A METHOD TO IMPROVE URBAN MOBILITY AND REDUCE EMISSIONS OF CARBON

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ABSTRACT

This paper aims to contribute to the management of passenger transport in small and medium-sized cities, through the proposition of a construct that meets the need of integration between the modal bicycle and public transport passengers. This integration enables the improvement in coverage ratios of means of transport, promoting better interaction between individuals, spaces and urban activities. For this we used a case study in São José dos Campos to apply the concepts developed. From the survey data relating to existing bike lanes, bus lines with their respective levels of passenger kilometers (IPK) and distribution of the economically active population in the city, provided by the City Hall, we propose a model for the integration of modes in urban transport.

INTRODUCTION

The multimodal integration can provide a better performance of public transport systems. There is need for links between different modes, giving them the structural role (subway, train, light rail vehicle) and, second feeder (bus, minibus, van, bike or foot) in order to promote mobility urban quality to the population.

In this context, cycling can play an important role in the sustainable development of cities. Bicycles do not harm the environment, do not emit pollutants, rationalize the use of public spaces - allowing for greater harmony and equality between the elements of traffic, as well as building up a healthy physical activity (Vasconcellos, 2001).

According to data from the Ministry of Cities (2007) Brazil has the sixth largest fleet of bicycles in the world with approximately 75 million units, just behind China, India, USA, Japan and Germany. As a producer, Brazil is the third largest producer of bicycle (4.2%), behind only the absolute leader, China with 66.7% of the world and India with 8.3%. The infrastructure for its use, however, does not fit. In Brazil there are only 600 kilometers of bike paths.

To adopt the bicycle as a means of urban transport, there are still several barriers. Presents vulnerability to motor vehicles, but presents a danger to pedestrians. Its use is associated with toys or play activities, and is recognized as a means of transportation for those who do not have the economic capacity to have another vehicle.

Urban Sustainable Mobility

De acordo com Alvarenga e Novaes (2000) para se organizar um sistema de transporte é preciso ter uma visão sistêmica, que envolve planejamento, mas para isso é preciso que se conheça: os fluxos nas diversas ligações da rede; o nível de serviço atual; o nível de serviço desejado; os tipos de equipamentos disponíveis e suas características.

The sprawl of the urban population coupled with the low level of planning is mainly due to decrease of urban mobility. According to Suen and Mitchell (2001), one can understand mobility and availability of services and transport to any destination and time, with information about its operation, the way they use and their means of payment.

Authors such as Greene and Wegener (1997) and GUDMUNDSSON and HÖJER (1996) state that for effective implementation of policies for sustainable mobility should be considered such aspects as the balance between different modes of transport and encouraging the use of non-motorized modes. The same authors claim that by developing technology for sustainable transport, should also focus on issues related to demand and supply of transport and transport integration with land use.

According to Vasconcelos (1996), there are several criticisms of the process that was traditionally used in transportation planning in Brazil: technical beacon for political and ideological decisions. One criticism is related to the decision process for adoption of proposals, which are usually policies from a technical rationality. The benefit to society is in the background.

The different forms of land uses, for instance, residential, commercial, industrial, among others, affect human activities, such as live, work, shopping and leisure. The need of the individual to perform these activities in turn generates the need to make travel between different locations in which they work. The transport system then creates the opportunity to allow the interactions, that is, promotes accessibility to sites that are possible in the various activities.

Accessibility is also considered as a determining factor in deciding the location of activities. Thus, we identify a chain of actions and reactions in which the land use has an influence on the transport and the transport influences land use and about himself (Lautso ET AL., 2004).

To Bertolini et al. (2008), there is a need for an integrated approach in which there is integration between transport and land use.

According to Alvarenga and Novaes (2000) to organize a transportation system is necessary to have a systemic view, which involves planning, but this one has to know: the flows in different network connections, the current service level; the level of service wanted, the types of equipment available and their characteristics.

Integrating cycling and public transport

Ideally, the best would meet the demand for transport through a single shift by a single shift. However, in most cases this event does not occur. It is then that the intermodality between transport modes becomes a powerful tool to provide connectivity to the current context of urban cities.

In its own way, the use of bicycles as a means of transportation can present a high efficiency when operating in a complementary way with public transport. Several variations may occur from this combination: cohabitation bike / bus lanes for buses; cohabitation bike / VLT towards segregated from the VLT; intermodality train / subway and bicycle-bicycle, carriage of bicycles inside the bus, VLT's, trains and subways, and parking of bicycles on public transport stations.

Additionally, the integration of bus and bicycle may extend the reach of the rider's path, allowing it to cross natural barriers or traffic of vehicles, besides being an option in case of bad weather. It also allows the connection of the bike with the other modes.

The role of bicycle for social inclusion

According Sposati (1998), social exclusion includes, besides insufficient income, social discrimination, spatial segregation, non-equity and denial of social rights. Social exclusion is thus a situation of being not only individual but collective.

The existence of an affordable public transport, efficient and quality to ensure the accessibility of population to the urban space, can significantly increase the disposable income and time-poor, provide access to basic social services (health, education, leisure) and work opportunities. In this sense means the public transportation as an important tool for combating urban poverty and promoting social inclusion.

According Rolnik (1999), social exclusion creates the situation of the city divided between the formal portion (rich and infrastructure) and illegal (poor and remote, characterized by low supply of public services and lack of infrastructure). The current process of urbanization, characterized by the occupation of urban neighborhoods, increases the need for transport and public services, which often do not adequately supply the demand. As a result it has the poorest spatially segregated and limited in their mobility status.

DEVELOPMENT OF A CONSTRUCT OF INTEGRATION

Considering the scenario described, one can admit that cycling is an important tool in addressing the challenges inherent in the transportation and transit cities. The integration of the bicycle collective urban transport can provide social inclusion and accessibility, creating citizenship.

From the analysis of several cases around the world, Amsterdam, Barcelona, London, Paris and Bogotá, where policies aimed at spreading the use of bicycles have been successful, a construct was developed to systematize the process of integration of bicycle urban transport. The proposal is to interconnect the city using public transport - buses equipped with racks or meters - allowing the rider to overcome barriers infrastructure and access the most diverse destinations within the urban area safely and comfortably by connecting this individual to other bike paths or neighborhoods.

1. Initially it is performed the identification of lines (bus or subway) and their correlation with paths. For both are selected, the public transport lines that graze the highest number of bike paths. It is obtained, thus, points to the bus stop at the intersection with bike paths.

2. In general the lines will be prioritized to have the lowest indicator of passengers carried. The increase in choice of destination transport, generated by new connections can reduce the average size of travel, increasing turnover and increasing the use of indicators.

3. Breakpoints might be indicated in order to minimize the displacement of the cyclist or limit it to more than 2 km from its point of origin and destination. So, we try to select the breakpoints within a radius of 400m of the breakpoint chosen to suggest the installation of parking lots, and paracycle bicycle rider if the resolve to complete its path without a bicycle.

4. Browse provide parking for bicycles, especially in the critical breakpoints - such as hospitals and shopping centers - and points the lines that lead individuals to the city's financial center.

5. It is suggested to mark out the number of modal intercessions on the assumption that the submission of a proposal to integrate basic urban does not require a large number of possible connections. Thus, when more than one bus route at the same time meet the same path, one should consider the use of their inclusion.

Application of proposed construct: The case of the city of São José dos Campos

São José dos Campos is a major Brazilian city, known for promoting investment in the development of socio-economic policies, institutional frameworks and cultural avant-garde and new developments in high technology and security.

The population of São José dos Campos is 615,871 inhabitants (IBGE, 2009), mostly living in this area of the town. This concentration of population in urban areas occurs, among other reasons, the provision of infrastructure, active labor market and social services of quality.

However, the growth of the city imposed on its people the need to adapt to the limitations of natural barriers (such as rivers and hills) and road. The President Dutra highway, divides the city into two sections, and directly impacts the behavior of the mobility of citizens, as shown in Figure 1.

Figure 1 - Representation of the limitation imposed by the highway Rod via President Dutra

According to the Master Plan for Integrated Development, the bicycle projection system for the city of São José dos Campos indicates the presence of bike lanes in all areas of the city, as seen in Figure 2.

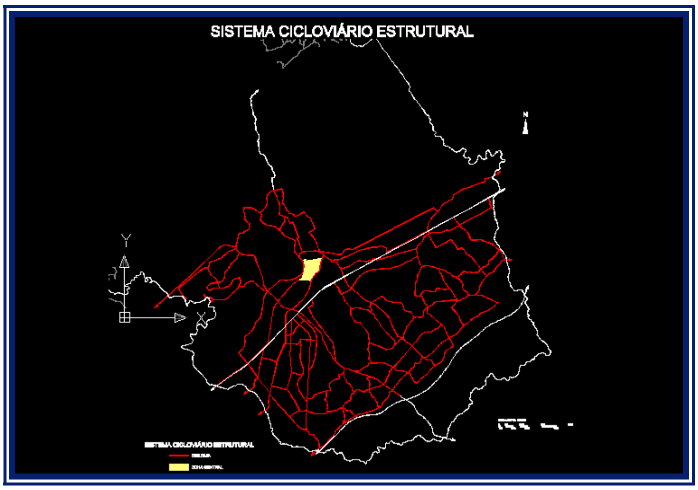

Figure 2 - Structural bicycle system. Source: Planning according to bicycle master plan.

Currently the process of building bicycle systems in the city is still short of the planned in the master plan. However, the city has a good road network in all sectors of the city, and with a system of conventional public transport appropriate to their urban projects.

However, it was still possible for the cyclist, cross roads and physical barriers that prevent them from accessing all areas of the city without causing any risk, entering not appropriate road systems.

According to the Department of Transportation in São José dos Campos the number of cyclists in the city's road system is about thirty thousand people, the transit undue reliance on these highways, putting themselves and other users of the system in danger.

The presence of these cyclists in the system is directly linked to the impossibility of alternative route which indicates that this is not a pure and simple irresponsible behavior, but above all, the inability of the user to adopt another action.

It is noticed a clear opportunity to integrate cyclists to urban public transport, whereas the factors limiting physical and technical deficiencies or administrative burden to both systems enables the implementation of measures to improve the efficiency of public transport.

Results of the application of tooling

After obtaining the socio-economic map of the corridor and frequency of public transport in the city, it was identified the bus routes serving the same with their routes and location of transfer points in their journey.

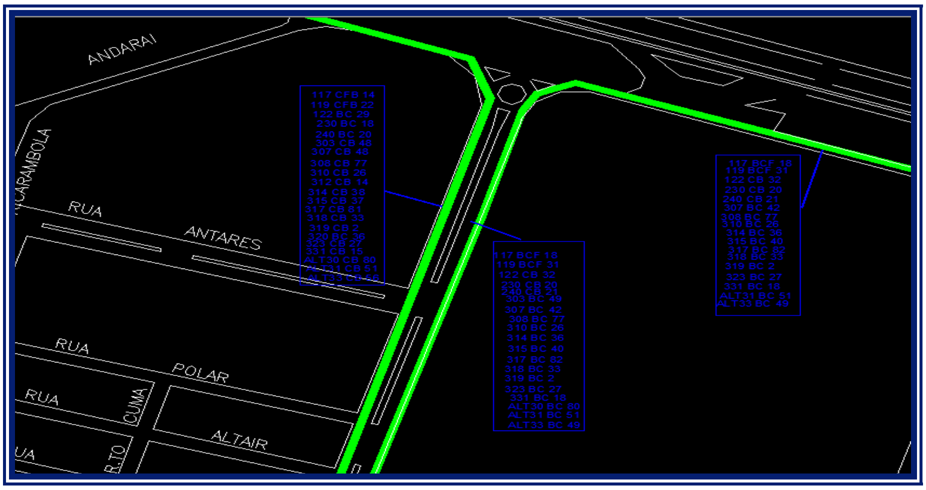

Figure 3 - Representation of part of the route of the line 240 - it indicates the location of the transshipment point and the lines that meet at this point

With the purchase of a bicycle map of the Secretariat of Transportation, prepared on 12/04/2007, making the bicycle planning DST/2005 - 2008, it was identified the paths and lanes, their location and design enabling project them into the AutoCAD environment as shown in Figure 4.

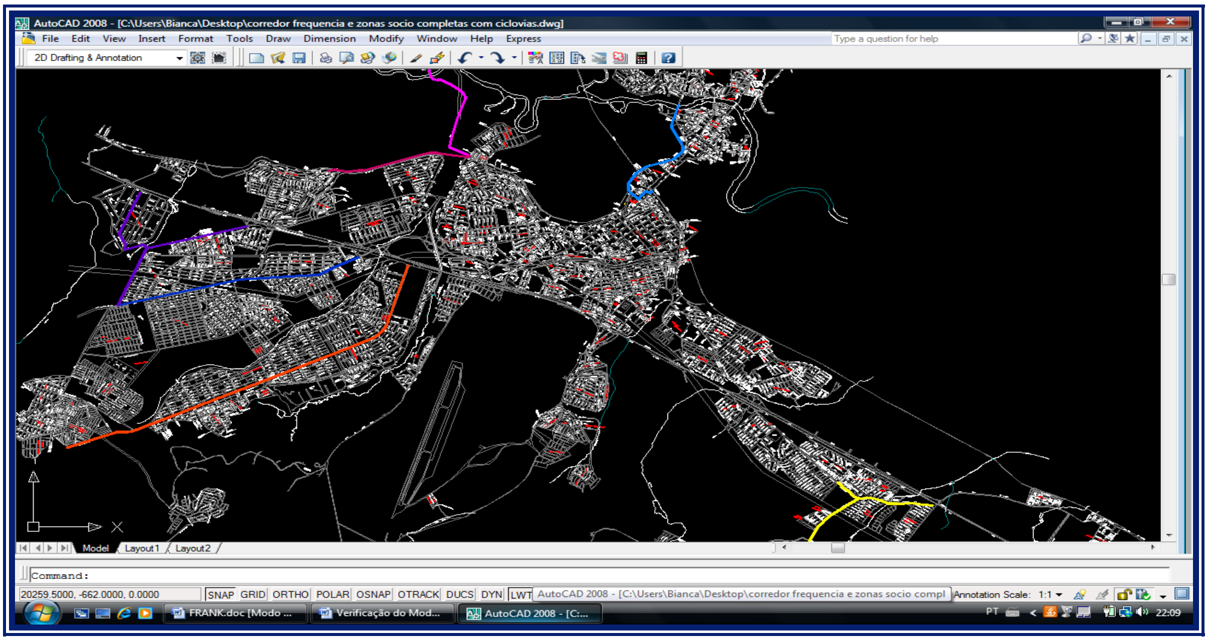

Figure 4 - Planning bicycle in AutoCAD - STD / 2005-2008

The intersection of location data paths of the routes of bus lines in the city and transfer points in the bicycle system, allows the planning of the city under study and verification of integrated systems to be analyzed.

LINHAS	CICLOVIAS	107	117	119	122	125	128	2048	230	232	237	240	2418	300	303	307	309	310	312	314	318	319	320	323
	A1		A1	A1	A1				A1			A1			A1	A1		A1	A1	A1	A1		A1	A1
P	A2		A2	A2	A2				A2			A2			A2	A2		A2		A2	A2		A2	A2
O	A3											A3		A3										A3
N	ACJ4											ACJ4		ACJ4										ACJ4
T	ACJ5											ACJ5		ACJ5										ACJ5
O	AJC6											AJC6		AJC6								AJC6		AJC6
S	AJC7											AJC7									AJC7	AJC7		AJC7
	AJC8											AJC8									AJC8	AJC8		
D	TNBF1																							
E	TNBF2																							
	TN3							TN3		TN3	TN3	TN3	TN3											
P	BAC1															BAC1	BAC1							
A	BAC2															BAC2								
R	BAC3															BAC3							BAC3	
A	BAC4			BAC4					BAC4					BAC4	BAC4					BAC4				
D	BACJB5			BACJB5					BACJB5					BACJB5	BACJB5									
A	JICLM1	JICLM1		JICLM1		JICLM1		JICLM1			JICLM1											JICLM1	JICLM1	
	JICLM2		JICML2	JICML2	JICML2		JICML2								JICML2		JICML2	JICML2	JICML2		JICML2	JICML2		JICML2
D	LMSH1						LMSH1																	
E	LMSH2						LMSH2																	
	LMSH3						LMSH3																	
Ô	LMSH4						LMSH4																	
N	LMSH5						LMSH5																	
I	LMSH6						LMSH6																	
B	VN1	VN1			VN1	VN1				VN1														
U	VN2					VN2																		
S	CIC1													CIC1						CIC1				
	CIC2													CIC2						CIC2				

Figure 5 - Representation of the identification of bus lines x transfer points – each different color in line represents a bike track ; each alpha numeric code represents a transfer point (bus stop) and each numeric code represents a bus line.

After identifying the lines of buses, whose routes coincide with the route of the bicycle, it is located the main transfer points for passengers and generates a correlation matrix that is represented in Figure 5.

In this matrix the rows are identified by their bus numbers and routes within the perimeter of paths, bus lines whose routes overlap partially or totally with the route of cycle paths and bus stops district, ordered in ascending order, that along the routes are the interface between the bicycle paths and bus lines.

CICLOVIAS / CICLOFAIXAS	LOCAL	PARADA DE ÔNIBUS
	Av. Andrômeda / Av. Cidade Jardim / Av. Adilson José da Cruz	(A1-3)/(ACJ4-5)/(AJC6-8)
	Tancredo Neves	(TNBF1 e TNBF2)
	Av. Bacabal	(BAC1-BAC4)
	Jardim das Indústrias / Jardim Colinas / Ligação Lineu de Moura	(JICLM1 e JICLM2)
	Av. Lineu de Moura ligação Av. Shishinma Hifum	(LMSH1-LMSH6)
	Via Norte	(VN1 e VN2)
	Av. Central / Estr. do Imperador / R. Caravelas	(CIC1 e CIC2)

Figure 6 – Key table for Figure 5- each different color in line represents a bike track ; each alpha numeric code represents a transfer point (bus stop).

It may be noted that the 23 bus lines that serve the bike track in SJC, 69.6% of them have their way coinciding with the bike track of “Jardim das Indústrias /Jardim Colinas” connection Lineu de Moura and 65.2% lines coincide with the system of bicycle av. Andromeda.

Comparing the paths and bus lines of both systems, it appears that the bike lane of “Avenida Andromeda” there are a number of possibilities for integration as well as being greater in extension, its serves a population of users substantially more significant.

A proposal to basic urban integrate does not require a large number of transfer points possibilities. A suggestion is to select those with fewer users. So will be a minor impact for the non bikers users. This study uses an indicator called IPK (indicator of passenger per kilometer). The data were the values of the IPK for the month of April 2007.

This method applied to the transfer point selection proposal aims to identify the lines that present opportunities for integration, increase the options for destination of transport generating intermediate connections that reduce the size of average travel, increasing the turnover of the system and could include increase in the IPK.

This study selected among the busses lines array, those lines with more bike tracks accessed, more bus stop in each bike lane and with the lowest IPK. The Figure 7 shows the IPK of the initial selected lines.

	CICLOVIAS																							
LINHAS		107	117	119	122	125	128	204B	230	232	237	240	241B	300	303	307	309	310	312	314	318	319	320	323
	IPK0407	2.93	1.56	1.90		1.61		3.17	2.51			3.05	2.69	1.57	2.41	2.95	1.98	1.84	1.15	2.51	2.11	1.78	2.08	2.46

Figure 7 - average IPK of April 2007 (STDST-PMSJC) of each one of the lines that serve the bike paths of SJC

According to the proposed criteria, five bus lines was selected - 319, 300, 240, 125 and 128 - which are, according the proposed construct, the option to integrate the system of transportation of the city of São José dos Campos, as shown in Figure 8.

	CICLOVIAS					
LINHAS		319	300	240	125	128
	A1			A1		
P	A2			A2		
O	A3		A3	A3		
N	ACJ4		ACJ4	ACJ4		
T	ACJ5		ACJ5	ACJ5		
O	AJC6	AJC6	AJC6	AJC6		
S	AJC7	AJC7		AJC7		
	AJC8	AJC8		AJC8		
D	TNBF1					
E	TNBF2					
	TN3			TN3		
P	BAC1					
A	BAC2					
R	BAC3					
A	BAC4		BAC4			
D	BACJB5		BACJB5			
A	JICLM1	JICLM1			JICLM1	
	JICLM2	JICML2				JICML2
D	LMSH1					LMSH1
E	LMSH2					LMSH2
	LMSH3					LMSH3
Ô	LMSH4					LMSH4
N	LMSH5					LMSH5
I	LMSH6					LMSH6
B	VN1				VN1	
U	VN2				VN2	
S	CIC1		CIC1			
	CIC2		CIC2			
	IPK0407	1.78	1.57	3.05	1.61	

Figure 8 - Representation of the accompanying

The line 128, for example, could be an important instrument of social integration. This line connect the southern tip of the city, likely supplier of labor, to the other end of town, possible consumer of services.

Identification and Analysis of Opportunities

The point AJC6 meets the lines 240, 300 and 319 simultaneously and it is indispensable to the line 319 that only serves the bicycle system from this point. In this place there is still an educational and health complex. So the point AJC6 is defined as a key point of intersection in this bike path.

Section A1 has a strategic position in the distribution of passengers, already serving 13 lines (117/119/230/240/303/307/310/312/314/318 / / 320 and 323), which communicate with other lanes of the city. It also has proximity to major shopping centers. According to these characteristics, it is defined as the second key point of intersection. At key points suggest the deployment of cycle integrator or definition of potential collection points for cyclists and their bikes. The bus stop TN3 is the only one that serves the line 240 at that bike track, so it must be selected.

To assist the population of cyclists that lead to the path to get to and to return from work using a bike, points BAC4 and CIC1, served by line 300 are considered key point of intersection in this bike.

Point JICLM1 is attended by the lines 125 and 319, while point JICLM2 is served by lines 128 and 319. Both points are essential to the lines 125 and 128 respectively, and the latter being an important point of connectivity to other lines of transportation and is close to points of attraction. These characteristics are similar to the key point A1. These factors are crucial to define them as key points of this bicycle intercession.

Point VN1 located serves 17 bus routes that mostly do not match the lines that integrate the other lanes. This fact defines a range of opportunities to be explored: the integration of the other riders of bus lines and bicycle systems.

Figure 9 presents the key points in the perimeter of paths and area (circles of radius 400 m) of points of interest which must be installed bicycle and paracycle stops.

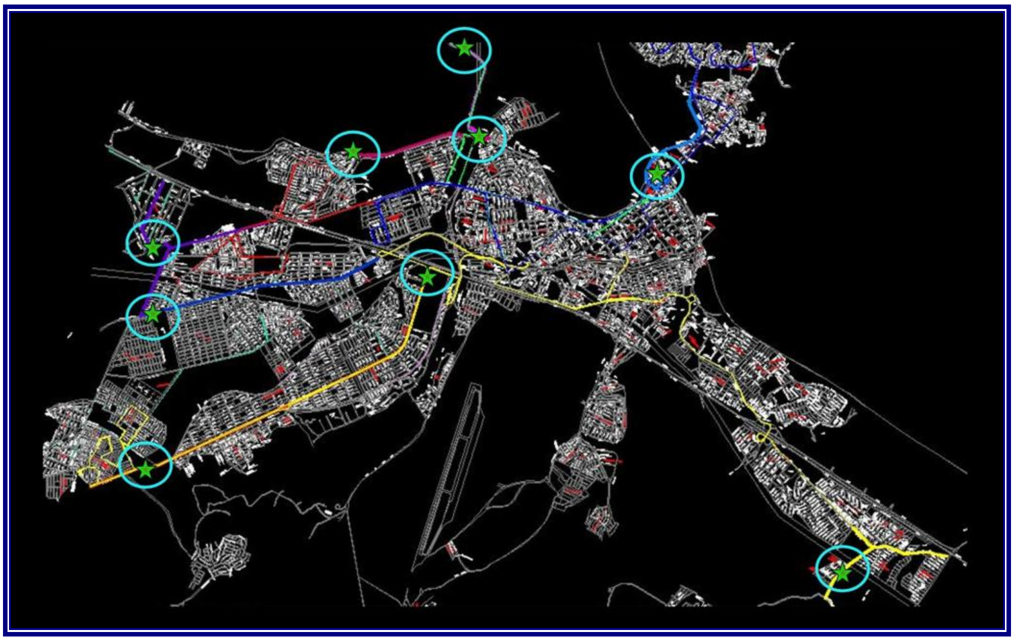

Figure 9 - Illustration of the key points in each track and area of coverage of points of interest for installation of bicycles / paracycles - points of attractiveness

The application of the tools developed in this study allows to expand the coverage area of public transport without increasing emissions. Accepting an extension of the covered area of the transport system to a radius of 2 km - equivalent to five minutes by bicycle - from any point of stop contained in bike lanes, the coverage area of public transportation was expanded to 73.74% , from 144.75 km² to 216.80 km², as displayed in yellow and red lines in Figure 10.

Thus, as an example of practical application, we suggest the selection of strategic points near the rural areas for deployment of bicycle integrators. In this place, users from remote areas, without access to public transport, can leave their bicycles and ride to your destination, or simply place it on the bus and continue the journey.

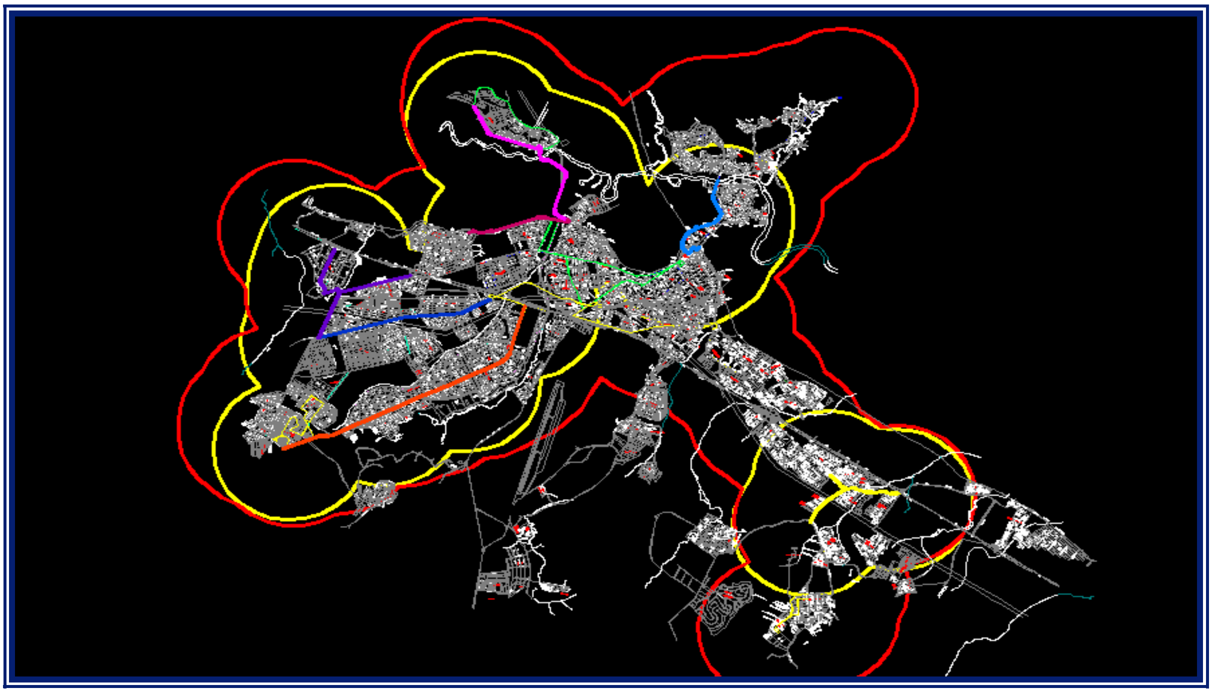

Figure 10 - Representation of the application of the model with the overlap of coverage before and after

Conclusion

This study aimed to analyze the main determinants of intermodality in an urban environment, in order to promote the simultaneous use of modal.

It proposes a model able to analyze the current context of small and medium-sized cities and indicate ways to provide the integration of cyclists to public transport.

Using an indicator of occupation by distance traveled (IPK) as a reference element for application of the construct was established for the selection of five bus lines that represented within the sample space, the best option for the integration of bicycle transport system groups to the city of São José dos Campos.

Through the application of the tools proposed, we identified opportunities for improvements in public transport system of the city to be operated from the case study conducted.

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