agency has three thematic chambers linked to the so-called mobility axis. According to the Metropolitan Plan for Strategic Development of the Baixada Santista [2], the role of the thematic chambers is to maintain regional forums active so that the managers of several spheres discuss projects of metropolitan interest. In addition, thematic chambers collaborate in metropolitan plans, consolidating a regional vision on transport and the interrelationships with local planning, in order to optimize the application of resources. The thematic chambers guide the performance of metropolitan governance, where decisions are made by CONDESB—Strategic Development Council of Baixada Santista, formed by the mayors of the nine municipalities of the region.

One of the fruits of this system of governance was the elaboration of the Metropolitan Plan for Strategic Development of the Baixada Santista [2], which was attended by managers from various spheres. The plan defines four main thematic axes: economic development, housing, mobility and basic sanitation. For the mobility axis, according to the observations of the current transport situation in the RMBS contained in the plan, there is a low use of other modes, besides the terrestrial motor, difficulty of displacements due to commuting, increase of the fleet of individual motor vehicles and competition with the transport of loads in the road system. In this way, if no regional action is

implemented, the plan foresees a greater participation of the commuting displacements on the total of trips, the increase of the rate of motorization in a rhythm superior to the demographic growth and the saturation of the metropolitan road system until 2026.

The PMDEBS 2015 presents as solutions for a greater efficiency of the transport system in the RMBS integrated regional actions increasing the governance on the transports, extension of the modal integration of the public transports and extension of the participation of the modal bicycle. These actions aim to, according to the plan:

- increase the number of users of public transport;
- increase the number of bicycle users;
- decrease travel time for people.

The implementation of a metropolitan passenger rail system is also foreseen in the plan, highlighting the importance of the beginning of operation of the VLT system, between the municipalities of Santos and São Vicente, and its expansion to other points in the region.

In relation to the municipalities of the region, in an isolated way, the Santos municipality prepared and published a pre-diagnostic of urban mobility of the municipality of Santos [29], in compliance with Law 12,587 of January 4, 2012, establishing the guidelines of the national policy on urban mobility. In the pre-diagnosis carried out by the technical group of the city of Santos itself, there is a concern with metropolitan transport and its interaction with the municipal modalities. There is also concern about the development of non-motorized transport, but without further details regarding actions to improve the mobility of pedestrians and cyclists. It is noted, in the specific case of the modal cycle, a concern for integration with other modes of collective transportation, now non-existent. The issue of integration is also discussed in relation to other modals. The pre-diagnosis emphasizes the inexistence of tariff integration between the different modalities, forcing passengers to make long stretches on foot and

to bear the cost of transfers (intercity bus for boat crossing system, for example). In the specific case of the implementation of the light rail vehicle, pre-diagnosis has already planned a greater integration of the new modal with other existing systems. Integration that, according to pre-diagnosis, is important for the system's own operational efficiency. The urban mobility plan of the other municipalities is still under implementation, however, without publication so far. The Metropolitan Agency of Baixada Santista also plans to draw up a metropolitan mobility plan, according to information obtained from the technical staff.

3. Results

According to the transport characterization carried out in the previous item, it is possible to analyze the transportation system of the Metropolitan Region of Baixada Santista, in relation to the proposed model. In relation to metropolitan transport modes, there are motorized collective modalities and individual motorized and non-motorized modes. The existing motorized collective modalities are the bus and the passenger boats. Also in implementation is the light rail vehicle system, linking the municipalities of Santos and São Vicente, with influence in other municipalities of the region.

In relation to the individual modes, there is a high rate of motorization, responsible for the reduction of efficiency, especially of buses. Based on data from the last Origin-Destination Matrix 2012, 26% of all displacement is carried out by car or motorcycle, a fact that affects the travel time of bus modal users, in order to increase congestion. On the other hand, non-motorized modalities correspond to 37% of RMBS movements, with emphasis on foot trips, and important participation of bicycle trips. Specifically in relation to bicycles, the metropolitan agency has developed a Metropolitan Cycle Plan with the objective of safe and integrated cycleway expansion.

In the pre-diagnosis of the Santos Mobility Plan,

emphasis is placed on the need for greater integration between modes, both physical and tariff. According to the flowchart supporting planning, and the requirements for sustainable transport, which encompass environmental, social and economic objectives, public participation and public policy and planning measures, there are points that diverge and others that converge to the proposed model.

Regarding the environmental objectives, for motorized modes, there is no use of clean energies, only fossil fuels. The rate of motorization is high; on the other hand, there is an important participation of non-motorized modes, which contributes to waste reduction, preservation of free areas, prevention of climate change and saving of energy resources. As for the social aspects, the increasing use of motorized individual modes decreases the quality of life of the population besides increasing the number of accidents. Collective transportation is responsible for 37% of travel, which contributes to economic development, security and equal access. The use of non-motorized modes contributes to the health promotion of the population. Regarding economic aspects, there is the use of water transportation, low operation and deployment costs, and the VLT—light rail vehicle, more efficient than the conventional metropolitan bus system. There is no direct participation of the population or the users of the transportation system in the planning process, only technicians and managers of the various municipalities in the region and governmental bodies in other spheres, through thematic chambers organized by the Metropolitan Agency of Baixada Santista. In the referred thematic chambers, organized by sector, there are meetings that deal with various themes on mobility and proposals are presented from the various municipalities for a mediator coordinator. The proposals presented at the meetings, after discussion, are formalized and sent to the CONDESB—Development Council of Baixada Santista, composed by the mayors of the region.

With regard to the measures, both public policy and

planning, there are some points that converge towards sustainable transport. In relation to public policy measures, some are not the responsibility of municipal public authorities, such as discouraging the ownership of the car and raising taxes on the ownership of vehicles or fuels. In Brazil, such measures are the responsibility of the federal public power. The analysis of the previous item reveals a concern with measures of quality of life, in view of the expansion of the metropolitan cycle network and improvements in public transportation as faster and more comfortable boats. Technological measures are being implemented at the start of operation of the light rail vehicle and the existence of information systems on departures of boats and buses. The only economic measure found was in relation to the subsidy to the metropolitan buses, by means of a differentiated rate for students. No measures of behavioral character, physical planning and spatial measures, governmental measures or other economic and technological measures being applied in the region were found. Measures are much more difficult from the political point of view that involve parking restrictions, car-free areas, charging for certain roads, and are not considered in any study developed by the municipal public authorities or by the Metropolitan Agency itself, although there is still a preponderance of the conventional model of transport planning, such as the concern only for reduction of local pollution, planning focused on capacity to meet demand, lack of consideration of the cost of ownership of vehicles and little public involvement in decisions, several points such as: incentives for the use of non-motorized transport, expansion of public transportation infrastructure and use of cleaner sources of energy such as the implementation of VLT, where sustainability objectives are achieved and public policy measures compatible with these objectives.

In relation to the Metropolitan Development Plan of Baixada Santista [29], actions or objectives are foreseen that lead to sustainable transportation. The

expansion of the participation of the modal bicycle in the displacements corresponds to an environmental and social objective for a sustainable transport. The implementation and forecast of the expansion of the VLT system contributes to the use of renewable sources of energy and waste reduction, in line with environmental objectives. Modal integration favors greater efficiency of the transport system by being consistent with the economic objectives of sustainable transport. In relation to public policy measures, there are technological actions, such as the prediction of the use of VLT, and quality of life, with the encouragement of bicycle use and improvements in the integration of public transport.

4. Conclusions

The use of the support flowchart helps the managers of the sector in the verification of the necessary points to reach the requirements for a sustainable metropolitan transport as well as the modalities necessary for this objective. Checking the situation of the Metropolitan Region of Baixada Santista, it is possible to observe the existence of a series of actions that converge towards sustainability as well as others that diverge. On the other hand, it can be seen that many objectives, mainly related to sustainable transport, are difficult to implement. Some actions do not depend on the local public power and others require great political will for being unpopular, such as discouraging the ownership of the automobile and increasing taxes on the ownership of vehicles or fuels. However, there is still the issue of popular or public participation, provided for the bibliographic review on the subject. The thematic chambers that occur in the Metropolitan Agency of Baixada Santista allow the participation of only the technicians of the sector, remaining to listen to other actors in the process such as the population and the users of the transportation system. Thus, it is necessary that the construction of solutions takes place in an active way, permeated by the participation of the actors and

respecting the structure of values of the various actors within the context of the region.

References

- [1] Pedroso, F. F. F., and Neto, V. C. L. 2015. "TRANSPORTES E METRÓPOLES: ASPECTOS DA INTEGRAÇÃO EM REGIÕES METROPOLITANAS." Brasília, julho de 2015, Instituto de Pesquisa Econômica Aplicada—ipea.
- [2] AGEM—Agência Metropolitana da Baixada Santista. 2015. *Plano Metropolitano de Desenvolvimento Estratégico da Baixada Santista*.
- [3] Qureshi, I. A. 2007. "Urban Transport and Sustainable Transport Strategies: A Case Study of Karachi, Pakistan." *Tsinghua Science and Technology* 12 (3): 309-17. [https://doi.org/10.1016/s1007-0214\(07\)70046-9](https://doi.org/10.1016/s1007-0214(07)70046-9).
- [4] Litman, T. 2009. *Sustainable Transportation and TDM*. Online TDM Encyclopedia, Victoria Transport Policy Institute.
- [5] TAC. 1996. Transportation Association of Canada., Sustainable urban transportation initiatives in Canada. Presented at APEC Forum on Urban Transportation, Seoul, Korea, November 20–22, 1996.
- [6] Ferreira, D., Silva, J. P., and Bastos Silva, A. 2013, "Impactos dos Modos de Transporte Sustentáveis em Instituições de Ensino Superior—O Caso do Instituto Politécnico de Leiria." Presented at 7º Congresso Rodoviário Português "Novos Desafios para a Atividade Rodoviária", Lisboa, LNEC.
- [7] Shiftan, Y., Kaplan, S., and Hakkert, S. 2003. "Scenario Building as a Tool for Planning a Sustainable Transportation System." *Transportation Research D: Transport and Environment* 8 (5): 323-42. [https://doi.org/10.1016/s1361-9209\(03\)00020-8](https://doi.org/10.1016/s1361-9209(03)00020-8).
- [8] Litman, T. 2012. *Well Measured: Developing Indicators for Sustainable and Livable Transport Planning*. Monograph Victoria Transport Policy Institute. Accessed Jan. 2, 2015. <http://www.vtpi.org/wellmeas.pdf>.
- [9] Nijkamp, P. 1994. "Roads toward Environmentally Sustainable Transport." *Transportation Research Part A: Policy and Practice* 28 A (4): 261-71. [https://doi.org/10.1016/0965-8564\(94\)90002-7](https://doi.org/10.1016/0965-8564(94)90002-7).
- [10] Greene, D. L., and Wegener, M. 1997. "Sustainable Transport." *Journal of Transport Geography* 5 (3): 177-90. [https://doi.org/10.1016/s0966-6923\(97\)00013-6](https://doi.org/10.1016/s0966-6923(97)00013-6).
- [11] Geurs, K., and Van Wee, B. 2000. "Backcasting as a Tool to Develop a Sustainable Transport Scenario Assuming Emission Reductions of 80–90%." *Innovation* 13 (1): 47-62. <https://doi.org/10.1080/135116100111658>.
- [12] Shiftan, Y., Kaplan, S., and Hakkert, S. 2003. "Scenario

- Building as a Tool for Planning a Sustainable Transportation System.” *Transportation Research D: Transport and Environment* 8 (5): 323-42. [https://doi.org/10.1016/s1361-9209\(03\)00020-8](https://doi.org/10.1016/s1361-9209(03)00020-8).
- [13] Steg, L., and Gifford, R. 2005. “Sustainable Transportation and Quality of Life.” *Journal of Transport Geography* 13: 59-69. <https://doi.org/10.1016/j.jtrangeo.2004.11.003>
- [14] Vasconcellos, E. A. 2012. *Mobilidade urbana e cidadania*. Rio de Janeiro: SENAC NACIONAL.
- [15] Zündt, C. 2006. “Baixada Santista: uso, expansão e ocupação do solo, estruturação de rede urbana regional e metropolização.” NEPO, UNICAMP.
- [16] IBGE. 2014. *População Residente Segundo as Unidades da Federação*. Diário Oficial da União.
- [17] Cunha, J., Jakob, A., and Young, A. 2008. *Dinâmica demográfica intrametropolitana na Região Metropolitana da Baixada Santista, no período pós-1970*. Campinas: LICHITI.
- [18] Vasques, D. A., and Sena de Oliveira, I. C. 2015. “Mobilidade urbana e ocupação social do espaço urbano: uma análise do movimento pendular na Região Metropolitana da Baixada Santista”. In *Baixada Santista: transformações na ordem urbana*, edited by Marinez Villela Macedo Brandão, Maria Graciela González de Morell, André Rocha Santos, 1st ed., Rio de Janeiro, Letra Capital: Observatório das Metrôpoles.
- [19] Instituto Pólis. 2014. *Agendas de desenvolvimento sustentável: contribuições para a Baixada Santista e Litoral Norte de São Paulo*. São Paulo: Instituto Pólis.
- [20] AGEM—Agência Metropolitana da Baixada Santista. 2005. *Indicadores Metropolitanos da Baixada Santista—IMBS—Edição 2005*. São Paulo: Governo do Estado de São Paulo.
- [21] FIBGE—Fundação Instituto Brasileiro de Geografia e Estatística. 2000. *Censo demográfico de 2000*. Tabulações especiais Nepo/Unicamp.
- [22] EMTU. 2013. *Estudo Preliminar Pesquisa Mini OD Domiciliar*. Consórcio Projetos SIM RMBS, p. 137.
- [23] VETEC. 2007. “Pesquisa Origem-Destino 2007—Região Metropolitana da Baixada Santista: Sumário de Dados.” São Paulo: Vetec Engenharia, Secretaria dos Transportes Metropolitanos do Estado de São Paulo.
- [24] AGEM—The Greater Santos Metropolitan Agency, Technical Studies, Surveys, Diagnoses, and Guidelines for Creating a Plan for a Bike Lane System in the Greater Santos Metropolitan Area, or the Baixada Santista, 2006.
- [25] DERSA. 2012. Travessias litorâneas: travessias litorâneas 2012. Accessed June 05, 2013. Available on: <http://www.dersa.sp.gov.br/travessias/estatistica.asp>.
- [26] AGEM—Agência Metropolitana da Baixada Santista. 2014. *Plano Metropolitano de Desenvolvimento Estratégico da Baixada Santista*.
- [27] AGEM—Agência Metropolitana da Baixada Santista. 2014. *Plano Metropolitano de Desenvolvimento Estratégico da Baixada Santista*.
- [28] Alouche, P. L. 2008. “VLT: um transporte moderno sustentável e urbanisticamente correto para as cidades brasileiras.” *Revistas dos Transportes Públicos*.
- [29] PREFEITURA MUNICIPAL DE SANTOS. 2015. “Pré-Diagnóstico da Mobilidade Urbana no Município de Santos.” GTT-PLANMOB—Grupo Técnico de Trabalho para a Elaboração do Plano Municipal de Mobilidade Urbana.