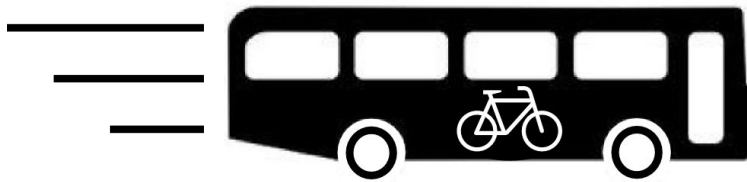**TECHNISCHE UNIVERSITÄT DRESDEN**

Faculty of Transportation and Traffic Sciences "Friedrich List"

Sustainable urban transport approaches for Brazilian megacities – the example of Rio de Janeiro

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F: Transport, Land Use and Sustainability

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AZIA	Audiobasierte Zusammenfassende Inhalts-Analyse Audio-Based Content Analysis
BRS	Bus Rapid System
BRT	Bus Rapid Transit
CBD	Central Business District
LRT	Light Rail Transit
PDTU	Plano Diretor de Transporte Urbano Master Plan of Urban Transportation
RMRJ	Região Metropolitana do Rio de Janeiro Metropolitan Area of Rio de Janeiro
SAMBA	An acronym that refers to the public bicycle system
SUPERVIA	An acronym that refers to the private concessionaire in charge of operations and maintenance of the suburban rail
UFRJ	Universidade Federal do Rio de Janeiro Federal University of Rio de Janeiro

1   INTRODUCTION

Today, the megacity Rio de Janeiro experiences an intense, rapid urban develop-
ment, supported by the pacemaker effect of the World Cup in 2014 and the Olympic
games in 2016. This situation offers a unique opportunity for decision makers to ease
the current transport situation, because the city's road system is no longer capable to
serve current traffic flows and the inefficient public transport system does not offer a
reliable mobility alternative.

Previous approaches focused on the expansion of the road system, prioritized
low-capacity local buses, and neglected non-motorized transportation modes, and
thus created an unsustainable development of constantly growing car traffic demand.
Recently, the city's strategy has changed by implementing a high-quality BRT-system
and promoting walking and cycling.

Nevertheless, this process mainly derives from the external force of the upcoming
sports events and is not a result of an internal urban planning process. Hence, Rio de
Janeiro still requires suitable approaches to achieve a sustainable urban transport
concept. Therefore, the objective of this research project is to provide integrated and
sustainable approaches in order to tackle current transport problems, focusing on the
reformation of its public transportation system and the promotion of non-motorized
transportation.

The literature review examines the background of sustainable urban transport in Bra-
zil and provides a general overview of Rio de Janeiro's structure, its modal share as
well as future mobility issues. Furthermore, the audio-based qualitative content
analysis of seven expert interviews, with stakeholders in urban- and transportation
planning of Rio de Janeiro, Sâo Paulo, and Curitiba, provides recommendations on
how to tackle transport problems in Rio de Janeiro and gives a concise insight into
impact of the upcoming sports events.

2 LITERATURE REVIEW

2.1 SUSTAINABLE URBAN TRANSPORT

In Brazil, traditional urban mobility planning concepts, implemented from 1960 to 1990, focused on: traffic management (strategies to reduce congestion), transportation services (provision of public transportation), and transportation infrastructure (expansion of the urban road networks).

The results of this process are the supply of infrastructure for road transport through multi-lane roadways and expressways, the prioritization of individual transport to the detriment of the public transport, the disregard of the non-motorized transportation modes, and the separation of urban and transport planning. Those uncoordinated actions have resulted in the loss of financial resources, the lack of social control, and the disregard of environmental questions in the planning of urban transport in Brazil. [SILVA, SILVA COSTA, MACEDO 2008, P. 352]

The new concept of urban mobility has its basis in the 1998 Federal Constitution, but the debate about sustainable urban transport has started only after the *City Statute* and the following creation of the *Ministry of Cities* in 2003. The new mobility concept introduces social, environmental, and equity issues into the planning process. [SILVA, SILVA COSTA, MACEDO 2008, P. 352]

The *Ministry of Cities* describes "sustainable urban mobility" as the product of policies which provide broad and democratic access to urban space, prioritizes non-motorized and public transportation modes, eliminates or reduces spatial segregation, contributes to social inclusion, and encourages environmental sustainability [MINISTÉRIO DAS CIDADES 2007, P. 42].

However, a country like Brazil is characterized by economic, social, and structural differences between the mobility systems of the various municipalities. Each region and city has particular characteristics that limit the elaboration of one unique solution for all mobility problems. Thus, the sustainable urban transport concept has to be adapted to the social context and the needs and potentials of the specific location. [SILVA, SILVA COSTA, MACEDO 2008, P. 352]

2.2   RIO DE JANEIRO

2.2.1   GENERAL STRUCTURE

As shown in Figure 1, the *Região Metropolitana do Rio de Janeiro* (RMRJ) is situated at the state's southern coastline and is separated by the *Guanabara Bay* (port.: Baía de Guanabara), spreading out to the North into the lowlands of the *Baixada Fluminense*. It is the second largest agglomeration of Brazil [IBGE 2011a], expanding about 140 km from East to West and 70 km from North to South, and it contains 19 municipalities.

The city of Rio de Janeiro is the capital of the state and consists of 33 administrative regions. It is located next to the Guanabara Bay in the East and the Atlantic ocean on the Southern coastline. The city's expansion is about 70 km from East to West and 30 km from North to South. Table 1 shows the population, land area, and density of the state, metropolitan and city area for the year 2010.
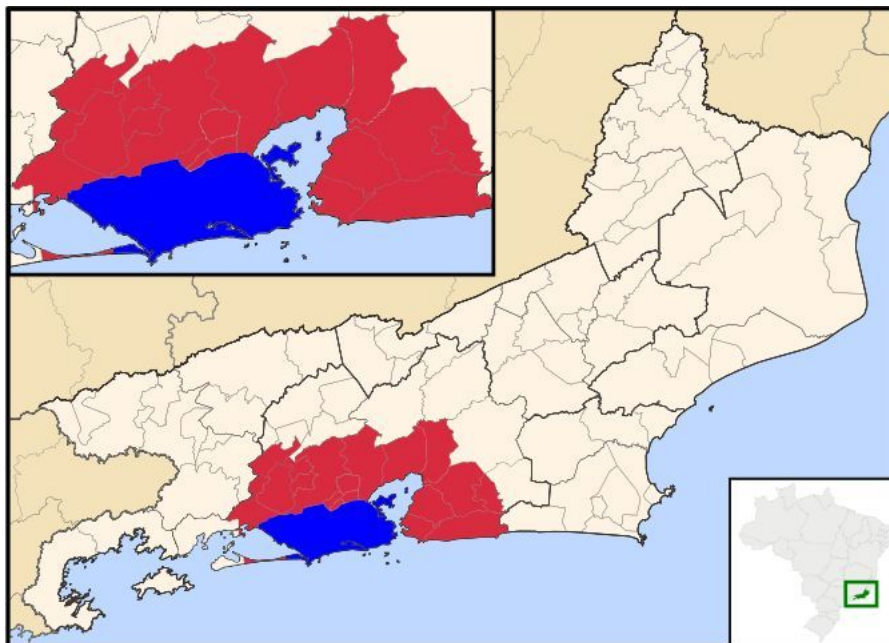
Figure 1: Rio de Janeiro state, metropolitan (red) and city area (blue);
Source: Adapted from [OLIVEIRA JÚNIOR 2011] / [ABREU 2006]

A lake system in the South and three mountain ranges, as high as 1,000 m, divide the city area, providing difficult conditions not only for non-motorized transportation modes. Its beauty and natural environment attracts tourists from all over the world, having its geographic setting as its most important asset and image. [ACIOLY JR. 2001, P. 510]

Spatially, the city area is divided into four distinctive zones the Center, South, North, and West. Most middle- and upper-income neighborhoods are located in the Central and Southern zones. This is the part of the city with the best urban infrastructure, commerce, services, and various modes of transportation. But it is also characterized by *favelas* (eng.: informal settlements), which benefit from being near to the center of the city.

Table 1: Population, land area, and density of the city, metropolitan, and state area of Rio de Janeiro in 2010; Source: [IBGE 2011a]

AREA Rio de Janeiro	POPULATION	LAND AREA (km²)	DENSITY (inhab. / km²)
State	15,989,929	43,780	365
Metropolitan	11,835,708	5,326	2,222
City	6,320,446	1,200	5.265

Low-income households and most *favelas* are concentrated in the Northern zone, where neighborhoods first emerged as the railroad system expanded from the city center towards the North. Middle-income households that are unable to afford the high costs of housing in the Southern zone tend to live in the Northern zone. The lack of developable land in the Central and Southern parts as well as high housing costs in central locations caused an urban sprawl towards the West. Poor settlements in this area are lacking paved streets as well as water and sewage systems and are located far away from the city center [PAMUK, CAVALLIERI 1998, P. 453].

2.2.2 MODAL SHARE

Rio de Janeiro has a comprehensive documentary system for mobility data as well as detailed information from each operator. In 2003, the State of Rio de Janeiro made a *Plano Diretor de Transporte Urbano* (PDTU) for the RMRJ by doing an intense research about origin-destination of trips, describing characteristics of supply and demand, making performance diagnosis, and analyzing the costs- and benefits of several alternatives of intervention. The plan makes suggestions to improve the urban public transportation system until 2013, and it provides tools to implement a PDTU as a permanent planning process. [ROSSI, ALVES, VIDER 2008, P. 87]

According to the main mode of transport[1], the distribution of trips in the RMRJ (see Table 2), shows that the ecomobility modes of transport sum up to 84 % of all trips. Public transportation has the highest share with 47 %, non-motorized modes of transportation reach 37 %, and private motorized transportation has the lowest share of only 16 %.

Table 2: Trips per day by main mode of transport in the RMRJ;
Source: [GOVERNO DO ESTADO DO RIO DE JANEIRO 2005, P. 1–3]

MODE OF TRANSPORT	TRIPS	
	(trips / day)	(%)
Total public motorized transport	**9,429,749**	**47.34**
Local and inter-municipal buses	6,586,742	33.07
Alternative transport[2]	1,630,985	8.19
Metro	355,404	1.78
Train	303,578	1.52
Taxi	139,109	0.70
Water transport[3]	82,091	0.41
Tram	2,195	0.01
Others[4]	329,645	1.66
Total private motorized transport	**3,100,004**	**15.57**
Automobile	2,969,634	14.91
Motorcycle	100,922	0.51
Trucks	29,448	0.15
Total private non-motorized transport	**7,386,198**	**37.09**
Walking	6,740,688	33.85
Cycling	645,510	3.24
TOTAL	**19,915,951**	**100.00**

Walking (33 %) is the prime mode of transport, closely followed by local and inter-municipal buses (33 %) and the automobile (15 %), although these numbers do not represent today's share, in regard of the increase of registered automobiles and motorcycles in the past decade. The alternative transport represents the second highest share of the entire public transportation system, thus bringing significant competition

1 The main mode refers to the one in which the user spent most of the travel time. [GOVERNO DO ESTADO DO RIO DE JANEIRO 2005, P. 1–3]
2 Alternative transport refers to transport with vans which are just partially regulated. [GOVERNO DO ESTADO DO RIO DE JANEIRO 2005, P. 2-2]
3 Ferry, hovercraft and catamaran.
4 Chartered transport, school and executive buses.

into the public transport sector. Metro and train services, on the contrast, do not seem to play a significant role within the metropolitan public transport network. Motorized individual transportation is primarily realized with the automobile. Cycling has a very low share of 3 %, but is still higher than for example the one of the metro or the local train system.

2.2.3 FUTURE MOBILITY ISSUES

Until 2016, the public transportation system of the RMRJ will undergo significant changes (see Figure 2).
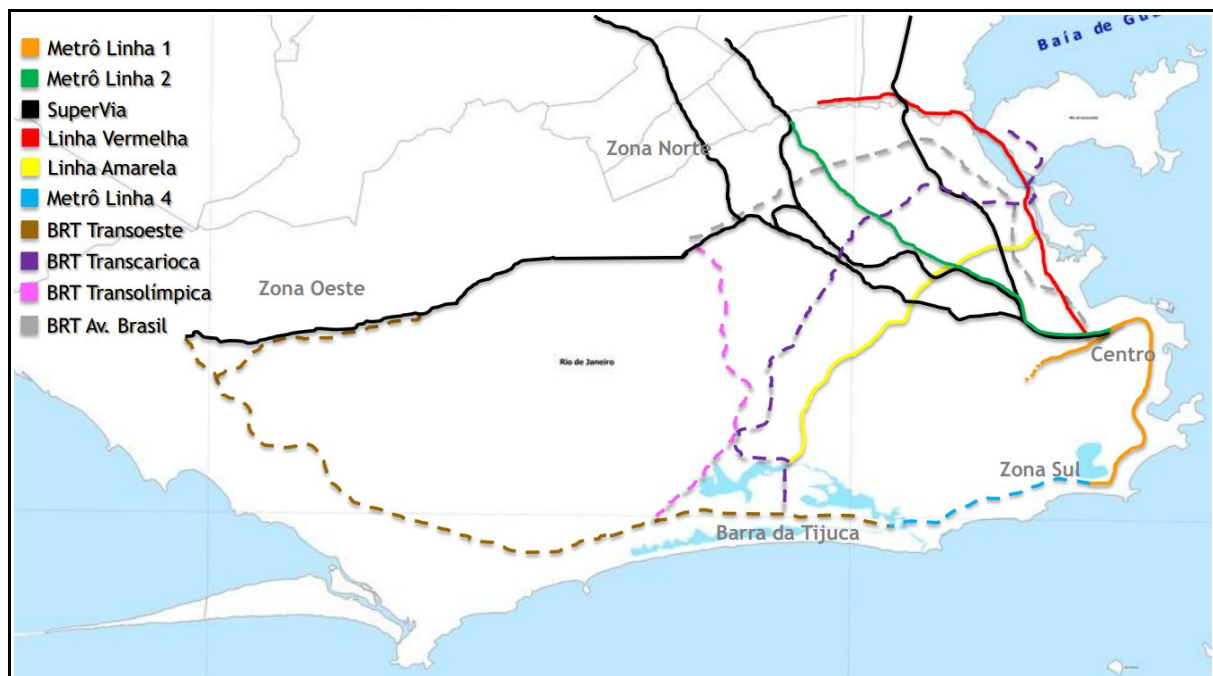
Figure 2: Future public transport network; Source: [OLIVEIRA 2011, P. 13]; Annotation: Solid lines represent the existing network, dotted lines the planned infrastructure

Planned infrastructure measures are the:

- Construction of a BRT-system, comprising four high capacity bus lanes (TransOeste, TransCarioca, TransOlímpica and TransBrasil), including new bus stations and articulated vehicles,

- Implementation of preferential bus lanes, called *Bus Rapid System* (BRS) in the South, Central, and North Zone,

- Improvement of the suburban railway network of SUPERVIA, including an upgrade of 120 new trains with air condition and several other measures,

- Extension of the metro system, connecting the city center with Barra da Tijuca (Line 4) and Niterói, São Gonçalo and Itaboraí (Line 3), and the

- Construction of a *Light Rail Transit* (LRT)-system, included in the Porto Maravilha project in Rio de Janeiro's city center. [MOBILIZE BRAZIL 2011, P. 50– 54].

The construction of this new mass transport system will interconnect the West, North, and East zones of Rio de Janeiro with the city center. More than ten million people, living in 20 municipalities, will benefit from this massive infrastructure investment and thus be enabled to take new mobility choices. Moreover, it will ensure the mobility needs for the upcoming events in 2014 and 2016. [SOUZA 2012, P. 25]

3 METHODOLOGY OF EXPERT INTERVIEWS

3.1 IMPLEMENTATION OF THE INTERVIEWS

At the beginning of this research project, a general overview of accessible literature was implemented to identify key issues of the Rio de Janeiro's urban transportation sector and to prepare the conduction and analysis of semi-structured expert interviews with the following objectives:

1. Identify current transportation problems,

2. Determine adequate approaches to tackle current transport problems, and

3. Assess the impact of the sports events in Rio de Janeiro.

From October to December 2011, 20 face-to-face interviews with stakeholders of urban- and transportation planning were conducted in Rio de Janeiro, São Paulo, and Curitiba. The participants were chosen by means of knowledge deriving from literature research, individual evaluation of lecturers during the *18th Brazilian Transport and Traffic Congress* and several other workshops, as well as recommendations from the interviewed participants.

Depending on the language skills of the interviewee, the interviews were held either in English or Portuguese, enabled by a trilingual interview guide (including German). The interviews lasted up to 70 minutes and were implemented at various locations, such as offices, cafes, or other public places. All conversations were recorded, with the permission of the participants, to enable the audio-based qualitative data analysis (see Chapter 3.2).

In the beginning of each meeting, personal details on their current field of work as well as former work experience were collected to validate their status as experts. Within the framework of this Diploma thesis, participants were considered to be experts, if they had profound knowledge on the basis of research or professional experience with the:

• Urban- and transportation planning processes of Brazilian megacities

• Planning and implementation processes of the current public transport infrastructure measures in Rio de Janeiro, or

• Promotion of non-motorized transportation within Brazilian society.

3.2   AUDIO-BASED QUALITATIVE CONTENT ANALYSIS

Adapted from KNORR's *Audiobasierte Zusammenfassende Inhalts-Analyse* (AZIA) [KNORR, P. 170–188], this audio-based qualitative content analysis comprises five distinctive phases (see Figure 3):
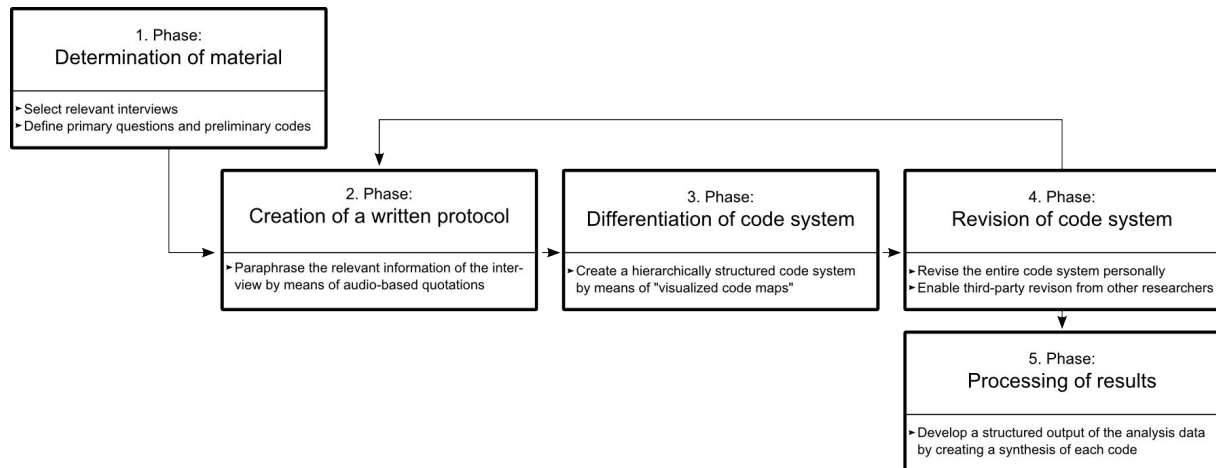

Figure 3: Five phases of the audio-based qualitative content analysis

1. Phase: Determination of material

Only seven interviews with high quality information were selected for further audio-based qualitative content analysis. Without doubt, this spectrum of participants cannot provide a complete image, rather a concise insight into the current transport situation of Rio de Janeiro. Primary research questions were chosen in consideration of the objectives of this exploratory research (see Chapter 3.1) and facilitated the development of a preliminary code system.

2. Phase: Creation of a written protocol

Recorded verbal data of each individual interview was efficiently converted into a higher level of abstraction by means of an audio-based quotation process, using the software ATLAS.ti.

3. Phase: Differentiation of code system

The differentiation of the hierarchically structured code system, consisting of top-codes and sub-codes, was implemented in an inductive process. All interviews were encoded individually, while each quotation was assigned to a single code, according to their content. Starting with the preliminary code system, each code was assessed by means of "visualized code maps" (network views) to identify specific top-and sub-codes (see Figure 4).
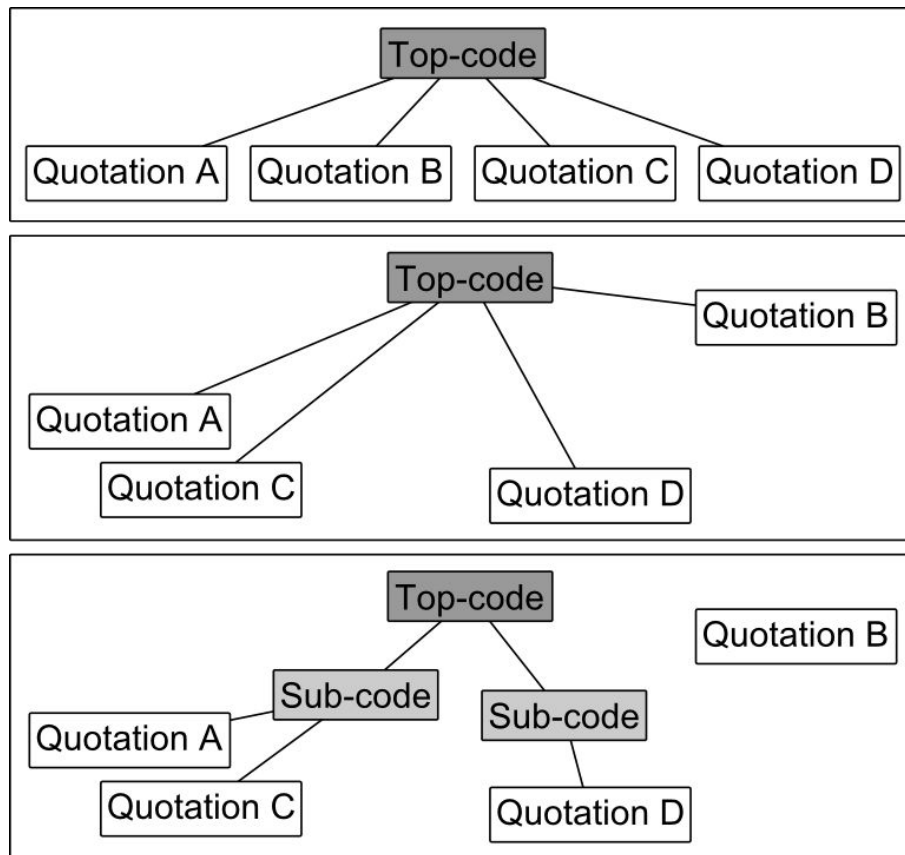
Figure 4: Differentiation of code system using "visualized code maps"

4. Phase: Revision of code system

The entire code system was revised after each interview by verifying each code and quotation. Moreover, a third-party revision with the developer of the AZIA was implemented after the first interview as well as an information exchange on further evaluation procedures. The final code system was reviewed upon consultation with the supervisor of this research project. Therefore, the analysis features a precise evaluation of the code system, implemented by specialist with different backgrounds.

5. Phase: Processing of results

In conclusion, a structured output of the entire analysis data was developed by creating a synthesis of each code using Z3 / Z4-rules [MAYRING 2008, P. 62]. A concise output of the relevant content of all selected interviews was provided by means of an overview of the code system and a comprehensive table of each code, which is not included in this paper.

4 RECOMMENDATIONS

4.1 TACKLING TRANSPORT PROBLEMS

4.1.1 ADAPT URBAN PLANNING PROCESSES

In the context of Brazil, a sustainable urban transport concept is enabled by providing equal access to urban space, prioritizing public and non-motorized transportation modes, and reducing urban sprawl, while this concept has to be in reconciliation with environmental sustainability.

In order to initiate a sustainable development of the megacity Rio de Janeiro, the urban planning process must be integrated with transportation planning and executed by a metropolitan agency which is responsible for the entire RMRJ for the definition of mobility corridors, infrastructure projects, and investments. Thus, this agency might be able to overcome short-time planning processes.

Hence, an independently growing long-time planning process – encouraged by the movement of the upcoming sports events in 2014 and 2016 – has to be enforced by this metropolitan agency, whose prime directive must be in accordance with the principles of sustainability. Then, urban planning processes will be able to focus on the inclusion of all social classes to implement the best urban design for poor people and create a balanced supply of transport infrastructure, so that everyone has the same opportunity of sound and seamless travel. Thus, the gap between rich and poor will not be further perpetuated.

Furthermore, Rio de Janeiro's urban structure has to be decentralized and urban transport infrastructure redesigned, so that people do not have to travel enormous distances to go to the city center. Instead of having one CBD, sub-centers with all urban facilities have to be created in every neighborhood. This reorganization can be implemented in accordance with the current restructuring of the city: Integrated BRT-stations with public and social services, for example kindergartens, hospitals, and shopping centers, can be built along the new BRT-corridors, as well as recreation areas, squares, and cycle lanes to revitalize the surrounding areas of the BRT-system.

4.1.2 RATIONALIZE CAR USAGE

In Brazil, urban mobility is characterized by a high need for motorized transportation based on a strong car culture within the Brazilian society and supported by the priori-

tization of the automobile by politicians and technicians. In order to rationalize the use of private motorized transportation, future policies have to encourage smarter mode choices by providing a general scheme of mobility, in which people can choose their best mode of transportation, regarding time, cost and distance.

Therefore, all three levels of government have to create conditions in which the use of private motorized transportation is disincentivized by making it more expensive. This can be achieved by means of restrictive fiscal policies, such as: 1) parking fees (distimulate free parking, charge for on-street parking, or higher prices for parking garages), 2) fuel- or vehicle taxes, or 3) a congestion charge. Likewise, more public funds can be directed towards public transportation, making it faster and cheaper than private motorized transportation.

This process has to be accompanied by a systematic reeducation for decision makers, planners and traffic engineers in Rio de Janeiro in order to change their mindset and improve technical capacity, clarifying that the goal is to move people instead of cars. At the same time, awareness building campaigns for citizens should be performed to inform people about the benefits of each mode of transport, the best mode for each type of travel, the real cost of the car, and the functioning of an integrated public transportation network. The citizens have to learn how to take smart decisions on mobility. In addition, pedestrians, cyclists, and car drivers should be motivated to share the road with each other.

Eventually, a paradigm shift from "owning a car" towards "access to mobility" has to be initiated in which car-sharing and car-pooling is seen as a part of the solution. Such a long-term approach can be initiated within condominium blocks or shopping centers, due to the high demand for these places by the middle class car users.

To ease the prevalent transport situation in Rio de Janeiro, the key objective for all urban transportation activities has to be the supply of a decent transport system, not for the upcoming events rather for the city, to maintain and increase the current share of public and non-motorized transportation.

4.1.3   REFORM THE PUBLIC TRANSPORT SYSTEM

The first step towards an efficient mass public transport system is to create an integrated metropolitan public transport network, consisting of all modes of public transportation (train, metro, BRT, ferry boats, cable cars, local buses, etc.). In such an integrated network, the BRT-system as well as local buses function as feeder lines for

the train or metro system which do not compete, rather complement the entire public transport system, similar to the already existing *metrô na superfície* (eng.: surface metro) integrated in Rio de Janeiro's metro system.

This network has to be designed and managed by a cooperative institution (transport association), deriving from the state and municipal government which also defines the system's service quality. The different public transportation modes have to be physically integrated with each other and should feature in the best case interconnected timetables with optimized transfer times. This metropolitan public transport network also depends on an integrated fare-system which enables easy transfers between all public transport modes with one single fare (daily / monthly tickets). In consequence of the vast differences in income of Rio de Janeiro's citizens, these fares have to be subsidized for the low-income class.

In general, Rio de Janeiro has to improve its existing public transportation system by investing in efficient, high-quality transportation which focuses especially on the needs of the car users (mainly middle class), so that these people gain a personal benefit (time, comfort, safety, reliability) and eventually shift back to public transportation modes. Thus, it is imperative to create a well-balanced system in which the capacity of each mode is equilibrated, so that overcrowded stand-alone solutions are avoided. Likewise, public transportation has to offer similar services, already known from chartered buses (air condition, wi-fi and newspapers), to provide a new utility of travel time for its users.

However, the most significant change will be accomplished by reorganizing the existing local bus system, due to the fact that it carries the highest share of public transportation users. This process consists of three incremental steps:

1. Improve the quality of buses by investing in low-floor buses and taking out turnstiles in buses which will enable easy and convenient entry and exit of passengers and simultaneously minimize station stop times.

2. Make the system more efficient by expanding the new BRS-system which will reorganize traffic flows, rearrange bus stops, and rationalize the number of bus lines.

3. Rationalize bus lines drastically by merging various lines into a single "Mini-BRT-corridor" which features exclusive bus lanes, high capacity buses, unique bus stops, and pre-paid boarding.

Moreover, Rio de Janeiro has to invest in useful information on the public transportation system in order to enable intelligent mobility choices. Such information is literally unknown for Rio de Janeiro's citizens. Thus, in order to make the public transportation system more understandable for the people, there has to be created an entire new system of information on public transportation stops featuring timetables, information on bus lines, expected travel times, and integrated route maps about the metropolitan public transport network.

The *MobiRio*[5] – an integrated map of the metropolitan transport network – is a first approach from the UFRJ towards an adequate system of information. Furthermore, real time information can be provided at websites or via smartphone applications, using the internet as a communication tool with the users. In addition, mobility information can be disseminated throughout society by means of social networks, enabling real time support by friends or other users.

In addition, the benefits of this new system, such as shorter travel times and the new utility of time, can be promoted by adequate advertisements, for example via *telenovelas* (eng: soap operas), reaching the entire country and eventually creating a new reputation of public transportation within Brazilian society.

4.1.4 PROMOTE NON-MOTORIZED TRANSPORTATION

In order to tackle current transport problems of Rio de Janeiro, the promotion of non-motorized transportation is indispensable. In respect of the high share of pedestrians and the great potential of cycling within Rio de Janeiro's society, a paradigm shift must be performed towards the use of non-motorized modes of transportation as a daily mobility alternative.

In general, solutions have to be developed neighborhood by neighborhood, due to the vast differences in between them. Good quality non-motorized transportation infrastructure has to ensure a safe, pleasant, and clean environment, while a maximum speed of 30 km on residential streets produces safe and comfortable conditions for pedestrians and cyclists. Therefore, existing streets have to be redesigned and new streets planned in accordance with a standard sidewalk policy, enabling a uniform design, and taking into account the responsibility, deriving from the high share of pedestrians. In any case, the condition of sidewalks has to be improved by removing holes, making them free of obstacles, and ensuring a certain standard surface.

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5   More information available online at: http://mobirio.poli.ufrj.br/

Cycling should be promoted by implementing infrastructure which focuses on the local demands of short trips. These measures can be interconnected with each other in order to build a complete bicycle network throughout the city, creating fast and direct connections. This infrastructure has to ensure a safe and comfortable environment for cyclists by means of good bicycle parking facilities, adequate pavement markings and shaded bike lanes. Moreover, specific demands, for example at train stations, should be identified and promoted by connecting these places to the existing infrastructure network in the surrounding areas which is especially important in the Western parts of Rio de Janeiro.

In general, technicians should think more systematically in order to promote the integration of non-motorized transportation with the public transportation system. Every public transportation user is also a pedestrian or cyclist, feeding the system. Therefore, non-motorized transportation modes play an important role in the mobility system, completing the group of ecomobile modes of transportation which was often neglected by Brazilian technicians in the past.

Thus, it is important to create good access for non-motorized transportation modes at public transportation stops by means of sidewalks and bicycle lanes, equally considering the needs of handicapped people. Such infrastructure investments should initially focus on a 1 km radius around every public transportation stop in the network. In order to promote intermodal mobility, it is necessary to implement good quality sidewalks with trees and illumination. For the upper class, it might be useful to meet their high demands in regard to security by means of public security guards.

Nevertheless, it will be difficult to change the image of cycling within Brazilian society. Showing to the people that they can use bicycles for everyday mobility by means of bicycle user groups, awareness campaigns, or even a public bicycle system, can achieve a change in their mindset. The people have to understand and see that it is possible to cycle with good cloths to work or to go to restaurants by bicycle. Brazilians, who went for example to Europe, started to cycle in Rio de Janeiro, because they saw people like them and thought that it is fashion. Such multiplicators play an important role for the promotion of cycling, because the lower class people intend to behave like the medium and higher classes. In fact, if people start to cycle more on Sundays by means of the public bicycle system SAMBA, they might be more attracted to cycle during weekdays and eventually creating a higher demand incrementally.

4.2   IMPACT OF SPORTS EVENTS IN RIO DE JANEIRO

The World Cup in 2014 and the Olympic games in 2016 are a landmark for the public transportation system in Rio de Janeiro, because the currently built infrastructure measures have been on paper for over 30 years. Unfortunately, these changes do not arise from an internal planning process, because the municipal government promised to improve its public transportation system in order to win the Olympic bid for 2016. Thus, after the city won the bid in 2009, it was rather forced by the external interest of the FIFA and the Olympic committee to implement the new infrastructure measures until 2014 / 2016.

Nevertheless, if Rio de Janeiro is able to implement all planned infrastructure measures until 2016, it will create a comprehensive metropolitan mass public transportation network. In this network, the new BRT-corridors will function as a basis to integrate the already existing system by reorganizing local buses, rationalizing the number of bus lines, and implementing a new trunk and feeder system. This will change the entire design of the mobility as well as its philosophy from an isolated towards an integrated view. All these measures represent adequate approaches towards a sustainable urban transport concept which would have never been implemented without the pacemaker effect of the sports events.

However, the biggest concern is the integration of this infrastructure measures into the urban development. There will be no institutionalized and integrated urban- and transportation planning process which enables short, medium and long-term planning processes and includes social-economic issues. Moreover, the new infrastructure will not be useful for all citizens, because it mainly benefits the wealthy South zone instead of providing decent public transportation for the higher populated North zone. Furthermore, the new BRT-system will not be able to reduce car usage, because the projects include new road infrastructure for the automobile which will create even more automobile traffic demand. Hence, in the future it will be more and more difficult to rationalize the use of automobiles and provide a sufficient level of public transportation services, so that people do not migrate to private individual transportation.

In fact, the sports events will not be able to achieve an integrated sustainable urban transport concept for the megacity Rio de Janeiro, because several challenges for the urban transportation sector remain unsolved: First, the sports events will not be able to ease social exclusion by means of the new mass public transportation sys-

tem. Second, the true intention behind the BRT-system was to improve the road system, thus it does not entirely prioritize public transportation. Third, it does not reduce urban sprawl, rather promotes it by creating infrastructure in less developed areas with great distance to the city center.

However, it is the right time for this innovative process because of the currently ongoing process of the pacification of *favelas*, a higher income of the people, and the massive reformation of the city. In addition, there is a good relationship between the municipal, state and federal government and the mayor has the political acceptance. Likewise, the city has capable technicians at all involved institutions and they are willing to change the current situation which creates a perfect background.

Hence, the sports events have the potential to initiate the first step towards a sustainable urban transport concept, but it depends on the right guidelines and principles from decision makers and technicians in order to plan and enforce a long term sustainable urban development of the entire RMRJ and eventually improve the mobility for all people living in Rio de Janeiro.

5   CONCLUSIONS

In view of the World Cup in 2014 and the Olympic Games in 2016, the megacity Rio de Janeiro is going through an important change, offering a unique opportunity to tackle current transport problems and to achieve an integrated sustainable urban transport concept. Within the context of Brazil, this concept can be accomplished by enabling access to urban space, prioritizing public- and non-motorized transportation, and reducing urban sprawl, while this process has to be in reconciliation with environmental issues.

In order to achieve such a sustainable development of the megacity Rio de Janeiro, the urban- and transport planning processes must be integrated with each other and executed by a metropolitan agency. Furthermore, an integrated metropolitan public transport network has to be created, designed and managed by a transport association, deriving from the state and municipal government. In addition, the local bus system has to be reorganized in three incremental steps by improving the quality of buses, expanding the new BRS-system, and rationalizing bus lines.

For the promotion of non-motorized transportation modes it is necessary to develop solutions neighborhood by neighborhood. Existing streets have to be redesigned and new streets planned based on a sidewalk policy. Likewise, the condition of sidewalks has to be improved by ensuring a standard surface. Cycling infrastructure has to be implemented in regard to the local demands, incrementally building a comprehensive bicycle network. Moreover, cycling to train stations should be further promoted, in particular in the Western zones of the RMRJ.

Without doubt, the upcoming sports events are a historical moment in Rio de Janeiro's urban transportation history. Unfortunately, the new infrastructure measures do not arise from an internal planning process, but rather because the city was forced by external interests. In fact, Rio de Janeiro's future public transportation system has the potential to become a comprehensive metropolitan mass public transportation network, but the megacity will not be able to achieve an integrated sustainable urban transport concept.

In conclusion, future transport measures have to focus on the mobility behavior of the middle class, while ensuring a needs-oriented mobility for all social classes. Decision makers should concentrate on the three "I's": 1) Information which enables real transport mode choices through better information on public transportation, 2) Integration

which facilitates sound and seamless travel by means of an integrated fare system as well as physical integration, and 3) Inclusion which attracts more people towards ecomobile transportation modes. Eventually, a paradigm shift towards ecomobility is needed in order to enable a sustainable urban transportation concept for today's and future generations.

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