Booming Brazil Study Tour 2010

"Foundations for a Sustainable Future"

Final report

Colophon

This report is published by Booming Brazil, a committee of study association ConcepT. ConcepT is associated with the Department of Civil Engineering at the University of Twente, the Netherlands.

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Preface by Booming Brazil

Skyscrapers, stadiums, bridges, hydroelectric dams, universities and favelas. The Amazon jungle, Copacabana, churrascarias, cerveja and girls. How are these keywords related? Let's add some more and answer this question; contradictions, ambitious plans, sustainability and finally: new experiences. This is 'Booming Brazil' in a nutshell.

Finally the moment was there! On the 18th of September 2010, we were ready. Ready to head for Brazil! Everybody was curious, uncertain and excited. We as an organizing committee in particular. What to expect? Will everything go according to plan? How will the group behave? Worries disappeared after three weeks of traveling together, through such a beautiful country as Brazil. I'm proud to conclude that our study tour was big success!

The study tour was not only an organizational success. Also the research activities and supervision progressed without many problems. We visited many companies, institutions, organizations and universities during our stay in São Paulo, Manaus and Rio de Janeiro. We discussed our preliminary findings and questioned which role sustainability plays in civil engineering projects in Brazil. The Brazilians were eager to receive us and discuss the role of sustainability in their projects. We summarized our results and conclusions in this final report. Without prejudging our own conclusions, I could say that the Brazilians approach sustainability from another level. Wealth, economy, politics and living conditions have another dimension compared to the Netherlands. While we in the Netherlands focus on optimizing existing systems, the Brazilians first have to create them. This creates many opportunities for both Brazil as the Netherlands.

The leisure activities allowed us to experience the Brazilian life. We discovered both nature and culture. We experienced the Amazon on a two day jungle trip, had a great time in the vibrant nightlife of Rio and tried the Brazilian cuisine at São Paulo's hotspots.

Finally, I must acknowledge that all of this would have never been possible without the hospitality of all companies, institutions, and universities in Brazil, our financial sponsors, our university, and study association ConcepT. Special thanks for their contribution to this report are for our supervisors Eric van Berkum, Maarten Krol and Gerrit Snellink, and all participants. I would like to thank everybody who was involved in the organization, no matter in which way, for their contribution and support. They made our tour possible, it was an experience which we will never forget!

Muito obrigado!

Reinier Reijnhoudt
President study tour committee

Preface by ConcepT

Booming Brazil a Sustainable future for ConcepT

The world is changing. Demands of consumers grow skyhigh, but earth has her limits. The last decades people realize that we should take care of our world and not use all our resources. The western countries try to take care of sustainability, but how are developing countries thinking in this respect? This is important, because countries like Brazil may be the leading nations of the future.

Brazil is one of the fastest growing economies in the world, how do companies, universities, and governmental bodies in Brazil think about sustainability? A big group of civil engineering students asked themselves the same question. They went to Brazil to find out if companies help to create a sustainable future. Six students took place in the study tour committee of study association ConcepT. Not only did they organize this trip to companies in Brazil, they also arranged education for all 27 students before departure. This final report contains company reports from the visits in Brazil and the final studies conducted.

Every second year a new group of civil engineering students goes abroad. Last seven years ConcepT went to China, India, South Africa and Brazil. I'm really proud to see that every single trip we made became such a success. This year we even had to select a few students, based on their motivation and CV, because so many students subscribed to join this amazing trip.

The board of ConcepT was the homefront for this study tour. We read all the stories of this special trip. And we were available in

case of emergencies. It was very well organized and I can only thank the committee for making a dream come true for so many students. Thanks for making this happen.

All the stories of the participants have made me very enthusiastic about the study tour. I hope next trip will be as good as this one, I'll make sure I will personally join that one.

Ruben Langeveld
Chairman ConcepT

Preface by prof. dr. ir. E.C. van Berkum

The preliminary report of the Booming Brazil Study Tour 2010 showed that preparation of this tour has been considered a very serious job. In fact the Dutch consul in Sao Paulo did use similar words when we visited his home. He was sincerely impressed by the amount of work and also by the depth of this study of a country that he had begun to like a lot.

Indeed, Brazil as a country has all the features to host a group of students in Civil Engineering. Its economy is booming, many projects are ongoing, its population has a great spirit to move forward, and sustainability issues, which were a main objective of this tour, were tangible and could be witnessed in real life.

With these two observations, what could go wrong? Actually many things. Making appointments in Brazil has some other dimensions as in our country. Health and also crime are serious issues, which, without the necessary precautions, could potentially spoil a tour as this. And then, travelling with a group of 30 without too much privacy, sometimes without a lot of sleep or in a stifling heat could easily result in irritations which could emerge in some serious disputes.

Well, none of the above happened. All members of the group and especially the organizing committee have been excellent in all respects. I have had a wonderful time in Brazil, and the tour has been a great success.

Eric van Berkum
Professor Transport Engineering & Management, study tour supervisor.

Content


ORDEM E PROGR

Part I
About the Tour

1. INTRODUCTION

After visiting India, China and South Africa the study tour of study association ConcepT has visited Brazil this year. ConcepT is the study association of the department of Civil Engineering and Management at the University of Twente. The 'Booming Brazil' study tour is a project set up by a committee of 6 students studying civil engineering, and is a project that has lasted over a year. The study tour itself includes a 3 week stay in Brazil, where twenty-seven students and three academic researchers have visited companies, projects and universities related to civil engineering. We have visited Rio de Janeiro, São Paulo and Manaus. To facilitate this, students followed preparatory master courses and conducted research on the different aspects of civil engineering within the central theme. This chapter shortly introduces the University of Twente, Study association ConcepT and this preliminairy report.

The University of Twente is a research university that focuses on technological developments in a social context within an active knowledge economy. This focus is reflected in 22 bachelor's and 31 master's programs in the fields of engineering, social and behavioral sciences. Approximately 5.500 bachelor and 2.500 master students are challenged to look beyond their field's borders and to interact with other disciplines. This multidisciplinary approach stimulates innovation in science and society. The strength of the University of Twente lies in how it combines the sciences: design sciences, natural sciences, and life and social sciences. Studying at the University of Twente means acting entrepreneurial, thinking internationally and working across disciplines.

Study association ConcepT is an active association managed by students. ConcepT represents the interests of Civil Engineering students and employees at the University of Twente. It was founded in 1990 and has about 750 members, of which approximately 500 are still student. Throughout the year many educational and leisure activities take place. From excursions, study tours, conferences to publishing its own magazine 'ConcepTueel' and social activities like water-skiing or barbecuing. Approximately 100 active members divided over fifteen committees facilitate these activities.

This final report of the 'Booming Brazil' study tour contains the results of the study tour. Part I describes everything about the tour, like the organizing committee, the supervisors, the participants, a travel report and research set up. Part II summarizes the visits to projects in Brazil and part III contains the results of our research conducted during the study tour. Part IV concludes with a description of our partners, which made our study tour possible.

2. PEOPLE

In this chapter we will introduce all travellers to Brazil, starting with photo's and short facts of the committee. Then the same information about our participants. This chapter concludes with a short contribution of each of the supervisors.

2.1. Committee

Name: Reinier Reijnhoudt
Function: President
Date of birth: May 23, 1987
Specialization: Construction management & engineering

"This is my fifth year at University of Twente. Currently, I am studying to obtain a masters degree in Construction Management and Engineering. I grew up in Westkapelle, a small town in Zeeland. After secondary school, I left the Netherlands to explore the beautiful country Norway. After my return, I moved to Enschede, where I live for four years now. Next to my education I started to organize excursions, lectures and courses related to civil engineering. I also and organized the yearly symposium of ConcepT. This was a good preparation to become president of the study tour committee. Something which would stimulate my personal development and enhance academic skills even more.

As the president of the committee, I was responsible for the study tour project as a whole. With this leading and coordinating role, my task was to keep up with the schedule while staying on the right track. During the tour I represented our university and study association. Organizing this tour both challenged and enhanced my personal and emotional skills. Besides the study tour as a serious activity, I also enjoyed organizing it. We had a lot of fun together, both in Brazil and during the preparations. In the end, Niels, Kees, Léon, Thijs and Stephan, and I organized a very successful study tour. It enabled every participant to expand his knowledge and academic skills, while experiencing a new culture and having lots of fun. I think we can be proud of our achievements!"

Name: Niels Vossebeld
Function: Secretary and treasurer
Date of birth: October 07, 1987
Specialization: Construction management & engineering

"Last year we as study tour committee members worked together with a lot of people to conduct research and organize our study tour to Brazil. For us this report reflects a major experience. An experience we will never forget. Experiences that helped us to learn a lot. Just to illustrate, during the organization I learned: how to budget and financially control quite a project; how to make a website; and how to communicate to a group of participants. During the studies I learned a lot about Brazil, especially about social sustainability. But, with our committee, we experienced many more things, because: we e.g. promoted our tour; we had to select participants; and we travelled through a far away country with a group of 30 people (for three weeks!). I am very glad to have been part of the Booming Brazil study tour. Our tour would not have been possible without the help, knowledge, and/our resources of ConcepT, employees of the university (in special our school of Civil Engineering), sponsors, and previous study tour committees. They all contributed very much. Thanks!"

Name: Kees Morren
Function: Public relations commissioner
Date of birth: October 09, 1987
Specialization: Construction management & engineering

"During the preparation of our Study Tour, I thought a lot about how it would be to travel through Brazil. But before it was possible to visit Brazil, a country with extensive civil engineering projects, we needed support of Civil Engineering companies. This was my job. Many phone calls and company visits later, it became clear that we had enough support for making our Study Tour plans a reality. So on the 18th of September we travelled to Brazil with 30 enthusiastic people.

Once in Brazil, I was impressed by the diversity and the beauty of the country. One moment I was walking through cities like Sao Paulo and Rio de Janeiro, becoming aware of their constant need for change and expansion. The next moment I was navigating through the green bushes and rivers of the Amazone Jungle, becoming aware of the need to preserve all this beauty for the future generations.

The visited projects gave us a nice view of how Brazilians deal with future developments, both in urban and in green areas. In the end I think we can look back at a wonderful trip, filled with civil engineering and cultural highlights!

Special thanks to our sponsors, without their financial support it wasn't possible to go through all these experiences!"

Name: Léon olde Scholtenhuis
Function: Travel commissioner
Date of birth: October 28, 1987
Specialization: Construction management & engineering

"When I became part of the study tour committee in summer 2009, I didn't have a clear idea of what to do to get ready for September 18th next year. The date that seemed far away approached quickly, and before I realized, even Christmas holidays of 2010 passed by and everybody acclimatized to the freezing Dutch temperatures again. What happened meanwhile? Well, after more than fifty hours of committee meetings, dozens of phone calls with our travel agency, and hours of working on information packages we prepared the greatest study tour ever! Once in a lifetime experiences like walking in the middle of the Amazon Jungle, getting eye in eye with members of drug gangs in Rio, hanging out at the Copacabana, and hunting for caimans and piranhas are just a few examples. More importantly, we had the time to conduct our studies. We found out more about how Brazilians deal with inner city redevelopment, build sustainable stadiums, and take care of coastal sanitation problems. I think we can be proud of our work and can look back at a wonderful time. I hope you will enjoy this final report!

Muito obrigado to everybody who contributed to our study tour. You made it worth naming Booming Brazil!"

Name: Thijs Homan
Function: Excursion commissioner
Date of birth: May 10, 1987
Specialization: Transport engineering and management

"Starting in the spring of 2009 by applying for the study tour committee, the journey to Brazil took off. From the beginning I wanted to do something that was direct related to the three weeks of study tour on the other site of the world, so that's why I ended up being the excursions commissioner. Right from the start I set my mind on Latin America, so in the fall of 2009 I was very happy when we decided to go to Brazil! From that point on, the excursions of this study tour were the only things on my mind for an entire year. In May the excursions program was filled in and the micro study started, but that didn't mean my task was done, through the summer I was trying to arrange dates and places for the excursions. And then it was finally September 18th, the day of departure! In the following three weeks we have done and seen the most amazing things in Brazil. The study tour is definitely the highlight of my year and I am glad that I participated in this group that made the ConcepT Booming Brazil study tour 2010 an experience to never forget!"

Name: Stephan Meijers
Function: Research commissioner & Vice Chairman
Date of birth: April 10, 1988
Specialization: Construction management & engineering

"Having had the honor to experience this absolutely amazing Study Tour to Brazil this year, I find it difficult to write an introductory piece that would do justice to the trip. Organizing this trip to, and visiting Brazil was one of the most amazing experiences in my life, and this entire project has had a huge impact on my life both professionally as personally. Booming Brazil has changed my perception of Brazil and with it South America as a whole. I'm afraid that the trip has somehow infected me with a virus, constantly nagging in the background, urging me to return to South America and experience more of its amazing culture and beauty.

Together with an amazing group of dedicated committee members, I spent the last 13 months working on this project to ensure a smooth trip for all 30 travelers. We were successful in gathering the resources needed to organize this unforgettable tour to Brazil. However, I feel that we owe this for a large part to our willing participants, and that the committee owes everyone involved in the project a huge 'thank you'. Everyone willingly and actively participated in all the activities required to make Booming Brazil a huge success! Participants, for example, spent 100 hours each working for organizations in the Netherlands (most on the topic of sustainability) to ensure enough funds were available to make the trip at all! So indeed, a big thanks to everyone for your dedicated support. I sincerely hope that the tour has lived up to your expectations.

This final report is the culmination of a year's educative study from all participants, committee members, and supervisors involved in Booming Brazil. I hope you enjoy reading about our findings in this book, and hope it may stimulate you to travel to Brazil and experience an absolutely amazing country!"

2.2. Participants

The following students joined the Booming Brazil study tour.

Name: Allard Horstman
Date of birth: July 5, 1988
Specialisation: Construction process management

Name: Arno Bouwhuis
Date of birth: October 28, 1986
Specialisation: Construction management and engineering

Name: Auke Terlouw
Date of birth: April 29, 1987
Specialisation: Water engineering and managagement.

Name: Bart Boeschen Hospers
Date of birth: January 10, 1987
Specialisation: Construction management and engineering

Name: Bart Leferink
Date of birth: August 26, 1988
Specialisation: Transport engineering and management

Name: Bart Wolbers
Date of birth: Januari 10, 1988
Specialisation: Construction process management

Name: Bert Lankheet
Date of birth: January 31, 1988
Specialisation: Construction management and Engineering

Name: Ferdinand van den Brink
Date of birth: April 14, 1988
Specialisation: Water engineering and management

Name: Hendrik van Meerveld
Date of birth: January 4, 1987
Specialisation: Construction process management

Name: Henk Barmentlo
Date of birth: September 23, 1988
Specialisation: Transport engineering and management

Name: Jeroen van der Meer
Date of birth: February 7, 1985
Specialisation: Construction management and engineering

Name: Jeroen van Vliet
Date of birth: November 16, 1987
Specialisation: Construction management and engineering

Name: Joël Meijers
Date of birth: June 26, 1988
Specialisation: Transport engineering and management

Name: Joey Willemsen
Date of birth: June 20, 1988
Specialisation: Transport engineering and management

Name: Julieta Matos Castaño
Date of birth: December 4, 1983
Specialisation: Construction management and engineering

Name: Mark Roelofsen
Date of birth: July 26, 1987
Specialisation: Transport engineering and management

Name: Niek Rolink
Date of birth: July 20, 1987
Specialisation: Transport engineering and management

Name: Peter Schoonderbeek
Date of birth: July 30, 1987
Specialisation: Construction management and engineering

Name: Rik Goossens
Date of birth: December 7, 1987
Specialisation: Construction process management

Name: Sander Dekens
Date of birth: May 16, 1988
Specialisation: Construction process management

Name: Tim van de Kruijs
Date of birth: June 26, 1987
Specialisation: Transport engineering and management

2.3. Supervisors

Below we intoduce our three supervisors.

Prof. dr. ir. E.C. van Berkum

Eric was born and raised in Hengelo (O) on the 27th of June 1959, not a particulary exiting or beautiful city, but interesting from a transport point of view, being an important node in the train and car network.

Figure 2.1: Prof. dr. ir. Eric van Berkum.

He studied Applied Mathematics in Twente and obtained a Bachelor degree with a specialisation in Discrete Mathematics and a Master degree with a specialisation in Operations Research and Systems Control.

His first job was as a software engineer at Cap Gemini. After some years he moved to a transport consultancy called Goudappel Coffeng in Deventer. There he became head of model development. In that same period professor Rudi Hamerslag started to work as an advisor to the company. Rudi was a professor in transport modelling at the Technical University of Delft. Also at that time Eric became involved in the European research project Eurotopp. This work later became the basis for his PhD thesis under the supervision of Rudi Hamerslag on the impact of traffic information on route and departure time choice.

In 1998 he became a part time professor in traffic management at the Transport group of Civil Engineering in Twente. At Goudappel Coffeng he was involved in many projects on transport planning and modelling, traffic management, traffic flows and software engineering. He was responsible for innovation for over the last 15 years. In 2009 he left Goudappel Coffeng and became a ful professor and also became the head of the Centre for Transport Studies.

His first trip to South America was in 1994 to Chile. In 2008 he visited Brazil for the first time. Main purpose of this trip was to visit the PhD project on personalized information for public transport in Brazil. This project is executed in collaboration with the Federal University of Rio de Janeiro by Warner Vonk, a former student who is currently living and working in Rio de Janeiro. During this trip he started to love the country and the people of Brazil, mainly because of their positive and open attitude towards life.

Figure 2.2: Dr. ir. Maarten Krol

Dr. ir. M.S. Krol

Any route is allowed to get to Brazil.

Writing these words with the world championships soccer right ahead, few lines easily do to explain why our destination is popular. Brazil is by far our favorite foreign country, when it comes to soccer. And Germany is least appreciated by us. This makes my personal route to get to Brazil quite peculiar: it was by first moving to Germany, to get to Northeast Brazil later.

Northeast Brazil has some of the most beautiful beaches of the world. Living in Fortaleza in 1999, I spent many weekends in amazing sceneries of dunes, lagoons, palm beaches, mangroves. Cheerful people around, never in a hurry, tanned bodies, soccer, cold beers and loud samba music. After one year, it was hard to leave Brazil, but how did I end up there?

After finishing my PhD in Utrecht (applied mathematics), I wanted to see more of the world, but rather by looking for a job abroad than by making a world travel. First I gained experience in working for Dutch research institutes (RIVM, TNO) on climate change and its impacts. When I had the opportunity to work on a project on climate change and drought in Brazil, I did not hesitate, even when this involved working 6 years in Germany to spend one year in Brazil. Back in Germany, my colleagues didn't mind me cheering for Brazil when they played Germany in the final of the 2002 world cup soccer.

Brazil has various typical ways of dealing with problems that is much different from ours. First of all, Brazil likes to think big in solving problems. Concerning water this means: huge dams, large scale interconnections of basins. These big solutions make sense: the country and the space available are huge, the availability of natural resources hardly a limitation. Secondly, Brazilian people are used to having to solve problems themselves and organize in their communities or on their own property. The few very rich are fully able to arrange for themselves; the many poor have experienced that problems are often beyond the control of authorities, and try to make small scale arrangements.

For me, either way of resolving water management problems is relevant and very interesting to study. Over the last years we had various BSc, MSc and PhD projects on these topics, focusing on hydrology, using remote sensing, or modeling water use, often in collaboration with colleagues in Brazil.

This study tour is yet another unexpected way to get to Brazil, to see its beauty, its development and water management and be inspired.

Ing. G.H. Snellink

Gerrit Snellink was born in Arnhem. He was married 25 years ago and has two kids. He studied Civil Engineering at the University College in Arnhem (HTS). After his military service, he started working at Witteveen + Bos in Deventer on the project Woensdrecht. For this project, an entire village was designed from scratch. The village was meant to house American military personnel who were stationed in the Netherlands for the maintenance of a nuclear rocket base. Due to the fierce resistance of the Dutch against the nuclear rockets, this village was never completely built.

Figure 2.3: Ing. Gerrit Snellink

At the same time, Gerrit followed the HTI in Amsterdam to become an expert in concrete and steel structures. After his work at W+B, he switched jobs and started working as a structural engineer at the company JVZ in Deventer. Among others, he started up working on design projects with AutoCAD (version 2.4). For his next employer, Technosoft in Lochem, he made an AutoCAD application in the programming languages lisp and C to design steel structures.

W+B asked Gerrit to return as structural designer. After several projects, such as some new air force restaurants and the redesign of the Deventer hospital, the software department of W+B asked him to join their development team. In that team, a load generator based on the Dutch building regulations was developed for structural frameworks.

Since 1994, Gerrit works for the University of Twente and teaches the courses in Mechanics I,II & III, Civil Material Science, Design Project Building, Sustainable Building. In addition, he is also the Bachelor thesis coordinator for the discipline B&I.

Due to his professional background, he likes functional structural designs, with wise use of materials.

Therefore, he is very interested in the way Brazil handles the coming events (the Olympic Games 2016 & the World Cup soccer), for which a great part of Rio will be rebuilt. How will this affect the differences between poor and rich? How to deal with the interests of the local population while protecting the rain forest?

Gerrit likes to play all kind of sports. He was handball keeper for UDI-Arnhem (that time 1° division). Now he plays hockey in the veteran-competition. The most challenging sport he practices is paragliding. Unfortunately, he was unable to find the possibility to make some flights near Rio with a landing on the Copacabana….

3. THEME AND COUNTRY

This chapter shortly introduces the theme of this study tour. Then it continues with basic information about Brazil. See the Macro study for more information regarding brazil.

3.1. Theme

Nowadays, it's almost inevitable to ignore the human impact on the environment. Last years' climate conference in Kopenhagen emphasized the importance (as well as difficulty) of creating policies to deal with climate problems. However, a developed country as the Netherlands tends to forget that the care for conservation of natural resources is also fed by discussions related to economic and social development. This people, planet and profit discussion is very current in developing countries. This led to the definition of the study tour's theme:

'Foundations for a Sustainable Future'.

3.2. Country

We think Brazil is the best country to research sustainability in a booming country. Brazil is named one of the BRIC countries, which means that it is a fast-growing developing economy with enormous potential. Besides that Brazil is the host of the FIFA World Cup 2014 and Rio de Janeiro is the host city of the Olympic Games of 2016. This all together makes Brazil booming! The country covers nearly half of South America and is the continent's largest nation and the fifth largest nation in the world. The total area of the country is about 8,500,000 km2, and borders every nation on the continent except Chile and Ecuador. It is also the only Portuguese speaking country on the continent. Its population is about 190 million. Brazil is a country currently enjoying enormous economic growth and is fast becoming one of the most important economic powers in the world. Yet the country still suffers from a large variety of economic and social problems such as an enormous wealth disparity, corruption, and environmental issues such as heavy deforestation of rainforests and pollution. This leads us to the question how the country is currently dealing with these issues and is preparing for a sustainable future.

Figure 3.1: Contour and flag of Brazil

History

Brazil is the only Latin American nation that derives its language and culture from Portugal. The native inhabitants mostly consisted of the nomadic Tupí-Guaraní Indians. Adm. Pedro Alvares Cabral claimed the territory for Portugal in 1500. The early explorers brought back a wood that produced a red dye, pau-brasil, from which the land received its name. Portugal began colonization in 1532 and made the area a royal colony in 1549. Following more than three centuries under Portuguese rule, Brazil peacefully gained its independence in 1822, maintaining a monarchical system of government until the abolition of slavery in 1888 and the subsequent proclamation of a republic by the military in 1889. Brazilian coffee exporters politically dominated the country until populist leader Getulio Vargas raised to power in 1930. Brazil underwent more than half a century of populist and military government until 1985, when the military regime peace-

fully ceded power to civilian rulers. Exploiting vast natural resources and a large labor pool, it is today South America's leading economic power. Today's president Luís Inácio Lula da Silva, who was elected in 2002 and re-elected for 2006 till 2010, brought Brazil finally its long-sought political and economical stability. But there is still much poverty and social inequity in the whole country.

Culture

The core culture of Brazil is derived from Portuguese culture; they introduced the Portuguese language, Roman Catholicism and colonial architectural styles. The culture was, however, also strongly influenced by African, indigenous and non-Portuguese European cultures and traditions. The indigenous Amerindians influenced Brazil's language and cuisine; and the Africans influenced language, cuisine, music, dance and religion. Brazilian cuisine varies greatly by region, reflecting the country's mix of native and immigrant populations. This has created a national cuisine marked by the presevation of regional differences. The national beverage is coffee and cachaça is Brazil's native liquor. Cachaça is distilled from sugar cane and is the main ingredient in the national cocktail, Caipirinha. Music is an important thing in Brazilian culture, with samba as the best known style. With samba automatically carnival comes up. Carnival in Rio de Janeiro is known worldwide for the elaborate parades staged by the city's major samba schools in the Sambadrome and is one of the world's major tourist attractions. In other regions such as Bahia and Pernambuco (and throughout Brazil), Carnival takes on a unique regional flavor. Carnival celebrations in Brazil feature locally-originating traditions and music. Sports are very popular in Brazil, the most notable being football. Football is a passion for Brazilians, who often refer to their country as "o país do futebol" ("the country of football"). Brazil is also the home of several sports which have become internationally popular, such as capoeira, footvolley and Brazilian Jiu-Jitsu.

Nature

Brazil's unparalleled natural treasures include not only the dense tropical rainforests of the Amazon that covers almost half of the country. On the west is the Pantanal, the world's largest wetlands. Northeastern Brazil is desert, with patches of tropical moist

Figure 3.2: Wildlife in the Amazon

forest on the coast. Southeastern Brazil hosts Atlantic rain forests, less well known than the Amazon but 20 million years older. The great Serra do Mar mountain range follows up much of the southeastern coast and inland north of Rio de Janeiro. Near the border of Argentina and Paraguay is one of the best known waterfalls of the world; The Iguaçu Falls which contains about 300 waterfalls. Given its awesome size, Brazil offers the opportunity to see many different ecosystems. The Amazon is the most well known treasure of Brazil. It is the most biodiverse place on earth. The Amazon River Basin harbors nearly one-third of the world's species and contains nearly one-quarter of the earth's fresh water. In addition to its wealth of discovered and undiscovered flora and fauna, the Amazon is home to many diverse traditional and indigenous human populations.

4. RESEARCH

In preparation for the study tour, all participants fulfilled an educative program with the main goal of preparing themselves for Brazil. With a focus on Sustainability, this educative program involved three different levels of study including a macro, meso and micro study. In this section, we explain the structure of this research. The entire research is summarized in the rest of the preliminary report.

4.1. Research objective

The theme for Booming Brazil is: "Foundations for a sustainable future." Following from the theme, the main objective of the study tour 2010 is:

"To develop a clear understanding of the role sustainability plays in civil engineering projects in Brazil and how this compares to the Netherlands"

We define sustainability in this context as the way in which the future is taken into consideration on economic, social, and environmental level, specifically within current civil engineering projects around Brazil. The three main areas of sustainability as the theory of the three P's (People, Planet, Profit, see figure 4.1) defines are the main subthemes throughout this research.

4.2. Goal of the tour

The main goal of the study tour to Brazil is to exchange knowledge between the participants working from a Dutch perspective with Brazilians working in Brazil. Participants prepared preliminary research in advance of the tour. In Brazil, we verified and expanded this research through discussions with Brazilian companies. This research is presented in this report.

The extensive preparation and the tour itself enable students to expand and deepen their knowledge and academic skills, and experience a new culture. All 27 students conducted the research, which was guided by a professor and two academic researchers of the Civil Engineering Department of the University of Twente. This research is a course valued at a total of 12.5 European Credits which students participating in the study tour have followed as a master course as part of the academic curriculum.

4.3. Research structure

The course was divided in three classes, each with its own goals and focus. The results of the studies on macro and meso levels of research have been published in our preliminary report, and the micro level of study is published in this report. The three levels of research include the following:

4.3.1.Macro

The macro study is, in essence, a study of Brazil in general. This focuses on seven subthemes including:

- Geography
- History
- National Politics
- International Politics
- Economics
- Socio-Culture
- Technology

The goal of this study was to compare Brazil and the Netherlands on each of these subjects, and formulate conclusions on the basis of this. These conclusions form the basis for meso level research.

4.3.2. Meso

The meso level research focused on various civil engineering sectors in Brazil and compares them to the Netherlands. Using a methodology called Porter's Diamond, participants analyzed the following sectors:

- Construction of Buildings
- Construction of roads, railways, and other utility and civil engineering projects
- Water engineering and management
- Land Transport
- Air transport
- Architectural consultancy and related technical consultancy

The conclusions drawn from these studies formed the basis on which participants could formulate project level research.

4.3.3. Micro

The micro level research is the most relevant, and most detailed research that the tour participants have completed. This level focuses specifically on a theme related to sustainability, which are linked to several projects that we will be visiting during the Study Tour. The six themes that we researched are as follows:

- The Olympics and World Cup: Future Perspectives
- Developing the Economy
- Contradictions in the Amazon
- Social sustainability
- Building the Oympic games and the world cup
- Improving life

The final results of this study are included in this report.

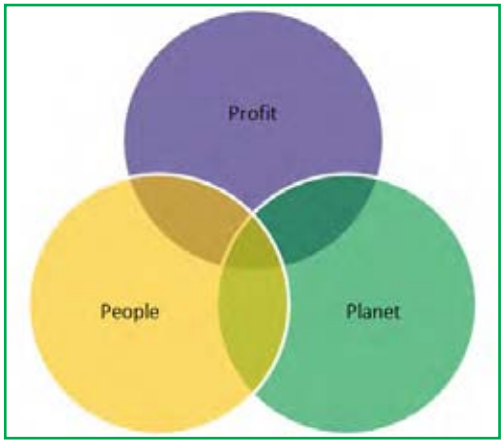

Figure 4.1: People, planet, profit

5. TRAVEL SCHEDULE

Below our travel schedule is depicted. This gives an overview of all our activities in Brazil. Since there were some adjustments from the initial plans, this table differs from the one published in the preliminary report.

Date	Part of day	Theme	Description
AMSTERDAM			
Sep. 18th **Saturday**	Morning	Travel	To São Paulo
	Afternoon	Travel	To São Paulo
	Evening	Optional	Spare time
SÃO PAULO			
Sep. 19th **Sunday**	Morning	Cultural	Guided tour
	Afternoon	Cultural	Competiçao de São Paulo
	Evening	Optional	São Paulo at night, Edificio Italia
Sep. 20th **Monday**	Morning	Excursion	Metro expansion project
	Afternoon	Excursion	Metro expansion project
	Evening	Optional	Spare time
Sep. 21st **Tuesday**	Morning	Excursion	ANTT High Speed Train
	Afternoon	Excursion	Consul-General & Business Reception
	Evening	Optional	Spare time
Sep. 22nd **Wednesday**	Morning	Excursion	LOGOS Engenheria: Coast San. Project
	Afternoon	Excursion	LOGOS Engenheria: Coast San. Project
	Evening	Optional	Spare time
Sep. 23rd **Thursday**	Morning	Excursion	INPE remote sensing Amazon forest
	Afternoon	Excursion	COHAB Renova Centro
	Evening	Optional	Spare time
Sep. 24th **Friday**	Morning	Optional	Spare time
	Afternoon	Cultural	University of São Paulo
	Evening	Optional	Spare time
Sep. 25th **Saturday**	Morning	Optional	Spare time
	Afternoon	Cultural	Museum Ipiranga
	Evening	Travel	To Manaus
MANAUS			
Sep. 26th **Sunday**	Morning	Cultural	Jungle Trip
	Afternoon	Cultural	Jungle Trip
	Evening	Cultural	Jungle Trip
Sep. 27th **Monday**	Morning	Cultural	Jungle Trip
	Afternoon	Cultural	Jungle Trip
	Evening	Optional	Spare time

Sep. 28th **Tuesday**	Morning	Excursion	Arena da Amazônia
	Afternoon	Excursion	INPA Balbina Dam
	Evening	Optional	Spare time
Sep. 29th **Wednesday**	Morning	Excursion	SEPLAN: Monorail and PROSAMIM
	Afternoon	Excursion	SEPLAN: Monorail and PROSAMIM
	Evening	Optional	Spare time
Sep. 30th **Thursday**	Morning	Excursion	Bridge over the Rio Negro
	Afternoon	Excursion	Bridge over the Rio Negro
	Evening	Optional	Spare time
Oct. 1st **Friday**	Morning	Excursion	Manaus Energia - Balbina dam
	Afternoon	Excursion	Manaus Energia - Balbina dam
	Evening	Optional	Spare time
RIO DE JANEIRO			
Oct. 2nd **Saturday**	Morning	Travel	To Rio de Janeiro
	Afternoon	Optional	Copacabana
	Evening	Optional	Samba!
Oct. 3rd **Sunday** *Elections*	Morning	Cultural	City tour: Corcovado, Sugarloaf
	Afternoon	Cultural	City tour: Santa theresa
	Evening	Optional	Spare time
Oct. 4th **Monday**	Morning	Excursion	Clean up of Guanabara bay
	Afternoon	Excursion	Clean up of Guanabara bay
	Evening	Optional	Spare time
Oct. 5th **Tuesday**	Morning	Excursion	Traffic and Transport plans
	Afternoon	Excursion	Facilities for Olympics
	Evening	Optional	Spare time
Oct. 6th **Wednesday**	Morning	Excursion	T5 Bus Rapid Transit Corridor
	Afternoon	Excursion	T5 Bus Rapid Transit Corridor
	Evening	Cultural	Football match
Oct. 7th **Thursday**	Morning	Excursion	IBISS Favela's
	Afternoon	Excursion	IBISS Favela's
	Evening	Optional	Spare time
Oct. 8th **Friday**	Morning	Cultural	University of Rio de Janeiro
	Afternoon	Cultural	Cycle tour with the consul-general
	Evening	Cultural	Closing Diner with consul-general
Oct. 9th **Saturday**	Morning	Travel	Official end of studytour
	Afternoon	Travel	To Amsterdam
	Evening	Optional	Start individual travels

Table 5.1: Travel plan study tour

6. WEEK REPORTS

We as committee asked our supervisors to each write a short piece to reflect on the weeks in Brazil in this report. First, mr. Krol will reflect on the week in the metropoiltan city of São Paulo. Second, mr. Snellink will reflect on the week in Manaus and the Amazon Jungle. Third, and last, mr. van Berkum will reflect on the final week in Rio de Janeiro.

6.1. São Paulo

the city that outgrew it's planning?

by Maarten Krol

To me, the most amazing experiences in our first week's visit of São Paulo were the unimaginable size of the city, and the absence of the feeling to have ever encountered "the city".

The size is impressive in the number of inhabitants and the landscape resembling a vast forest of skyscrapers. Somehow it appears that the city is autonomously growing beyond enormous dimensions, with city planning and civil infrastructure desperately trying to follow the development of the city, but not managing to keep up with that paste. We saw impressive traffic infrastructure, but with many elements that are badly connected. The city probably was never intended to grow to this enormous size, and projects tried combat urgent problems. Still we did meet attempts to envision an overall traffic system for the future and planning to approach such a future.

Frequently, we encountered tension between planning levels, e.g. in traffic management, and water quality management. Federal level, state level, metropolitan area, municipalities seem to all have their own goals, plans, and projects, with competition rather than coordination between levels. Maybe, this does relate to policies reacting

Figure 6.1: City centre of Sao Paulo

to the enormous paste of growth, due to preoccupation with large tasks at the individual planning level.

The basic impression I now have of São Paulo simply is it's enormous size. Many cities have specific sites to visit, icons; in São Paulo nobody knew what postcard to send home, next to pictures like the one above with dozens of skyscrapers. We did visit a nice museum, the town hall and opera house were nice to see, albeit in a deserted area, and the Avenida Paulista is the financial heart of Southern America; but we never had the impression to be in the city center. I remember Manaus for it's the city front at the Rio Negro and the theater, Rio de Janeiro for the Sugarloaf and the various neighborhoods at the beaches like Copacabana. São Paulo just offers the unimaginable size, in which you feel lost. No wonder that the Paulistas turn to make psychedelic graffiti!

6.2. Manaus

By Gerrit Snellink

In Manaus there were four different subjects:

- A boat trip followed by a jungle trek.
- Building site visits (2x)
- A visit of Seplan
- The Balbina dam (energy supply)

The jungle track through a nice part of the jungle was interesting. On the river, some alligators, dolphins and piranhas were seen. Unfortunately, probably due to the number of trees in the forest, animals were hardly seen. People, PLANET & profit.

The main subject during the site visits was sustainable building. The hosts mainly showed how they environmental friendly recycled and used their material. They hardly mentioned the way they took care of their staff: feeding, housing, education and for their relatives: family days.

PEOPLE, planet & profit.

At Seplan (the State Secretariat for Economic Planning and Development), the context of the already visited sites became more clear. Questions not important to the contractors, but for us the tip of the toe. It became clear that all state funded projects are more or less linked to a mayor or Governor, who is strongly supporting his projects. So, in this time of elections, projects are never sure if the next mayor or governor would continue it.

Figure 6.2: GPS route of Amazon trip

The EIA study (Environmental Impact Assessment) of the bridge over the Rio Negro, was very positive. The new bridge replaces the existing ferries between Manaus and the BR174 highway (to Porto Velho 900km). The conclusion was that the rainforest would not be infected by this road. Obviously the availability of an easily accessible part of land near a city of 2-million inhabitans, was not taken in to account.

The route of the Monorail (project of the state, build for the World Cup) is partially the same route as the BRT-line (a project of the municipality). Questioning how these systems would work together resulted in the answer: "we don't know yet, but we hope ...".

Philip M. Fearnside of the INPA had a sad story over the very controversial Balbina dam. This dam was established to provide a renewable electricity supply to the city of Manaus. The flat topography and small size of the drainage basin make output small. Vegetation has been left to decompose in the reservoir, resulting in acidic, anoxic water.

During the visit of the dam, the Eletrobras didn't have any reply on this story.

People, Planet, PROFIT?

During the visit of Manaus, I noticed a lot of energy consuming airco's to make the indoor climate comfortable (outdoor temperature 40°C; deltaT=+20°C). In the Netherlands the indoor climate is made comfortable by heating (deltaT=-20°C).

An important difference is the way of building. To avoid energy costs, buildings in the Netherlands are very well isolated. Double glazing, isolated roofs, solar heating systems. While in Manaus, there is just single glass, no isolation and even no water heating solar system. Just airco's.

Instead of building new hydroelectric dams, it would be an opportunity to investigate in the use of energy saving measurements.

6.3. Rio de Janeiro

By Eric van Berkum

Time flies, as we did. The 2nd of October, coming from Manaus, we landed at our final destination, Rio de Janeiro. Of all three we expected this city to reflect Brazil most. Sandy beaches, rain forest, nice weather, slums, crime, football, Olympics, discos and beautiful women. Wealso expected to find here many of the sustainability issues we were so eager to explore. The population is growing rapidly and also becoming increasingly wealthy, Booming Brazil is also Booming Rio.

Rio brought us everything we expected to find in Brazil. As it turned out, not everything was as well organized, as the official documents liked us to believe. Some of the visits were maybe different than expected, but we had become familiar enough with the Brazilian way of life to not be bothered too much by this.

The clean up of the Baía de Guanabara, the transport plans for the Olympics, traffic management in Rio, social aid in the favelas and a discussion on sustainability in the Federal University of Rio, all of these visits showed us that there still remains a lot of work to be done. However, the visits also showed us that sustainability is not only a buzzword in Brazil, but is taken seriously.

We have witnessed the problems in terms of water pollution by having a beer on the banks of the bay. The view on Pão de Açúcar was magnificent but the smell of the water

was appalling. The sewage treatment plant we visited may not solve the entire problem of water quality but will at least contribute to the solution.

We travelled in the evening peak to one of the important stadiums, Estádio Olímpico João Havelangeto visit a football match. We then witnessed what serious urban congestion means, and also how difficult it may be to solve or alleviate these problems in only six years from now. A decent Bus Rapid Transport system as was developed in Curituba may solve some of the problems to access Tijuca where many of the Olympic sport events take place, but in an urban environment with little extra space this may not be a feasible solution.

The main lesson learned in this trip is perhaps that problems may be evident, but since reality is often more complex than textbooks assume, solutions, often far from optimal, must always be viewed with this in mind.

An excellent example of this may be our final visit, where social aspects of sustainability were a major issue. We visited in a day tour all together three favelas. One may read about favelas, view a documentary or read a book or an article, but this day made us aware of what is actually going on in these slums. It was by far the most impressive day in the whole tour. The day after we were invited into the home of the Dutch consul. Indeed we received a warm welcome in his beautiful penthouse, with great views of Lagoa Rodrigo de Freitas, Ipanema and the famous statue of ChristoRedentor. Food was excellent, wine and beer were plenty, but many of our minds were with the people in the favelas.

Figure 6.3: Foto from our visit to the Favela


UFRJ
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Practical information

Part II
Company reports

1. EXPANSÃO SP: METRO EXPANSION SÃO PAULO

20-09-2010
Julieta Matos Castaño
Mark Roelofsen

Today we enjoyed our first company visit. We went to the governmental institution that takes care of the metro expansion project in São Paulo. In order to arrive at the office we took a metro line (line 2) that is subject to expansion itself. After a short and safe trip we arrived at the office and attended an interesting presentation about the whole project from the viewpoint of the public administration. The São Paulo metro system is currently 36 old and consists of 65 kilometers of rail tracks. Every metro line has to transport about 1 million passengers every day. Compared to other metro systems of similar age and demography, the São Paulo metro system is rather small. Therefore, an expansion of the system is needed.

The main goals of this expansion project are increasing capacity, linkage between lines and other modes of public transport and improving accessibility for low income groups. First of all, capacity cannot be increased anymore with current infrastructure. During the last years, the government has been boosting public transport usage to reduce kilometers travelled on the road. Therefore, new lines are under construction to provide a better alternative for private transport. Secondly, the railway system was not well integrated in the city because of a lack of linkage between lines. By building new integration lines, the formerly isolated lines were interconnected as an important step to close the metro network. In this new situation, the bus system will operate as a feeder for the metro stations. These systems will cooperate as one integrated PT system. These expanded metro lines will reach both high density employment areas and residential areas. As 6 to 7 million people need to travel from the outskirts to downtown daily, this expansion and integration will have a positive impact on their quality of life. Travel times are heavily reduced up to 25%.

Within this project, sustainability is a major topic. New technologies are adopted in order to consider energy savings and introduce environmental friendly building materials. For instance, one of the programs, called Estaçao verde, has the goal to develop new technologies to implement green stations. Furthermore, in collaboration with Brazilian universities, hydrogen busses are being developed. This fact shows that the government is currently investing in research and innovation to create sustainable infrastructure. Another sustainable aspect is the fact that from now on, new metro trains are produced in Brazil which creates more than 2000 qualified jobs. This is another step to reduce unemployment.

To gain insight in these innovations, we took a look at one of the major constructions sites. With the metro we went to the Luz station where a new connection hub is under construction underground. Here we realized that the São Paulo government is making serious efforts in improving sustainable transport. After this visit and excursion we learned about the key issues involved which will definitely contribute to improve our final report keeping the significant topics in mind.

2. ANTT: TAV BRASIL & DUTCH CONSULATE

21-09-2010
Rik Goossens
Reinier Reijnhoudt

2.1. TAV Brasil - ANTT

On the second day of the study tour the excursion to Agência Nacional de Transportes (ANTT) was on the program. ANTT is the national agency for transport and is concerned with traffic and transport topics in Brazil. Because the company's building is under construction, we were invited at the University of Sao Paulo. Here we got a presentation on the Trem de Alta Velocidade (TAV Brasil), a high speed rail link between Campinas, São Paulo and Rio de Janeiro. The presentation was given in Portuguese, so we needed the help of our supervisor Krol to translate. For which big thanks!

TAV Brasil is a big project with 510km of rail between the two economically most important areas in Brazil. Between São Paulo and Rio de Janeiro all transport is done by air, bus or car. To reduce the pressure on the transport system a new transport mode is necessary. For twenty years ANTT is studying the possibilities and design of a high speed rail link as in countries like France, Japan and Germany. They need this information from abroad, because till ten years ago there was no passenger transport by rail over such big distances at all in Brazil.

The main goal of the TAV project is to reduce emissions caused by busses and private cars. In the River valley, between São Paulo and Rio de Janeiro, and in the city centers these transport modes have little space for expansion. In total there will be 33,6 mil-

Figure 2.1: TAV Brasil representatives and our project group

lion transfers a year. Without TAV 14% uses air transport, 35% bus transport and 51% car transport. With the introduction of the TAV 7% will use air transport, 13% car transport, 26% car transport and 54% rail transport. Bus and air companies will not be compensated for loss of passengers, because the introduction of the TAV will reduce pressure on the existing system by generating more capacity and the demand will practically grow anyways.

The construction of the TAV the project has some challenges: the tunnel underneath Guanabara Bay: there is no space in Rio de Janeiro itself; a steep 800m climb from the coast to the highlands; mountain ridges with different geological conditions etc. In the future there are plans to expand the TAV to Curitiba and to Brasilia. It is even possible to connect the rail link to Belo Horizonte.

The project will be procured as an integrated contract. The concession will be a DBFMO contract with a lifespan of 40 years. The bid with the lowest price per kilometer will win the tender. After finishing the tendering and licensing process, the construction process will take about 6 years. The public investment will be 70% and the other 30% will come from private investors. In this project, the government is only responsible for land expropriation and the environmental assessment, 5000 families has to be resettled. Financial guarantees will be given by the government at start of the project. This will slowly decrease over the lifespan of 40 years of the project. Risks are accommodated in a legal construction; the only public risks are construction risks and the risk of not meeting the expected demand.

The public opinion about this project is mixed. People in São Paulo think the TAV project is a good thing, because it will boost local development. On the other hand they afraid that it will attract more passengers to city that's already too big, since transport from São Paulo will be much easier en quicker. People from Rio de Janeiro are positive about the TAV project. They think the introduction of the TAV will bring companies back to Rio de Janeiro who left the city after it lost his reputation as capital.

2.2. Dutch consulate

In the afternoon a visit to the Dutch consulate was on the program. In a very nice suburb of São Paulo, where each villa has its own security, we were invited in the backyard of Beatrix's residence. The Dutch consul elaborated on his job in São Paulo and his function as representative of the Netherlands. His function consists of personal affairs, like lost passports and prisoners, supporting Dutch companies settling in Brazil and improving trade relations between the Netherlands and Brazil. With great drinks and snacks there was a possibility to exchange more information about our tour and his work.

3. COASTAL SANITATION PROJECT: CLEAN WAVE

22-09-2010
Bert Lankheet
Stephan Meijers

Wednesday September 22nd we headed to Santos for the Coastal Sanitation project, we were invited by Logos Engenharia a Brazilian company that is owned by Arcadis, a Dutch consultancy company. Logos Engenharia is taking care of the clean wave program initiated by the state of Sao Paulo, goals of the project are to decrease the incidence of waterborne diseases, and so to improve the life of 3.5 million people living in the Baixada Santista Metropolitan area. Santos used to have a infant mortality of 33.7 per 1000 babies born alive, Sao Paulo state as a whole had a rate of 24.6. Main cause for this, was the pollution. Nowadays this is respectively 18.4 and 13.1, mainly deu to already implemented measures. The area is also benefiting from tourists who come for the beaches and the famous Mata Atlantica, as a result of lack of sewage beaches are polluted and unattractive for tourists going to this area.

The man giving the presentation worked at a technical institute at Delft, Holland. First we got a presentation of all activities that Logos has realized and is going to realize in Brazil. It appeared that the company worked in many different technical sectors, and they'd finalized quite a lot of big projects in Brazil. Logos Engenharia is mainly taking care of the project management in the various projects, as in Onda Limpa, the clean wave program.

Coming to this project, the project manager explained about the difficulties arising from the 'size' of the project, as the Baixada Santista Metropolitan area is 150 km wide. Therefore the company used several information systems to monitor the project. Technicians have to monitor treatment plants in this area. Largest challenge in this project was and is to convince people living in the poor neighborhoods to connect to the sewage system. The government and Sabesp use several promotional methods, as television and radio commercials to convince these people to connect to the sewage system.

The project is financed with relatively cheap loans from the Japanese organization JICA, because they want to support the sustainable development of the area. The total investment is R$1.9 billion, as a result the sewage collection index in Santos should rise from 53% to 95%, where all 100% of the sewage is at least being treated. The project manager assumed to reach 80%, but that new investments were needed to reach 95%. He thought it would take another 30 to 40 years to connect everyone in the area to sewage. The goal is reach 100% sewage collection, as if this is reached Sao Paulo will be the only Brazilian state to have this.

The next numbers of things being built illustrates the scale of the project:

- 22 sewage treatment stations
- 3 sewage preconditioning stations
- 149.000 new sewage connections
- 256 sewer pumping stations
- 3 submarine outfalls
- 1.500 new plumbing

Logos is responsible for the project until the pre-operation phase, they are not responsible for the maintenance.

4. INPE REMOTE SENSING & COHAB RENOVA CENTRO

23-09-2010
Ferdinand van den Brink
Bart Boeschen Hospers

4.1. INPE: Remote sensing Amazon deforestation

After driving two hours by coach, we reached the Instituto Nacional de Pesquisas Espacias (INPE), the Brazilian space research institute. The INPE consists of three areas, namely:

- Scientific
- Application
- Engineering

The institute deals with e.a. astrophysica, agriculture, environment and climate.

The presentation we visited was about the Brazilian Amazon Deforestation Assessment. Brazil has two major forest masses, the Amazone and the Atlantic forest. The orginal Atlantic forest has been deforested for almost 93% of the 1.5 million km² since 1850, mainly due to agriculture activities. Very rapidly the deforested land became unsuitable for intense agriculture, so more forest was torn down.

Since 1960 they started building roads through the Amazone area. This attracted small famers around the roads.

Since 1988 the INPE uses satellite images to check the rate of deforestation in the Amazone region. They have developed a tool called PRODES to compare satellite images to check if and where deforestation has taken place. In the beginning this research was done on a yearly basis. However deforestation did not declined and they had to develop a tool to check deforestation on a near real time basis. This tool, called DETER, has the ability to check deforestation every 15 days. This means that deforestation can be recognized in an early stage, so the local authorities can react directly. Furthermore, based on the new tool, a fine for deforestation has been introduced. This fine is set between R$ 1500 and 5000 per acre and the land may not be used anymore for agriculture, even the cattle will be removed from the piece of land.

Since 2005 till 2009 the deforestation rate dropped from 28.000 km²/year to 6000 km²/year.

Major problem when dealing with the control of the deforestation is the corruption of local authorities. Furthermore new hazards evolved around the roads through the Amazone that were built in the 60's. New plans have been made to construct roads to Bolivia and Peru, which enhances this effect.

The goal is to reach a deforestation rate that is around 80% of the baseline of 2000. This means that the goal is to reduce the deforestation to around 2000 – 3000 km²/year.

4.2. COHAB : Renova Centro

The presentation of the housing company of São Paulo (COHAB) took place in a conference room at the top of their office building in the middle of São Paulo, with a magnificent view at São Paulo. One of their goals is to unify the building types within the city. In order reach that goal they improve the different poor neighborhoods of São Paulo to a higher standard.

São Paulo is an ever expanding city which also expands into the environmental protected areas. To stop the city from expanding its borders, the growth should come from within the city center. To do so COHAB wants to revitalize the city center of São Paulo. The city center consist of mainly old and abandoned commercial buildings. The

Renova Centro project is one of the many projects that COHAB has initiated and also the biggest so far.

The main reason for the Renova Centro project is to lure people back to the city center in order to reduce the total amount of daily movements between the center of São Paulo and its suburbs. To get them back into the center, COHAB has selected 53 building that will be renovated to provide living space for these people. This also improves the living condition of the city center.

The selection of buildings has been done in cooperation with the FAUUSP (the faculty of architecture of the São Paulo university). The buildings are selected based on:

- Ocupation degree
- Databank information
- Juridical evalution (ownership and background)
- Construction (safety, conservation state)
- Architecture
- Economical feasibility studies

The property of the buildings is gained by negotiation with the owner of the building. If these negotiations fail, COHAB can use expropriation to gain the ownership of the buildings. The fast majority of these buildings are high rise buildings, because these building are the most suitable to house the apartments. In case they would rebuild a building instead of renovation it, the new building would have to comply with the new building code regarding to free surrounding area.

Many of these building are owned or inherited by people who don't have enough money to rebuild or renovate the building by themselves. Therefore the Renova Centro project is a good opportunity for them to sell their building to COHAB and let COHAB revitalize the city center. This has also a positive effect on the neighborhood.

The buildings are turned into small apartments, mostly one bedroom apartments and studio apartments. If possible, the current walls are kept in place to reduce renovation costs. If not possible, new walls are erected. All the new apartments have to meet the minimal safety requirements.

The renovation of the buildings has to be finished within three years. COHAB already has a database of around one million families that want to live in the renovated city center. "Gaining an apartment is almost like winning the lottery".

5. ARENA DA AMAZÔNIA & INPA

28-09-2010
Sander Dekens
Arno Bouwhuis

5.1. Arena da Amazônia

On the first day after our spectacular jungle trip a visit to the construction site of the new Arena da Amazônia was planned. The stadium will be constructed on the same location as the old stadium was located, next to one of the main roads of Manaus. The stadium will host several matches of the FIFA World Cup 2014 and this is also the main reason why the stadium will be constructed. The presentation was given by the project manager, Jose Antonio Grajeda Fernandes. Also several other representatives were attending the presentation.

The presentation was split up in three different parts. In the first part mr. Grajeda presented several facts about Andrades Gutierre (AG), the contractor that will construct the stadium. AG is a large construction company with over 30.000 employees and the focus of their projects is on roads and industry. In the second part he discussed the technical details of the stadium, like the roofing and the use of precast elements. In the last part of the presentation he presented some information about sustainability of the project and the aspects that were taken into account. The sustainability was about four different aspects of sustainability: Economical, Social, Cultural and Environmental sustainability. All those aspects were taken into account in the construction of the stadium. Several certificates were used to ensure the sustainability, like for example the LEED certification for environmental aspects.

After the presentation there was time to ask questions about the project and the sustainability of the stadium. Questions that were asked were mainly about the sustainability of the project. One of the questions was about the involvement of the stakeholders in the project. Mr Grajeda explained that before the construction project started a Public Audience was held in order that all people could give their opinion about the project. Other questions asked were about the sustainability with regard to the environment and the reuse of water. The main conclusion of the presentation and the questions asked was that the project seemed to be quite sustainable on all aspects.

When the question and answer-session was finished, we went to take a look on the construction site. Here we could see that the demolishing of the old stadium was almost finished. They had just begun with the foundation of the new stadium. After this tour we had a nice lunch in the company restaurant. This was the end of the excursion.

5.2. INPA: Balbina Dam

In the afternoon we went to INPA (Instituto Nacional de Pesquisas da Amazônia), a research institute which focuses on the Amazonia region. At INPA, professor Philip Fearnside provided us with some insights he gained with his research on the Balbina Dam. In his research he had analyzed (several documents from during) the design and the decision making process. These documents showed that some mistakes have been made in the design, resulting in for example a lower capacity to generate electricity and devastating effects on the surrounding nature.

He elaborated on the (negative) impact the Dam had on the environment. Behind the dam a flat area turned into a large reservoir, where trees couldn't survive. Because the trees weren't removed before this reservoir was filled, an enormous amount of greenhouse gasses were formed. Also the fish production in the river dropped. He further

mentioned that the international community agreed with the construction of the Dam, because large international companies provided equipment.

An important thing mr. Fearnside told was that there are several lessons that could be learned from this (and other) Dam(s). However, he has some doubts about whether these lessons are learnt or not. In for example, the new dam (the Belo Monte Dam), which will be built in the near future. Overall he gave a very clear and well-argumented presentation about the dam, its decision making process and the impact it has on the environment.

Questions we asked were about whether or not he thought the dam had advantages. We think he was clear about that: this one doesn't. On the other hand it also makes no sense to remove the dam, because the damage is already done.

6. SEPLAN: MANAUS MONORAIL & PROSAMIM

30-09-2010
Hendrik van Meerveld
Joël Meijers

Today, we had the opportunity to visit SEPLAN, (Secretaria de Estado de Planejamento e Desenvolvimento Economico) where we would first have the presentation of two projects where SEPLAN is involved with: Manaus Monorail and the PROSAMIM program. It is interesting to note that SEPLAN is also involved in two other study tour related projects: the Arena Amazonia and the Rio Negro Bridge, but the morning of the 30th of September we had presentations on the Manaus Monorail project and the PROSAMIM program. After a lunch we would had a tour and site visit by coach.

6.1. SEPLAN – Monorail

The following describes the most useful information gained at the presentation and the Q&A session at SEPLAN for the Monorail of Manaus.

SEPLAN is a state organization. It is planning to construct a monorail, which is part of the transport plan for the Fifa World Cup in 2014. The current BRT system of Manaus (which is of very poor quality, because of bad maintenance, bad information system and hard to access stations) will be upgraded, so it connects to the monorail. However, this is a plan of the municipality and thus not of SEPLAN.

Why a monorail?

The monorail was chosen out of a set of four possible option: a VRT system (light rail, trams), a BRT system and a monorail.

The metro was not chosen because the construction and maintenance costs are too high. The main point why the VRT was not chosen is the visual damage the necessary infrastructure would bring to the center of Manaus. The capacity of the system was also too limited and the system would not fit well in a city where the driving style is fairly aggressive (so many accidents would occur). The main reason why the BRT was not chosen is that such a system would take too much dedicated space. A BRT must have exclusive driving lanes, which means shutting off lanes for cars in an already very congested city network.

A monorail can, however, operate above the current driving lanes for cars. Only while constructing the monorail, one lane needs to be shut down. Visual interference is also lower because the monorail is high above ground level. The capacity is also medium to high, which makes it fit with the demand forecasts by PriceWaterHouse (expert in economic aspects of systems). These are a few of the reasons why the monorail was chosen.

The monorail

The monorail will have the same route as most of the main bus lines today. The monorail system is also expendable in the future, but will not be extended over the Rio Negro in the south. The monorail will be situated above the flower beds and one lane needs to shut off during the construction. Phase 1 and 2 of the construction will be ready in respectively 2013 and 2014. The operator still needs to be found (there will be an open tender soon). The maximum ticket price will be R$3,50 for a combination ticket for the monorail and BRT. This price is not more expensive than the current public transport, which means even the poorer families can use the system.

Planet

The electricity will be generated with natural gas, which will reach Manaus through a pipeline which is being constructed. The ‘fund’ which plays an important role in the promotion campaign of the monorail, is an

already existing 'reforestation' fund called RED. Part of the ticket price is donated to this fund.

Land use

SEPLAN believes the monorail will improve and increase commercial activity around the monorail stations (especial around the stadium and downtown). There are no plans to develop these areas. According to SEPLAN, the private sector will take care of this. Possible land use changes around stations did not play any role in choosing the locations of the station.

6.2. PROSAMIM; social sustainability

The second presentation of the morning was about PROSAMIM. Before this visit - during the visit of the Arena de Amazonia - we met the former project manager of PROSAMIM José Antonio Grajeda Fernandes, he spoke very highly of the program. The representative today provided a presentation concerning the problem definition/history of the program and about the current developments of the program. The basic, but very apparent problem of the water bank settlements in Manaus are a result of the growth of Manaus that has not been accompanied by the necessary investments in land use policies and infrastructure. After 30 years of neglecting the state finally designed an elaborate plan to solve this problem: PROSAMIM.

The program (PROSAMIM I, II and a supplementary project) will ultimately help 580.000 people, which is ~32 % of the population of Manaus. The program is aimed to improve the living conditions and quality of life drastically in a total of 33 Iguarapés (small streams that run through Manaus). People living here, mainly with very low incomes, are provided with (new) houses that will replace the informal settlements. After completion, there are parks, sanitation, protection against flooding, and so on. One of the most important aspects is the institutional sustainability of the program that insures success of the program. Institutional sustainability is provided by environmental education of the people and the high level of community participation.

Our questions mainly concerned the financing of the project and methods and policies to prevent the (re)creation of the informal settlements. On financing we asked how the benefits of the program were taken into account, the PROSAMIM program will generate savings (health, actions against pollution etc., and also increase the overall quality of wealth). According to the PROSAMIM representatives the benefits will be worth the investment, although they did not present any numbers. They further mentioned that financing PROSAMIM is no challenge for the state so the programme can proceed without running into financial difficulties.

Concerning recreation of settlements they stated that they do several things to prevent this. People living in the recreated areas e.g. attained ownership of their new dwelling, but are not allowed to change anything to their house; making it impossible for 'new' people to claim land in these new neighbourhoods. Not allowing people to change their own dwelling is a fundamental postulation, most small scale houses in Brazil are continuously changed by their owners; it is a demand contrary to the Brazilian housing culture. One of the most important aspects mentioned was that the program was considered a success by almost everybody, the government, the financial institutions, and the population. The state of Amazonas e.g. received an award for sanitation management for the results of the program during the 2010 World Water Week congress. This positive image helps for future investment;

the main financing institution, IADB, already supports future phases of the PROSAMIM program. The program's success also easies participation of future people involved, although, during the question round the representatives of PROSAMIM indicated that one of the main concerns for the future of PROSAMIM is its own success; many citizens of slums/Iguarapes in Manaus demand the government to apply a PROSAMIM program on their neighbourhood more swiftly.

Later that day we had the opportunity to see one of the new parks and one of the new neighbourhoods. What this visit showed that PROSAMIM really constitutes a major improvement in living conditions. But also clear was that old habits die hard. People still tend to throw garbage on the street for instance. Luckily, there is a continuous effort in education these people and to ensure that problems of the past stay in the past.

7. CAMARGO CORRÊA: BRIDGE OVER THE RIO NEGRO

29-09-2010
Allard Horstman
Joey Willemsen

This morning, the bridge over the Rio Negro in Manaus should be visited. However, due to a tragic accident at the construction site that morning, causing the death of one employee, the excursion was cancelled for that moment. Because of the great effort of the construction firm, we were nevertheless able to visit the company in the afternoon. Our condolences go out to his family, friends and colleagues.

The bridge over the Rio Negro is the first bridge over Amazon / Rio Negro in the far neighborhood of Manaus. The bridge is 3.595 m long and connects Manaus to the smaller municipalities south of the river, such as Iranduba, Manacapuru and Novo Airão. Nowadays, the main transport mode to cross the river is the ferry, but the bridge provides a 2x2 highway to the other bank. First, we were given an elaborate presentation on the bridge itself and the construction of it. This was done by two engineers of the construction department of Camargo Corrêa, which is one of Brazil's biggest private conglomerates. The presentation started with the main goals of the bridge, after that they elaborated on the requirements, subsequently the characteristics were presented. Then, the phases of the construction were shown. The presentation ended with the general benefits of the project. Other benefits besides the travel time reduction are an increase in employment during the construction, an improvement of the environment at the south of the bridge and an improvement of the growing tourism. After the presentations and the question and answer session, the construction site was visited. By bus, we went on a part of the bridge which was already built. Here, we had a good view on what was actually happening during the construction phase.

The questions that were asked during the question and answer sessions had mainly to do with the phases other than the construction, because the construction phase was clearly described during the presentation. Questions that were asked had to do with the relocation of the local population around the ramps of the bridge, the compensation for the losses of the ferry owners and the capacity of the bridge in the future. Unfortunately, these questions were not in the scope of the construction firm, but of the local government. However, they tried to answers these questions as good as possible. The, mainly poor, local population was moved to better houses. Ferry owners are not compensated for their income loss, which is the reason of their demonstrations over many years against a bridge. The bridge is built for the future and so the bridge is designed to fulfill in the demand for at least 20 years. With these answers, we gained more insight into the sustainability of the bridge.

We can conclude that the excursion was very interesting and helps us to complete our research about the sustainability of the bridge. The excursion ended with a nice photo of our group together with the representatives of the company, with on the background the astonishing sunset above the Rio Negro. We would like to thank the company for their useful information.

8. AMAZONAS ENERGIA: BALBINA DAM

1-10-2010
Bart Leferink
Auke Terlouw

Today we went to the Balbina Reservoir and the Balbina Dam. This dam is built in the mid eighties, during the military government. It was build to provide energy for the city of Manaus and the state of Amazonas. Nowadays the dam still produces energy, but is mainly known for its impact on the environment.

During our visit we got a presentation by the Amazonian department of the Brazilian electricity company: Eletrobras Amazonia Energia. The presentation was given by Mr. Milton, and was mainly about the technical achievements on the dam. He also gave us some general information of the energy supply in Brazil, like information about the changes in the national grid and the expected demands in the future.

At first, the technical details of the dam were presented. To produce kinetic energy, the water flow makes a free fall with a height difference of 22 meter. The water flows into five turbines. These turbines generate 50 MW each. So a total amount of 250 MW can be achieved. To provide potential energy the water level of the dam can reach 51 meter. At this level, the reservoir has a size of 2300km2. This lake contains about 3000 small islands which could improve the ecological value.

This dam is not the only dam constructed in the north of Brazil. The Nunes dam (close to Belem) has a capacity of 718 MW, the Samuel dam (in Porto Velho) 205 MW and the Tucurui dam in the Para state has a capacity of 8600 MW. The aim of Eletrobras is to connect these dams and create a national grid. The Amazon grid is separated from the main grid at the moment, but will be connected in 2014.

After the presentation we took a look inside the dam. After this, we sailed with small boats across the lake to see the impact of the dam on the environment. The lake was full of dead tree tops that were not cut before the construction of the dam. This is why the dam is world-renowned.

The day ended with a visit to a center that takes care of mistreated animals. This ecological centre is sponsored by Eletrobras.

9. CEDAE: GUANABARA BAY CLEAN-UP PROGRAM

4-10-2010
Ferdinand van den Brink
Bert Lankheet

Today we went to a sewage treatment plant of CEDAE to get informed about their activities and their in particular their role in the clean-up of the Guanabara Bay. José Maria Mesquita, responsible for the treatment plant, started with a presentation about the sewage treatment plant. In the afternoon a second presentation was given by Carlos Braz about the Guanabara Bay clean up programme.

During the first presentation the three steps of sewage treatment was explained. First a preliminary treatment is executed to filter out garbage which actually should not be in the effluent. Afterwards a primary treatment filters out oils and suspended material by slowing down flow velocities and removing floating and sedimented substances. Finally a secondary treatment is executed to further degrade oxygen demanding material. The degraded material is filtered out after sedimentation of the particles. The filtrate is flushed into a river and is much better in quality than the surface water surrounding the plant, i.e. the water of the Guanabara Bay. The banks of the bay were covered with a layer of all kinds of waste.

CEDAE considers itself as a company that cares about society, because it participates in various programmes. First of al, they use the residue of both the primary and secondary treatment is to obtain biofuel. Biogas is used for the electricity supply of the plant itself, while biodiesel can be used for other purposes. A small part is used as compost. Furthermore they participate in projects on the planting of trees and on resocializing of prisoners.

The treatment plant was the biggest of its kinds of Brazil. Furthermore, it is unique because usually the secondary treatment is not executed done if waste water is treated.

In the second presentation, the programmanager, Carlos Braz, again explained about the treatment process. After this he gave a short explanation about the clean-up program and about the progress of their engineering work. Their part involves the construction of a main sewage system that connects several locally existing sewage systems to the treatment plant. These local systems disposed of their effluent directly to the surface water. The system consists of 16 km pipeline at a depth of at least 10 meter below the ground surface. Part of it still has to be constructed. This has not been financed yet, but funding is already ensured by the government of Rio de Janeiro state before the Olympic Games.

Since the plant has been brought into use, the water quality of the bay slightly improved. However, it is uncertain whether this is due to the plant or due to other actions. The project mainly aims at the long term and is part of the arrangements for the Olympic Games.

During the presentation it appeared that CEDAE was only responsible for the sewage collection and treatment. They had nothing to do with the other activities concerning the clean-up. The leading party in the clean-up seemed to be the state government of Rio de Janeiro.

10. CET: TRAFFIC MANAGEMENT & MARACANÃ STADIUM

5-10-2010
Niek Rolink
Jeroen van Vliet

10.1. CET Traffic Management

This morning we arrived after a short bus ride at the CET Traffic Management company which is a part of the municipality of Rio de Janeiro. The people over here are busy with all the traffic and transportation issues that arise in the city. This entails designing new roads, public transport facilities but also traffic management, our topic of interest for today. We were expecting a presentation about the traffic management plan during the Olympics and the world cup for the entire city and the period thereafter. However they were not really prepared for such a presentation so instead they gave a presentation about the current situation around the stadium Joao Havelange.

The main issues addressed during the presentation were about the busy and very dense area around the Joao Havelange stadium. This results in various conflicts between the football stadium visitors and the existing environment and traffic. For example car traffic was heavily congested, pedestrian areas are way too small and public transport facilities lack capacity. Next to the infrastructure improvements they also thought about some traffic management solutions like promotion of public transport.

Afterwards we had a thorough and interesting discussion round in which we tried to gather more information about this project as well as the management situation in the entire city. Unfortunately we could not get much information about the management during the Olympics & World Cup and the management of the entire city. However we got some useful information, for example that people who have a ticket for a sport event (Olympics and World Cup) can use the public transport facilities for free.

10.2. Maracanã stadium

Unfortunately the excursion to the maracanã stadium was canceled by the people of the Maracanã stadium.

11. SECTRAN: T5 BUS RAPID TRANSIT

6-10-2010
Jeroen van der Meer
Bart Wolbers

Today we only visited one project, this took place in the morning when we went to the same municipal building as yesterday to visit the SECTRAN company which is the secretary of transport, which is a part of the municipality of Rio de Janeiro. Today we got a presentation about the T5 Bus Rapid Transit corridor.

The T5 BRT is actually called TransCarioca and is part of a multiple BRT corridor system and complementary bus lines. With these lines the most important parts of the city are covered by high quality public transport, BRT or metro. With this public transport system they want to keep the city accessible during the Olympic Games, the World Cup and the future.

During the long but very interesting question round some interesting topics were discussed. The private company which will operate the TransCarioca is obliged to the fixed ticket price during the concession time of 20 years. They also give an explanation about the choice for a BRT and that was mostly about the money, because a metro system is up to 10 times more expensive. Also electric and hybrid buses were too expensive but they will equip 20% of the buses with biodiesel, so these buses are more sustainable than the current busses.

We can conclude that they are about to implement an enormous public transport system that expands the current situation of already 8500 buses. This system should provide the necessary accessibility for the city. However the sustainability aspect of these plans is not as important as it is in the Netherlands. In this project we saw that money is the key factor in the decision making process.

12. IBISS: FAVELAS

October 7, 2010
Hendrik van Meerveld
Peter Schoonderbeek

12.1. Project 1: Terra Encantada

We were picked up at the hotel by Nanko van Buuren with two IBISS vans, which were important to be recognized by inhabitants of the favelas as guests of IBISS. Our first excursion took us to a fairly new favela, Terra Encantada, which was established about eight years ago on the premises of an old steel factory. The favela houses almost 3.500 people. After the founding of the favela, IBISS was asked by the inhabitants, who knew the organization from other favelas where they had lived, to start its work there too.

We were welcomed in a class room where IBISS provides breakfast for children before they go to school and where they give informal lessons to those who don't go to school. Here, we listened to a presentation by Sandro, a former drug boss from another favela who was converted by the IBISS program "Soldados Nunca Mais" ("Soldiers Never More") and was now an IBISS employee. He told us about the things IBISS was doing in the favela, while Nanko translated this and added more information.

At first, the favela had no water or electricity supply and it was not acknowledged by the government. Electricity was tapped illegally from nearby lines. Through negotiation by IBISS with the local power supplier, a formal electricity grid was built. This costs the inhabitants more money, but in return they get an energy bill which proves they have an address. As a result of this, they can show the government that they legally exist and that they need to be acknowledged. This will force the government to build more facilities, like health care, schools and waste collection. Because there is no formal water system yet, IBISS taps water from nearby water pipelines and stores in old tanks used by the factory. From here it is distributed through the whole favela with informal pipelines built by the people themselves with the assistance of IBISS.

IBISS employees especially try to keep the youth of the favela from getting involved in crime and drugs trade. The most effective way to do this is to talk to them informally and tell them about the dangers and drawbacks of a life as a gang member. This is rather effective, but they acknowledge that it is still very attractive for youngsters to get involved in this world of easy money. IBISS tries to develop new programs to offer them other attractive opportunities to keep them out of the gangs. IBISS is going to provide a lot of training for youngsters to get more skills which are needed to get a job, for example like teaching people to use computers, make music or weld optic fibre cables, for example.

After the lecture, we had a site visit in an old factory building in renovation, where IBISS is building music and film studios, a cinema and a computer room to learn to work with computers. The trip continued with a walk through the favela to show the simple measures that are implemented to try to enhance the living conditions in the neighborhood. One small example of this is the stimulate the building elevated doorsteps, to prevent the houses from flooding and to make sure that if the streets will be paved in the future, the houses will still be accessible. We also visited a bridge built out of scrap metal by our colleagues of the TU Delft. Nanko showed us the river that runs past the favela, which is used by the people to throw their trash in. He told us that IBISS tries to inform people that this habit is bad, because it leads to diseases and causes the river to flood the favela. This still does not work very well though, but they

hope to convert people to throw their waste away normally in the future

The trip through this favela showed us that, in contrary to our earlier beliefs, IBISS really does make use of civil engineering knowledge, like building enhancements and the planning of power and water systems. It is however not professionalized, but more informal and ad hoc than we are used to. The organization is still in need of more professional knowledge to increase their activities in the area of civil engineering. It is however becoming clearer how IBISS tries to handle sustainability, not only in the People branch, but also on the Planet (waste management, flooding prevention) and Profit (helping people to get profitable jobs, lobby for electricity and address acknowledgement) sides.

12.2. Project 2 Vila Cruzeiro

After lunch in a local churrascaria, which was founded with a micro credit provided by IBISS, the vans took us to one of the most violent favelas of Rio de Janeiro, Vila Cruzeiro. We brought a visit to the IBISS center here, which is a large cultural centre with sports and dance rooms, a swimming pool and a large football field. Inside the building, we got a short description about projects, like trainings in different kinds of sports, dancing, swimming and of course football. Inside the building there were also lectures given to learn people to read and write, to combat the analphabetism in the favela.

On the bottom floor of the building, IBISS provides free dentist and doctor facilities. Every few months, the University of Amsterdam sends a few Dental Care students to IBISS for an internship. This enables IBISS to provide this service for free to the inhabitants of Vila Cruzeiro.

During a short trip around the favela and a football match with local kids, Nanko told more about the sustainability of IBISS projects. The largest part of this is aimed at People, which are not only rescued from the world of gangs, drugs and an almost certain dead, but are also provided with better opportunities to build a life in or outside the favela. But IBISS also looks at the profitability of its own projects. Nanko showed us some clothes from the clothing brand "Soldier Ware" which was started by a few ex-soldados and is owned for 51% by IBISS. Other projects are for example a very famous percussion band, a rap group, a party centre with its own training school and a training project which helps people to excel in football and get a job at a large football club. These projects are ready to make profit, which could flow back to IBISS if they will experience money shortage in the future. Until that time, the profit is invested in the projects themselves, to expand them even further.

The excursion was concluded with a street barbecue on the edge of a third favela, together with some IBISS employees and local people.

Part III
Micro Study

Micro Study

1. THE OLYMPICS AND WORLD CUP: FUTURE PERSPECTIVES

Thijs Homan
Joël Meijers
Kees Morren
Niek Rolink
Jeroen van Vliet

1.1. Introduction

This micro study focuses on projects in preparation of the Olympic Games and Fifa World Cup in the cities of Manaus and Rio de Janeiro. Three traffic-related projects are studied. The first project is the construction of a monorail passenger system in the Amazon city of Manaus. The other two projects are situated in Rio de Janeiro and entail a Bus Rapid Transit system introduction and the traffic management plans during the two events.

Special attention is given to the "future perspectives" of these projects. This means the projects are not only evaluated on their usefulness during the events, but also on their long term value after the events. In other words: how sustainable are the projects really? Experiences from previous large-scale events have shown that transportation measures can be particularly strong and positive if the infrastructure and management measures are maintained properly (Bovy, 2004).

Before evaluated the three projects, a framework is set up which consists of a definition of sustainability, a study for similar project and an analysis of the current infrastructure in both cities. Chapter 1.2 shortly describes the definition of the term sustainability as used within this report. This results in some criteria which the project should fulfill in order to be sustainable. Chapter 1.3 and 1.4 are studies of respectively literature on similar systems (monorails, Bus Rapid Transit systems) and traffic related project for comparable events of the past. These chapters both lead to insights which can be translated into yet more criteria on which the three projects can be tested. Before finally looking at three projects themselves in chapter 1.6, the current infrastructure in Manaus and Rio the Janeiro are shortly discussed in chapter 1.5. The overall findings of our study tour research will be concluded in chapter 1.7.

1.2. Sustainability

The definition of sustainability, according to the book Our Common Future (World Commission on Environment and Development, 1987) is:"development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

There are many definitions about sustainability, in this micro study we focus on sustainability within the transport sector. The Council of the European Union's already formulated the following definition of a sustainable transport system:

- **People:** Allows the basic access and development needs of individuals, companies and society to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations;
- **Planet:** Limits emissions and waste within the planet's ability to absorb them, uses renewable re-

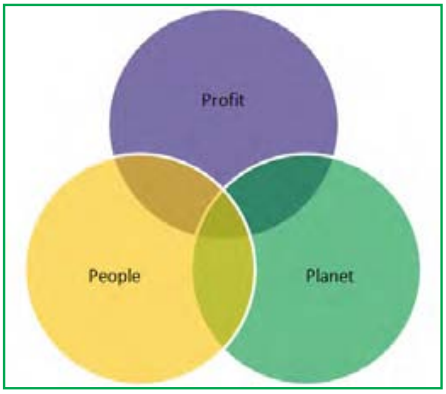

Figure 1.1: The three p's of sustainability

sources at or below their rates of generation, and uses nonrenewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land and the generation of noise." (Council of the European Union, 2001)

- **Profit:** Is affordable, operates fairly and efficiently, offers a choice of transport mode and supports a competitive economy, as well as balanced regional development

This definition will be the basis for sustainability in this report, categorized in the three criteria People, Planet, Profit. These three main areas of sustainability are the main subthemes throughout this research. For each area we formulated the following two criteria whose will be described per chapter (Marsden, Kimble, Nellthorp, & Kelly, 2009):

People

- Poverty, defined as the average real cost of journey to key destinations
- Accessibility: defined as a) access to the transport system and b) access to key destination

Planet

- Resource Efficiency: defined as a) total non-renewable energy by all transport and b) energy use per person-trip
- Total emissions

Profit

- Costs, devided in a) government costs, b) operator costs and c) user costs
- Benefits, devided in a) government benifits, b) operator benifits and c) user benifits

1.3. Literature & case studies

This part of the research framework looks at the literature and other projects to set up a framework to try and better understand the concepts of public transport. The aim is to come up with literature and case studies that can be compared with the future plans in Brazil. Therefore the focus will lie on other projects in Brazil, or South America. This part focuses on Bus Rapid Transits (BRT), monorails and traffic management which should provide a useful context for the BRT project and the traffic management project in Rio de Janeiro and the monorail in Manaus.

1.3.1. Bus Rapid Transits

There are numerous definitions of BRT's, the following two give a clear description of the essence of BRT's (Jarzab, Lightbody, & Maeda, 2002):

- The FTA (United States Department of Transportation – Federal Transit Administration) defines BRT as a "rapid mode of transportation that can combine the quality of rail transit and the flexibility of buses" (Thomas, 2001).
- A more detailed definition, which was developed by the transportation research board, is: BRT is a flexible, rubber-tired rapid transit mode that combines stations, vehicles, services, running way, and ITS elements into an integrated system with a strong positive image and identity. BRT applications are designed to be appropriate to the market they serve and their physical surroundings and can be incrementally implemented in a variety of environments.

In brief, BRT is a permanently integrated system of facilities, services, and amenities that collectively improve the speed, reliability, and identity of bus transit. In many respects, BRT is rubber-tired light rail transit (LRT), but with greater operating flexibility and potentially lower capital and operating costs.

Major BRT systems have been implemented in Belo Horizonte, Curitiba, and São Paulo, Brazil; Quito, Ecuador; and Bogotá, Colombia. These systems typically use physically

separated median lanes along wide multi-lane arterial roadways. Stations are typically spaced 1,200 to 1,500 feet between major intersections, with provisions for overtaking on some systems via passing lanes at stations. Multi-door articulated (18 meter) and biarticulated (24.5 meter) diesel and trolley buses are used, depending on the system, and several systems offer off-vehicle fare collection. Peak-hour and peak-direction passenger flows range from 10,000 to 20,000 persons per hour (Gordon, Cornwell, and Cracknell 1991).

Sustainability

People

The accessibility of the Bus Rapid Transit system is relative high, this because the access to key points and the transport system is high. Because the BRT system has the option to make use of their own and the current infrastructure it's possible to reach a lot of key points. These key points could be situated in the residential areas as the industrial areas. The access to the BRT system itself is high because the stop density of the system is high.

The use of the BRT system by poor citizen is strong dependent of the ticket price and the destinations of the BRT. For the poor citizens making and saving money is very important, so their reason for travelling will be much more business than leisure. If the BRT has a direct connection between the households and the business it's conceivable that the poor people make use of this system.

The ticket price will be dependent of the investments and the operational costs of the BRT system. The investments costs are relative high in comparison with the operational costs. If it's possible for the poor citizen to increase their working circumstances by making use of the BRT, they will make use of the system.

Planet

BRTs reduce CO_2 emissions per passenger compared to conventional transport systems. This is achieved basically by using larger units, a higher occupation rate of buses, new and energy efficient units and a mode switch from other vehicle types to the BRT due to its speed and convenience (Grűtter consulting). The actual CO_2 offsets depend on each city.

The use of resources for building and operating a BRT is relative low because it makes use of low-cost infrastructure elements such as bus turnouts, boarding islands and curb realignments. BRT systems can also share existing roadways with other traffic or use bus lanes that restrict other traffic from a portion of the roadway. Service along public roadways can be improved by taking advantage of bus priority methods, so there is no need for using new resources. Another big advantage of the BRT system that it's relatively flexible in changing the route. If appeared that some stops are not that popular it will not cost, financial and resources, much to remove that stop from the route.

Profit

The cost of a bus rapid transit system can be divided into construction costs and operating costs. Construction costs include the infrastructure investments of construction of stations, lane separations, and miscellaneous installation of signs, traffic signals, and other aesthetic installations. These investments are mostly done by the government and are mostly much higher than the operating costs. In systems around the world, infrastructure costs have varied from under $1 million per kilometer to over $10 million per kilometer (Instituto Nacional de Ecologia, 2008) . These costs are in comparison with other big transport systems relative low. The operating costs are handled by the operator and consist of the investments of vehi-

cles, employers and fuel. These costs must be compensated by the ticket sales.

Next to the costs, a BRT system has also economical benefits. Through a BRT system the travel times will reduce in comparison with car transport. There will also be an increase in economic productivity, employment and work conditions. The exact amount of these benefits depends on the situation.

1.3.2. Monorails

The definition of a monorail, as stated by The Monorail Society (TMS): "A single rail serving as a track for passenger or freight vehicles. In most cases rail is elevated, but monorails can also run at grade, below grade or in subway tunnels. Vehicles are either suspended from or straddle a narrow guide way. Monorail vehicles are wider than the guide way that supports them." (The Monorail Society, n.d.)

Brazil has known one monorail. This one was, however, not very successful, as indicated by the Monorail Society (The Monorail Society, n.d.):

"The resort town of Pocos de Caldes installed this single track line monorail to connect a major bus station on the outskirts of the town with downtown destinations. Designed and built by J.Ferreira Ltd., the trains were fabricated largely of aluminum "to give prestige to the local specialty." Alcoa Aluminum has had a plant in the area since 1971. The system was designed to allow the addition of a second beam should ridership require it. Ridership on weekends is made up mostly of tourists while local residents use the monorail for transit during weekdays. The 80-passenger trains are electrically powered, but can also be operated using built in backup diesel motors. J. Ferreira designed and built the monorail at their own expense and they have been granted a 50-year concession to operate the line. ...the monorail "started up in 1990, then a few months later shut down with safety/engineering problems."

Today, there is not a single working monorail in South America. Therefore monorail projects are studied, which are somewhat comparable with the situation in Brazil. The alternative is to look at monorails in Asian countries, which are just like Brazil developing countries, thus the situation is somewhat comparable. However, a set of well functioning monorails are found in Japan, which is a developed country. The successful monorails in this country should however be an example to the future monorail in Brazil.

Sustainability

People

In general, the accessibility will increase when a new monorail is built. This because it is a fast way of transportation, which probably improve the accessibility of the areas around the monorail. The situation where a monorail has the most advantages, is a situation where there is a need for a fixed route through a built-up area and with an anticipated medium passenger load. A disadvantage of the monorail is that it has no at-grade junction, so that it is not very easy to change modes. (Fleming, Advantages of Monorail for Mass Transit , 2010)

The access towards the transport system depends on the area in which it is built, but is often harder than by another transport system, since the monorail is an elevated system along other infrastructure. There is little space for parking cars, so it is important that there is a good bicycle lane towards it and a good bicycle parking place. (Cunican, 2003)

The cost of a monorail ticket differs a lot around the different countries, but in most cases the fares are quite high. The price in

other countries is often around or above 5 dollar when the passenger drive the whole route. This price is higher than most other modes. (Moscow News, 2007) (Sydney Monorail, 2010)

Planet

The monorail track is built with concrete. Because it is an elevated system, a lot of concrete is needed. The train of a monorail is built mostly of aluminum with rubber tires. Because a lot of resources is needed for the track, it is not efficient. Another important aspect which makes it inefficient is the flexibility of the system. If the system is not used anymore, a lot of materials are wasted and the trains cannot be used on another type of rail. (Worldlingo, 2010)

During the construction phase, a huge emission will take place, since a lot of materials are used in the construction. In the operational phase the total emissions are very low. A monorail is quite energy efficient and is mostly powered with electricity. (Long, 2009) A new technology of Metrail can power the monorails with a hybrid electric powertrain which is self-powering. (Metrail, 2010)

Profit

Building a monorail system is not very cheap and it costs more than regular bus systems. However, a monorail cost less than light and much less than heavy rail or subway systems. However it cost much more than a bus system, it could be better compared to a BRT system, with grade-separated crossings, these costs are also in the same range. (Fleming, Advantages of Monorail for Mass Transit , 2010) In figure 1.2 the cost/km of monorails are shown compared to the LRT-systems. It is obvious that a monorail is cheaper than an LRT system.

In figure 1.3, the operation and maintenance cost of different transport systems are shown. In this figure can be seen that the new technology of metrail is the cheapest, but also the good working Tokyo Monorail is cheap in operational cost.

The only revenue of a monorail system is the revenue of fees. Every user has to pay for using the system, so that is the income of the monorail system. But beside the revenue, it has more benefits. A new monorail system would, if implement correctly, improve the travel time between certain areas. This improvement in travel time means less delay for travelers, which is a benefit and this can be quantified when exact numbers are published. A third benefit is that improvement in accessibility, attract companies to

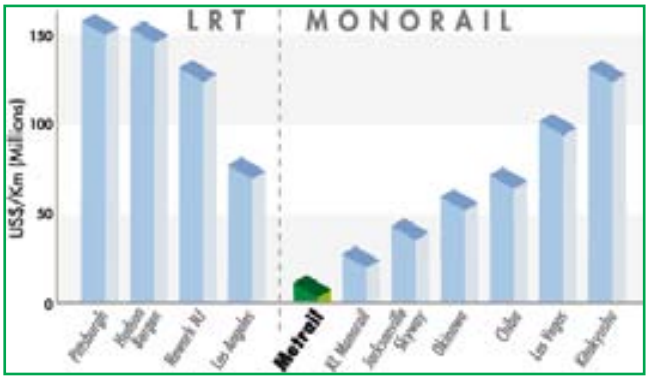

Figure 1.2: Overall system cost per km (Metrail, 2010)

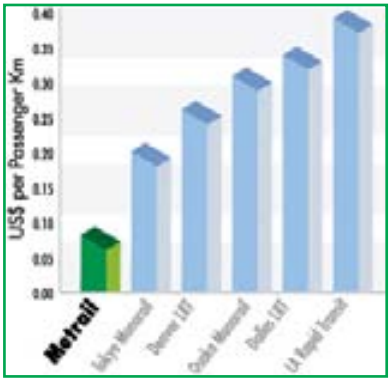

Figure 1.3 - Operational and maintenance cost per passenger Km (Metrail, 2010)

settle along the route. This also can result in a lower unemployment number for the city.

All in all, there are a lot more benefits than only the revenues for the operator. The whole city can perceive the benefits if the system is implemented correctly.

1.3.3. Traffic Management

Traffic management entails a wide range of possible measures. All these measures are focused at establishing a more efficient use of the current infrastructure. Infrastructure enhancements are thus not part of traffic management. Measures such as rewarding behaviour with subsidies and guiding traffic via certain routes are typical examples of traffic management. In the previous Olympic Games in Beijing, the municipality used a fairly severe measure: only cars with an even licence plate numbers were allowed to drive on one day, cars with odd numbers on the other (also see chapter 4).

Below we will describe the way traffic management can contribute to the three P's of sustainability. However, since we do not know exactly what the specific management measures will be in Rio de Janeiro, the description below remains general.

Sustainability

People
Traffic management can change the equity situation between different groups. For example, when the government want to discourage car traffic by raises the car tax, the car captives are worse off than other people. Reducing traffic in a certain street by closing it of in certain periods will please the inhabitants of that street. But the traffic will probably drive through another street.

If we look at the accessibility criterion, it is hard to say whether access to transport really be changed through management plans. Access to destination can be improved, for example if the route the destination is less congestion due to a management measure. The same is true for the poverty criterion: the total trip costs can be reduced (but also increased) when certain measures are taken into effect.

In the Beijing example (not allowing to use the car on certain days based on license plate number), accessibility for the poorer people is worsened, while the rich people who are able to afford a second car do not experience any less accessibility.

Planet
The environment is a typical externality of traffic management. Traffic has influence on several variables on a local scale (smog pollution, noise levels) as well as a global scale (CO_2 emissions). Rerouting traffic can solve or relocate local problems, while modal shifts toward clean modalities contribute to solving the problems on global scale.

The energy-use per person trip criterion can of course be decreased when applying a strategy focussed on establishing a modal shift toward clean modalities. The same holds for the non-renewable energy consumption criterion. Both criteria in fact need a modal shift to change, which can be achieved by various management strategies.

Profit
Management measures can have investment and operating costs themselves, but can also influence the profit of public transport operators, petrol stations, car parks, etc. Strategies which establish a modal shift will automatically support industries which depend on the use of a certain modality.

Looking at the users, changes in profit can become clear when the government for example decides to subsidise public trans-

port, which reduces ticket fares for the users.

Criteria for sustainable transport systems

In the previous paragraphs, the different transport systems are described to give a clear view of these transport systems. In this paragraph, key aspects of these systems are turned into criteria which are important for successful construction or implementation of the systems. The different criteria are described below.

At the construction of new infrastructure it is important that the route runs along key destinations in the city. Key destinations are for example, residential areas, the industrial areas and the city center. This is essential to get a high number of passengers into the transport system.

Another important criterion for success is the number of stops on the system and the feeding possibilities. Those two will help also help to get passengers into the system. The feeding of the system can be done by short walking distances to the stops or a connected feeding system with other modes (bicycle or public transport).

To attract passengers, and especially poor people, the ticket price should be low. In that way all people, even the poorest can use the system and this will increase accessibility for the people.

To make the system environmentally sustainable, the occupation of the buses or trains should be high. When the occupation is high, the emission per passenger kilometer is low, and this is desirable for the environment.

To implement successful traffic management measures, the measures should affect all people (all income groups) to keep or improve social equity; it should definitely not worsen it. Also traffic management should be implemented to affect a high number of people, to have the biggest effect and thus the most success.

Another important criterion for traffic management is that it should not relocate problems but solve them by e.g. creating a modal shift. If traffic management relocates problems it is not really a sustainable solution.

1.4. Future plans of previously hosted mega-events

In this part of the framework of the micro study, there will be looked at traffic and transportation measures of previously hosted mega-events and the future plans of those. First the plans and measures and how was dealt with the demand peak of the different mega-events will be described. After that, there will be a description about how the infrastructure and measures were used after the event and with that, criteria for a useful legacy will be described. In the end, also the profitability of the measures from previously hosted mega events will be described.

For this part of research the Olympic Games in Beijing in 2008 and the World Cup in 2002 in Seoul (South Korea) are chosen, because both are big metropolitans in a developing non-western country. This situation is comparable with the current situation in Brazil.

1.4.1. Dealing with the demand peak of a mega-event

Planning and managing the transportation infrastructure for mega-events is a complex and difficult task. Host cities already have traffic problems and must secure acceptable levels of service for the increasing traffic needs during the event. A large effort is necessary to manage the addition of large

traffic generated by a mega-event, and it requires a considerable improvement of the existing infrastructure and additional measures to manage the traffic.

In almost all biddings of previously hosted mega-events you will find both investments in new infrastructure as well as additional traffic management measures. The hosts are convinced that only new infrastructure wasn't enough to secure an acceptable level of service for traffic during the mega-event, and that is why also traffic management is included in the plans. In the next few paragraphs several traffic plans of different mega-events are described to see in what way new infrastructure and traffic management plans are combined.

Olympic Games Beijing 2008

The organization committee of the Olympic Games in Beijing in 2008 saw the games as a unique opportunity for huge investments in the transportation sector. The next quote from the Olympic Action plan shows the willingness to upgrade the transportation sector in the city of Beijing:

"The modernization process of transportation construction and management in Beijing will be greatly advanced to provide convenient, rapid, safe, orderly, efficient and environmental friendly transport services. The construction of railway, urban road, expressway, interurban transport hubs and modern transportation operation administration system will be accelerated to provide sufficient transport support that guarantees the development of Beijing's social economic development and urban construction, and to offer first class urban transport services for the Olympic Games."

The Olympic Action Plan of Beijing 2008 stated nicely that they want to reach a high level of service, during the demand peak that the Olympic games brings, with the construction of new infrastructure and with the development a transportation operation management system. New roads and rail were developed, a rotation system of alternative driving days based on the last digit of the license plate and also working days were staggered.

World Cup Seoul 2002

In Seoul, during the preparation for the world cup in 2002, the organization committee also focused on both traffic management and new infrastructure. Although the investments for a host city for the FIFA World Cup are lower that for the Olympic Games, the host city of Seoul saw the world cup also as an opportunity to develop the transportation sector in the city.

They wanted to: "promote a safe road environment by improving the traffic conditions around the competition arena in preparation of the large event as well as establishing proper transportation strategies to deal with the increased transportation demand and the traffic congestion in the surrounding area" (S. Lee, 2003)

In Seoul, 30 projects were undertaken, including the development of a road system for easy access to the Sangam main stadium, and the enhancement of the quality of the subway system. Also implemented was a system where people were allowed to drive only on alternative days based on whether their license plate was odd or even. The maintenance of traffic signs and the introduction of a mobile phone interpretation system for easier communication between taxi drivers and foreign customers were also introduced.

1.4.2.Sustainability

All newly build infrastructure is of course permanent, so this will remain after the

mega-event took place. But the usage afterwards can be quite different than the usage during the mega-event. Also the traffic demand management measures can be ended at the same as the event itself. In this paragraph the legacy for the city from the traffic and transportation plans of the mega-event are described.

People

That new infrastructure doesn't necessarily improve accessibility for citizens is shown in Beijing; the newly built metro line towards the famous Birds Nest stadium almost attracts no travelers anymore after the Olympics, and is by far the most desolate metro lines of Beijing. One metro station along the line has even been closed already.

But other new public transport facilities kept a high number of passengers after the Olympics; the fare level in Beijing's metro and bus systems has been implemented as part of Beijing's transport system development strategy and did not expire at the end of the Olympic and Paralympic Games. This led a large amount of citizens that still uses public transport after the Olympic Games took place (Official Beijing Organizing Committee, 2008). Thus some of the new infrastructure build for the Olympic Games did improve accessibility for the inhabitants of Beijing.

In Seoul also the newly built infrastructure remained as a legacy, but no further traffic management policies remained. The schedule of the public transport also changed back and there was no big change in passengers due to the World Cup. Because most of the measures were temporary and because Seoul was only host city of 3 matches, the improvement in accessibility for the citizens of Seoul was not as high in Beijing during the Olympic Games of 2008.

Planet

The construction of new infrastructure by itself has always a negative impact on the local environment. The materials used are in general not sustainable and the new situation is always less environmental friendly than the old situation (e.g. concrete instead of nature). But the infrastructure can provide positive impacts on the environment on the long term, and in that way new infrastructure can have a positive effect on the environment.

As written before, in Beijing the new metro line towards the Bird Nest Stadium almost attract no travelers and one of the stations is already closed. Of course, in such a short time, the negative impact of the construction can't be compensated by the positive effects in the long term. This is thus not a environmental friendly way of implementing new infrastructure for a mega-event.

Traffic management can also have a positive effect on the environment by improving air quality. In Beijing the traffic demand management measures continued after the Olympic Games (at least until 2012). It is said to have been effective in relieving traffic jams on major roads and improve air quality in the city. Current evaluation reports state that the average length of traffic jams on Beijing roads has decreased from the previous 1 hour and 45 minutes to just 45 minutes since the implementation of traffic control (EChinacities.com, 2010).This means that emissions due to traffic jams are declined, and the air quality in the city is improved.

A comparison of Wang and Xie (2009) between the predicted street concentrations in Beijing before and during the Olympic traffic control period shows that the overall on-road air quality was improved effectively, due to the 32.3% traffic flow reduction. The

different pollutants show diverse changes after the traffic control. PM10 decreases most, and the reduction effect focusing on the first half-day even clears the morning peak, whereas CO and NO2 have even reductions to minify the daily fluctuations on the whole. Opposite to the other pollutants, ozone shows an increase of concentration. The average reduction rate of PM10, CO, NO2 and O3 are respectively 28%, 19.3%, 12.3% and -25.2%.

Profit

Measuring all the economic impacts associated with a mega-event is an impossible task. This is because the impact on the society is so huge and broad and almost everything in the city is affected by it. (C.K. Lee, 2005) stated about the World Cup in 2002 in Seoul the following:

"In the longer term the World Cup's most enduring legacy might be simply that it provided a unique opportunity for the South Korean community to build and showcase its skills and capabilities, develop business contacts, partnering and investment, and to promote international awareness. Hosting a mega sport event has a strong symbolic function that invokes a sense of community, excitement and emotion. Furthermore, the success of the South Korean Football team provided the country with a sense of national pride and cohesiveness that no economic impact assessment could ever put a dollar value on. "

That is why it is very difficult to say anything about the profit of the transportation measures at mega-events. In Beijing in 2008 transportation improvements are part of the environmental improvements. Plans include expansion of public transportation systems and conversion of city buses to clean energy. The transportation plan addresses a wide range of topics, everything from highway construction and pollution control to teaching English to cab drivers and improve the driving habits of the general population (Owen, 2005).

What mainly can be said about investments in transport during a mega event is that it is probably not economical profitable on itself. For example; public transport in Beijing is still subsidized to attract passengers, it cannot generate enough passengers when they have to pay the full price. That is why environmental and societal benefits are included in the estimations. And when you do include other benefits than only the economic ones, the investments in infrastructure and other transport measures during a mega event can be profitable.

1.4.3.Criteria for a useful legacy based on previously hosted mega-events

In the previous section is written in what way traffic and transportation plans are a legacy for the city. But as shown in Seoul and Beijing, not all new infrastructure is useful afterwards. In this paragraph the most important criteria for a legacy that is useful are described.

Most important is for what reason infrastructure and traffic management plans are designed. Is it designed to transport people from the airport or city centre to the stadium, or does it reduce the travel time from the outskirts to the city centre significantly? Obviously, the latter one is the one in which it is most useful for the city after the mega-event took place.

In that way, an important criterion is that the infrastructure must not just be a connection from the airport to the stadium or vice versa, it should connect different parts of the city with each other. In that way local people can use the infrastructure as an alternative/

new option for daily trips (home-work etc.) after the mega-event took place.

Another criterion is the stimulation of usage of new public transport. When people are stimulated to use public transport (e.g. low fares) more people will remain using it after the mega-event took place. When public transport is not stimulated afterwards, it can lead in a huge drop in passengers, because citizens will return to their normal travel behavior afterwards.

Traffic management can be a useful legacy if it affects local people. Traffic management measures based on car use will affect local people the most, because foreign travelers will mostly use public transport. If a traffic management measure based on local people's car use will improve air quality and reduce traffic jams during an event, it will also have positive benefits afterwards.

The criterion for traffic management measures to be a useful legacy for the city is that the measure must affect local people the most, and one way to do this is by implementing measures based on car usage.

1.5. The current infrastructure

In order to place the projects of chapter 6 into context, this chapter describes the current characteristics of the infrastructure in the cities of Manaus and Rio the Janeiro.

1.5.1. Manaus

One of the most economically important cities in the Amazon area is Manaus. The transport infrastructure in the area now (air, land and river) characterizes the service of marine transport, related to long course and coastal traffic. When referring to coastal traffic, Manaus comes in first place in some of the services now in operation. In the long course, the cities of Belém and Manaus are scales of international services, making the Amazon an important center for countries such as the United States and the Far East, up to the Caribbean harbors (Silva & Dacol, 2006).

The public transport in Manaus takes formally place by bus, on the other hand the intercity transport is mostly done by boat.

Bus transport

In Manaus 250.000 passengers travel by bus a day. This transport of passengers is, since 2002, supported by the public transport system Saturday. The system consists of 124 buses; each bus holds 180 passengers and travel on an exclusive bus lane. The new

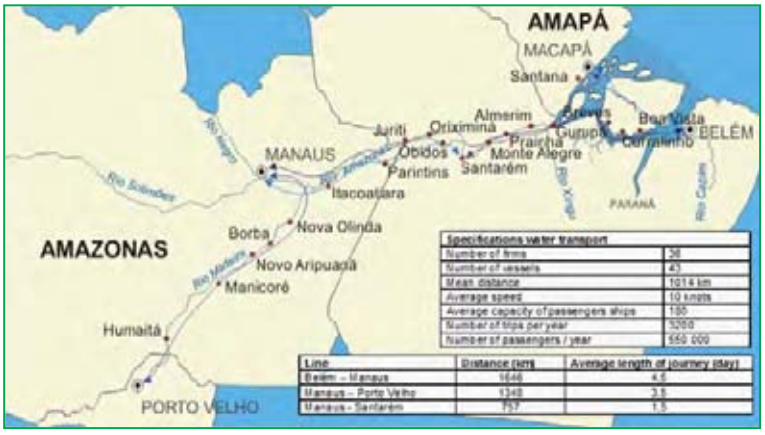

Figure 1.4: Water routes in the Amazonas

system replaces some 400 "traditional" buses that are a major source of downtown rush-hour traffic jams. Brazil's national development bank BNDES helped finance the bus purchase and necessary infrastructure (Manaus rolls out US$60mn public transport system, 2002).

There is not much known about the quality of the bus transport, reason for traveling, and the actual travel data. So it's not directly possible to say something about the need for developing a new system with new directions.

Water transport

Next to the city transport in Manaus, most of the intercity transport in the Amazonas is done by boats. From Manaus it's possible to travel by boat to Belém, Porto Velho and Santarém. There are 36 firms who facilitate the transport of passengers by boat. A total of 550 000 passengers a year make use of this service. This amount of passengers is relatively low in comparison with the 250.000 passengers a day who travel by bus.

The main reason for traveling by boat is business (34%), followed by personal affairs (29 %), leisure (21%), health (10 %) and others (6%) (Alves, 2007). During the big events, Olympic Games and Word Cup, it's conceivable that there will be a shift in these reasons, where an increase in leisure and a decrease in business visit's is imaginable. Through these big events there will also be a higher demand of transport and therefore it's necessary to increase the total capacity and frequency of the boats.

Most of the passengers are very content about the quality of the water transport. The aspects hygiene, comfort, food and security are rated positive for more than 60 %. The price and duration of travel are respectively rated positive with 46% and 52% (Alves, 2007).

1.5.2. Rio de Janeiro

The Rio de Janerio public transport system is very complex with many bus lines, two metro lines, a ferry and a tram line. There are even lots of (illegal) low capacity services (vans) operating on many busy transit lines (Balassiano & Braga, n.d.). The tram line is mainly an attraction used by tourists. The following will discuss the most important of these, namely the metro systems, the bus system and the van operators.

The Metro system

Rio de Janeiro has the second largest metro system of Brazil, after São Paulo. The quality of the metro system is high. It is for example fast, safe, clean and air-conditioned. (WHL Travel, 2006).

It consists of two lines, shown in figure 1.5. Line 1 runs from Copacabana to Tijuca (shown in orange on the map) and line 2 runs from Centro to Pavuna (green). Line 1 is fully underground and services the city business centre, some residential areas and the tourist area in the south. Line 2 is actually an elevated overground line for the largest part, due to the fact that it started as a light rail line. It services mostly working-class residential areas.

The metro lines do not cover the whole city. Only the eastern and northern parts are serviced. The municipality therefore plans to extend the metro with some new lines. Line 1 will be extended at the south end (see figure 1.4). Then, line 4 will be a further extension in the western direction (along the coast). The latter is scheduled to be complete before the 2016 Olympic Games.

Currently, this limited coverage problem is addressed by offering travellers combined tickets. This means that a passenger travels

part of his route by metro and part by another modality, such as a bus or a train. The combined ticket is cheaper than two separate tickets. (WHL Travel, 2006)

Bus system

The bus is the cheaper mode of public transport and is widely used in Rio. The coverage is high since there are over 440 bus lines covering the city frequently, which transport over 4 million passengers a day. The buses also attend all parts of the city. The services are carried out by many different operators. (World Travel Guide, 2010)

In contrary to daytime, the bus system is not always safe at night. (TripAdvisor, 2010) The bus system experienced a decrease of passenger in the 90s due to the increasing amount of low capacity transport and the rapid increase of car ownership. (Balassiano & Braga, n.d.)

Figure 1.5: Metro map of Rio de Janeiro (Metrô Rio, 2010)

Low capacity transport

In addition to the metro and bus, there are also many low capacity vehicles operating in many Brazilian cities, including Rio de Janeiro. The vehicles are mostly operated by independent operators who own one or two vehicles. The fares are usually higher than those of the bus and users grade the van services quite high according to research by Balassiano & Braga (n.d.). For the whole Rio de Janeiro metropolitan region, it is estimated that about 6.200 vans transport 310.000 passengers every day, which is about 5% of total public transport.

In the beginning of the 90s, these low capacity transport systems were contracted out by companies and schools to provide traffic for commuters and students. Soon, the van operators started running parallel services to the bus lines, since they coped with a lack of capacity, especially in the peak period. The vans were quickly accepted by passengers, mainly those who travel longer distances. Specifically in Rio de Janeiro, van operators started organising their services on the bus routes to provide an even more attractive alternative for the passengers.

The government started to regulate vans operated services in 1996. The operators are only allowed to run contracted services (which means only transfer passenger from points specified, such as school to home; picking up passenger along the route is not allowed). However, due to a lack of enforcement, there are still thousands of illegal operating van services in the Rio de Janeiro metropolitan area. (Vasconcellos & Balassiano, n.d.)

Competition between buses and vans

Since almost 90% of Rio's public transport is handled by buses, the van services usually

drive parallel to the bus routes, as well on internal as inter-municipal routes. The van services drive by bus stops to pick up and drop off waiting passengers. Obviously, the bus operators are not happy with the many vans. Although the van operating is indeed illegal and there is enforcement of these laws, it is not nearly enough to ban the van operators. Once van operators become part of the status quo, it is very hard to shut them down for authorities.

The bus operators are trying to compete with the vans by diversifying the offered services. For example, they introduced conventional buses with air-conditioning and minibuses with air-conditioning which charge higher fares (respectively 2 and 3 times the normal fares). The conventional bus fleet is expanded as well. (Balassiano & Braga, n.d.)

1.6. Transport projects in Brazil

1.6.1. T5 Bus Rapid Transit Project TransCarioca (Rio de Janeiro)

The mobility in Rio de Janeiro is not optimal. There is a lot of car traffic which leads to congestion and the traditional bus system in Rio de Janeiro is not of a good quality. The accessibility is a big problem in Rio de Janeiro and should be improved for the World Cup and the Olympic Games. To improve the traffic network, the municipality will implement BRT corridors in the city of Rio de Janeiro. One of these lines is the TransCarioca, which will be discussed. This line is the only one which was on the program before it was certain that the mega events come to Rio de Janeiro. The other BRT lines might have been build also, but over a longer period of time. (Prefeitura da Cidade do Rio de Janeiro, 2009)

In figure 1.6 the routes of the BRT Corridors are given, whereas the TransCarioca is the blue line.

As can be seen in the figure, the TransCarioca connects the southern-west side, where lies Barra de Tijuca with Penha, the northern

Figure 1.6: The route of the BRT TransCarioca in Rio de Janeiro (Sistema de Corredores BRTs na Cidade do Rio de Janeiro, 2010)

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end of the city. The last part of the route, from Penha towards the airport is a longer term project and will not be taken into account in this report.

All the current public transport is located in the eastern part. The bus rapid transit lines (TransCarioca, TransOlimpica and the TransOeste) are missing links in the public transport system of Rio. The TransCarioca covers the most important link, the distance of the trip with the TransCarioca is 28 km with 38 stations.

Along the route, the bicycle use is higher than the average of Rio. This has to deal with the fact that there are a lot of residential areas along the route and not as much hotels and apartments. This could be an opportunity to get people more on the bike. In the design stage of the BRT is dealt with this opportunity. The areas around the stations will be safe with a maximum speed of 30 km/h. There will be cycle lanes towards the stations, at these stations guarded parking places are available. These measures are taken to create a modal shift towards a combination of bicycle and public transport. (Institute for Transportation and Development Policy , 2008)

Sustainability

The TransCarioca is not only built for the mega-events, but is still present when the events are over. In this chapter the sustainability of this system is described.

People

The route of the TransCarioca is, as described above, a missing link in the public transport system of Rio de Janeiro. By implementing a good quality public transport system on that route, a huge increase in PT users can be reached. Even more because the travel time will be just 47 minutes, instead of 96 nowadays. (Government of Rio de Janeiro, 2009)

Important for the amount of users is the route of the TransCarioca. The TransCarioca goes through 12 neighborhoods and covers the most important areas of the city, like Tijuca, Meíer and Zona Sul. These areas are important living and working areas, which can lead to a high usage of the system. Along the route, a lot of poor areas are covered. The beginning and the end are more wealthy and touristic areas, but in between a lot of residential areas are covered. The low price of a ticket, which cost $1.30, is also attractive. (Dias, 2009) It is estimated that the TransCarioca has 380.000 passengers per day, a lot of them are daily commuters. (Government of Rio de Janeiro, 2009)

A negative aspect of the TransCarioca is that 3600 people have to move because a lot of houses are destructed for the construction of the BRT lane. These people get a compensation which is slightly higher than the value of their houses, but they are forced to leave their houses. This is not really sustainable, but the compensation is something. The opinion of the moved people about this topic is not known. (Dias, Prefeitura porá abaixo imóveis mesmo que haja discussão judicial , 2009)

Planet

Most important of the BRT, looking at the construction phase, is that it is a flexible system. When it seems that it does not works as good as expected, there is only a lane concrete built. This could probably be used for anything else, like a road. Also the buses can be used easily somewhere else. Another flexibility of the BRT system is the route. When it seems that an important area is missing, it is not real hard to change the route of a bus system. The flexibility of the BRT system makes that it could be sustainable, even when it is not a big success.

Looking at the operational phase, the emis-

sions plays a big role. The municipality tried to use hybrid/electric buses for the TransCarioca. These buses are limited available and the price was high. Then they tried to implement all the buses with biodiesel, but this was also too expensive. Because money is the key decision maker, only 20% of the implemented buses will use biodiesel. This is at least something, and better than the conventional buses, but from an environmental point of view there were a lot of opportunities to make a more sustainable transport system.

Profit

The project was estimated at 400 million US Dollar. But this was the cost of the project only, all side cases are not included. The costs of binding people to move are more than 150 million US Dollar. Also the cost of the stations and buses are over 75 million US Dollar. These side costs are more than 50% of the project itself. These costs are often not shown and probably not considered well in the beginning of the project. All these costs are covered by the government. (Dias, Rio dá a largada para Transcarioca, 2009)

There is a concession done for the coming 20 years. The private operator has to pay the operation costs and is bound to the fixed ticket price imposed by the municipality. The expectation is that the payback time for the operator is between 15 and 20 years. The construction cost cannot be paid back because the municipality has no income of this project.

The total costs for the municipality are now estimated at more than 600 million US Dollar. This is much more than was described in paragraph 3.1. This is caused by the case that there are a lot of grade-separated junctions, which have a high cost.

The benefits of these grade-separated junctions can be seen in the travel time. The TransCarioca is more than twice as fast as the current public transport system. The reduction in travel time loss is a huge benefit, since there are a lot of commuters which are going to use this TransCarioca. However, the benefits are not quantified anywhere.

Conclusion

The TransCarioca is, from a transport point of view, a good project because it provides the city of a new, good public transport system. It is a missing link in Rio de Janeiro and therefore it was necessary to create a good PT facility.

The main conclusion of this project is that money is the most important variable in the decision making process. The decision makers take sustainability into account, but will not spend money on this subject. A measure is chosen on the price and then will be looked if it is possible to make the measure sustainable, whereas it would be better to take sustainability into account from the very beginning. This can be seen by the fact that the choice is made for a BRT, while many people are forced to leave their houses and the environmental friendly buses are not available or have a high price. A metro system would be another (more expensive) solution but is more sustainable and provides better accesibility in stead of the very soon saturated new buslines.

However, the BRT line could be more sustainable than the current situation. It provides a lot of people access to good public transport and it decreases the travel time with half. Also the emissions will be decreased compared to the current situation, with a lot of cars and conventional buses. Another good aspect of this project is the fact that it had been build even when the mega-events were not held in Rio de Janeiro. This means that research stated that there is a demand

of the local people, which means that there will be enough demand after the World Cup and Olympic Games. But if the BRT lines can cope with the peak demands during the games is not known, and probably the usage of these lines will be regulated by traffic management during the entire games.

The BRT line is an improvement for the city, both from the traffic point of view as of the sustainable point of view, however it was possible to make a more sustainable system when money was not the key decision maker. The BRT provides a slight modal shift towards public transport, but a modal shift was not the intention, for example from a sustainable point of view. The incentive in public transport projects is improving accessibility with money as a key decision making point. Where this line has an additional demand: finishing before the Olympic Games.

1.6.2.Monorail (Manaus)

A requirement of the Fifa for the World Cup host is a good urban mobility. To create sufficient mobility in Manaus, a monorail will be built and is planned to be fully operational before the World Cup in 2014. This monorail can supply 170.000 people per day and the time reduce can be up to one hour. The investment costs of the project are estimated at R$ 1.327 million (~ € 561 million). This is financed both public and private. (SEPLAN, 2009) The company which is developing the monorail is an organization called SEPLAN ("Secretaria de Estado de Planejamento e Desenvolvimento Econômico"). SEPLAN is an organization of the Amazonas state.

The monorail runs on an elevated track above the main road in Manaus. There are two separated tracks so there is no interference between the directions. The support structure is carried by beams which are placed in the flowerbeds of the road. The vehicles can transfer 900 persons (of which 12% have seats) and are operated automatically. The time interval between two vehicles is 2,5 min. in busy periods and 5 min. in quiet periods. (SEPLAN, 2010). In figure 1.7 the route of the monorail line is given.

As can be seen in the figure 1.7, the monorail will connect the Eastern tip with the Southern Center of the city. The driverless monorail system passes through the historical center of Manaus and the city's port. It will interconnect with existing terminals and pass the stadium for the World Cup. The system is not only a monorail; it will be extended with Bus Rapid Transit lanes. While the monorail is from north to south, the BRT lanes have to serve other parts of the city. (Farah, 2010). However, the BRT system is being developed by the municipal transport organization, while the monorail is being developed by SEPLAN (SEPLAN, 2010). In reality, SEPLAN's design choices are hardly influenced by the BRT project.

The price of a combined BRT/monorail ticket will be R$ 3,50 (~ € 1,50). As a comparison: the current price for the (low quality) bus is R$ 2,50. The length of the total line will be 13.6 km and it will take 26.5 minutes, which means that the average speed is 36 km/h, in comparison: this is the same average speed as the North|South-line in Amsterdam. (SEPLAN, 2009)

Besides the upcoming mega events, there is yet another important reason for justifying the construction of a new transport system. In recent years, Manaus has grown rapidly in terms of population, vehicle fleet and bus fleet (SEPLAN, 2010). This growth is above average compared to other Brazilian cities (see table 1.1). GDP growth in Amazonas is also above average compared to other states. The transport network is thus getting congested very rapidly due the large growth of the city. Independent studies by Pricewa-

Figure 1.7: The route of the monorail in Manaus (SEPLAN, 2009) (SEPLAN, 2010)

terhouseCoopers show that the demand will increase from 20.100 to 39.200 passengers per hour (on the busiest route) between 2014 and 2020, which equals a growth of 97,7%. The new monorail should expand the current transport system so this growth can be accommodated.

Alternative modalities

There were four different alternatives for the transport system: a metro, a type of light rail system (such as a tram), a BRT system and a monorail. SEPLAN explained why the metro, light rail and BRT were not chosen (SEPLAN, 2010). A metro system was disregarded quickly because it would be too expensive. A light rail system would require a wide support structure which would be difficult to implement and would damage the visual view of the city. Another reason is that it would be very sensitive for accidents, considering the Brazilian driving style. The

	Average Brazilian city	Manaus
Population	**1,4**	1,0
Total vehicle fleet	7,4	8,8
Bus fleet	5,0	7,3

Table 1.1: Average annual growth (%) between 2004 and 2009 (SEPLAN, 2010)

capacity of such a system would also not be sufficient for future demands. A BRT system would simply occupy too much space, since separate driving lanes are required for an efficient BRT. The investments costs would also be relatively high, since some of the current infrastructure has to be replaced by separate driving lanes.

A monorail would cause less visual interference, because it is elevated, and would not take any space of the current roads, because the support structure will be placed in the flowerbeds of the current roads. Other reasons mentioned in the presentation were: a monorail is environmental friendly (running on electricity), a monorail can be implemented quickly, a monorail has "favorable" implementation and maintenance costs and a monorail offers good quality in term of comfort, safety, quickness and accessibility.

Land-use

It is expected that the areas around the stations will develop as a result of the monorail. This development will mostly be an increase in business activities in the private sector. The government has no additional plans (besides the construction of the monorail) to stimulate this process. Two area's are mentioned explicitly: the area around the football stadium and the downtown area. The latter has lost much of its attractiveness and SEPLAN believes the monorail can improve this.

Challenges

SEPLAN indicated a few challenges which are critical for the project's success. The Brazilian bureaucracy is seen as a major problem. Therefore, they intend to pay attention to the collaboration between different governmental organizations at national, state and municipal levels. The projects schedule is also heavily influenced by political agendas, since the project is needed for Manaus during the World Cup. Communication to the population is seen as an important factor as well.

Other challenges include finding investors and suppliers, supervising the execution and meeting the requirements of the stakeholders.

Sustainability

The legacy of the monorail developed for the 2014 World Cup in Manaus is, of course, the infrastructure that remains. The monorail will not only be developed for the World Cup in 2014, but also for the long term (until at least 2050) to improve traffic and transportation in the city. The sustainability of this legacy is described in the next three paragraphs.

People

The route of the monorail shall pass along nine streets of the city between the neighborhoods of Cidade Nova (North Zone), São José (East Zone) and the Historical Centre of the City (South Zone), it will also pass the new Arena da Amazônia stadium and the airport will also be connected to the monorail with a special bus system. The monorail will also be connected to two Bus Rapid Transit lanes, to service a bigger part of the city. The monorail journey should take one hour less

than the time taken at present with the use of conventional buses, which take almost two hours to reach the city centre from the East Zone.

The monorail route will pass mainly through the areas with medium and high incomes (>$ 1667 per household per month), it will not pass areas with the lowest income (<$ 833 per household per month). But these low income areas will be serviced by neq BRT lines that will be connected to the monorail.

The monorail route will run through mostly dense areas like the city center and the North East zone and it is also connected to the port of Manaus, the airport (via a bus line) and the new stadium. Some of the main resident's areas are served by the monorail, but most are serviced by the BRT that is connected to the monorail. The connected BRT lines will also connect industrial areas to the monorail.

In general, almost all inhabitants will have access to the monorail (direct, or serviced by the BRT lines). And because of the BRT lines that are connected to the monorail, the accessibility to the transport system can be high, but this depends on the service (number of busses etc.) offered by the feeding system. The number of busses on the BRT lines and travel time to the monorail is not yet determined, but they stated that this is essential for good operation of the total system and they will do a lot to make this work. The accessibility to the BRT station can be a problem, because the distance between stations is about 1 km on average (compared to 400 m in general) and this can be a threshold for using the BRT system. The monorail has 9 stations and during high demand the interval of the trains will be 2.5 minutes. The monorail route is running through the key destinations of the city like the city center, the airport (via a bus transfer), the new stadium, the North East residential zone and the port, and the BRT lines will run through industrial and residential areas.

The fare price of the monorail will be $1.50, and an integrated ticket (Bus + monorail) will be $2.50. The price for the system is comparable to the prices for public transport in other parts of the country. The fare price is thus not high and it will probably not affect the accessibility in a bad way. And also 60% of the trips nowadays are paid by companies were people work, so the majority of the costs is not for the people self. (SEPLAN, 2010)

Planet

The construction a monorail will always have costs for the environment. Materials used are often not sustainable due to the use of concrete and metal. So the construction itself is not sustainable. But the monorail is the smallest design of the possible alternatives, what means that the space needed for the construction is the least, this was one of the most important considerations.

Also Manaus has given itself the name "green host city" for the Fifa World Cup 2014 and this result in a policy whereby every ton of carbon emitted, will be compensated in an environmental fund for reforestation in the Amazon. A small part of the ticket for a World Cup match will be donated to this fund.

The operation of a monorail is in general environmentally sustainable, because it is using electricity instead of fossil fuels. The electricity is generated with natural gas, which is the best fossil fuel for generating electricity when looking at CO2 (45% less than coal and 30% less than oil) and NOx emissions (80% less than oil and coal) (EIA, 1998). According to studies from SEPLAN, the monorail will have some great environmental benefits for

the city. They state that when the monorail is operating, it will reduce CO2 emissions with 50,000 tons per year, which is equal to planting 1,000 trees a day.

SEPLAN also state that the monorail will contribute to a better urban environment, because there will not be much noise. The noise of a monorail is always lower than the noise of most other transport systems, so this will be a real environmental benefit for the city of Manaus. (SEPLAN, 2010)

Profit
The construction costs of the monorail in Manaus are $ 767 million for a length of 20.2 kilometer. This is around $ 38 million/km. The construction costs of other monorails around the world vary between $ 10 million/km and $ 130 million/km (see paragraph 3.2). The costs for the monorail in Manaus lies a bit below average, this means that the construction of this monorail is cost efficient.

When the construction of the monorail is completed, there are still some costs left; the operational costs. The operational costs of other monorails vary between $ 0.07 / passenger km and $ 0.40 / passenger km (see paragraph 3.2). The operational costs of this monorail are not known, since the operator is not known yet.

The economical benefits of the monorail for the society are, according to calculations of SEPLAN, around $ 11 million per year. This estimation is based on the reduction in travel time, which is 47,000 labour hours per day. The benefits for the operator are based on the ticket price, which is for the monorail alone $1.50.

Conclusion

It is obvious to say that the new monorail in Manaus is a sustainable transportation system. The monorail is connected (together with the additional BRT lines) to all parts of the city and the fare price is low, so the monorail is accessible for almost everybody. And also considering the rapid growth of the city of Manaus, the monorail is needed as a transport system in the battle for good transportation in the city. So from a people's point of view it will be a good sustainable project.

The monorail is also environmental friendly in operation, it runs on electricity that's generated by natural gas and it makes not much noise. The construction of a monorail is doubtful when looking to the sustainability, because it is elevated and that will costs lots of materials for the construction (compared to some other transport systems) but the city of Manaus will donate money into a environmental fund to compensate every ton cO2 emitted at the construction. Also the construction will cost a lot of money, but it is cost efficient comparing to other monorails, whether it is economically sustainable is not known yet, that depends on the operational costs and if the construction costs can be earned back in the operation.

In general we can say that this project is a sustainable transportation project where the policy makers did think quiet well before choosing an alternative for a transport system. You can see that environmental and social aspects were much more important than the economical one and that is a good thing for the people of Manaus and our planet.

1.6.3.Traffic and transportation management (Rio de Janeiro)

In our preliminary report we focused on the traffic and transportation management plans for Rio de Janeiro. Before our visit to Coordenadoria Regional de Tráfego (CET), there was not much known about the transportation management plans for the mega events and how sustainability was incorpo-

rated in these plans. The presentation at CET was about the traffic management plans for one venue; the Olympic stadium João Havelange. Therefore the focus in this final micro report will be on the traffic management plans for the Olympic stadium João Havelange and the way in which these are formulated in a sustainable manner. Next to that there is a small description of general traffic management plans for Rio, based on the information obtained during the presentation.

Traffic management at the Olympic stadium João Havelange

The stadium João Havelange, also known as Engenhão, is opened in 2007 for hosting the Pan American Games. Nowadays 46.931 sportfans could visit a match and this will be increased to 60.000 for the 2016 Summer Olympics. The stadium is situated in a residential area and is accessible by car, train, bus and foot. The train station 'Engenhao de dentro' is located south from the stadium. Next to that, around the stadium, there are four bus stops and 3500 parking places situated.

Nowadays there are several problems about reaching and leaving the stadium, by different means of transport. These problems are mostly caused by the limited open space around the stadium. Through these limited space the following problems occur:

Unsafe situations for pedestrians
Because the stadium is not entirely accessible by car or train, the visitors have to walk the last part of their trip to the stadium. Next to that a lot of visitors live nearby and reach the stadium by foot. Because the sidewalks are very small and they are obstructed by lampposts and displays of shops, most of the pedestrians make use of the nearby road. These roads are meant for cars, and because of the pedestrians the traffic flow deteriorates and also a lot of unsafe situations arise. This problem will become worse during the Olympic Games when the amount of visitors will increase.

Unsafe situations for bus users
Around the stadium four bus stops are located. By reaching and leaving the stadium by bus, the visitors have to make use of the bus stops located on the small sidewalks. Because the limited space around the bus stops

Figure 1.8: Engenhao stadium

Figure 1.9: Unsafe sidewalks

the high amount of waiting bus passengers will make use of the nearby road, through the interaction with cars and other pedestrians, accidents will be very likely. This unsafe situation will also increase during the Olympic Games if nothing happens.

Unsafe situations for car users

Around the stadium and in the nearby Norte shopping centre are respectively 3500 and

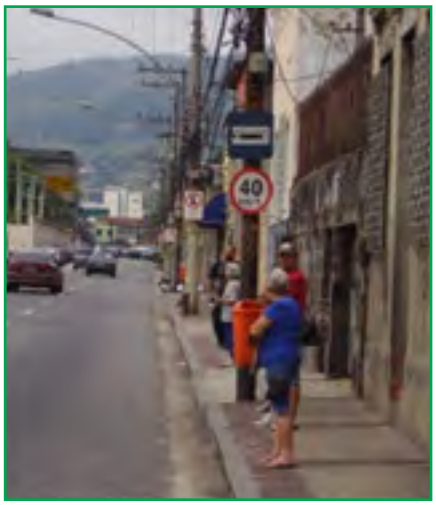

Figure 1.10: Bus stop

Figure 1.11: Interaction of cars with pedestrians

3000 parking places. The visitors who come by car make use of the roads to reach these parking places. During the matches the pedestrians also use this road because of the limited capacity of the sidewalks (see paragraph ##). Next to that the car users also interact with busses, which stop at the road for embarking and disembarking passengers.Both interactions lead to unsafe situations for car users.

Solutions

CET developed several management measures for improving the traffic situation around the stadium. In this paragraph these measu-

res are described.

CET implemented new road signs, so the car-users are advised in a better way, and it will be easier to reach their destinations in a fast way. Next to that they would like to diminish other traffic during the matches, which will be achieved by giving schools some time off. They also like to stimulate the use of trains, because in this way the intensity on the roads will be less and there will be a safer situation on the road. The trains will have special timetables during the matches, and the people get free access to trains with their ticket. This action will be promoted by articles and advertisements in local newspapers.

The car users could make use of the Park and Ride (P&R) facility, which is located near the Norte Shopping. This P&R facility has a capacity of 3000 cars. Next to the P&R facility, CET also thought about temporary changing the direction of traffic in one-way traffic. However the roads around the stadium are not big enough for implementing this measure.

Nowadays the whole area is clear in 30 to 40 minutes, but during the World Cup and Olympic events it will be doubtful if this clearing-time will be achieved because of the bigger intensities of spectators.

Traffic management plans for Rio de Janeiro

For the whole city of Rio de Janeiro also some measures are implemented to manage or control the traffic flows. The plans for this are described in this paragraph.

They are promoting the use of public transport by publishing positive articles and advertisements in local papers. In this way they want to create a modal shift and improve traffic flow. As described before, public transport will be free when possessing a ticket for a sports event and the timetables will be adjusted during the events. Next to the promotion of public transport the municipality also invested in improving infrastructure for car traffic. They provided new road signs for car users. Beside these fixed road signs they also provided dynamic information on Viarable message Signs (VMS). Most of the car traffic in Rio will be monitored by 90 cameras situated all over the city, this information is not yet connected with the VMS's but maybe will be in the future. During the peak hours a high intensity of cars will leave or will come to the city center, on some roads they manage these high intensities by temporary changing the direction of traffic into one-way traffic.

Conclusion

In our opinion it will be advisable to expand the P&R facility outside the center of Rio, on condition that the other car traffic on the nearby roads around the stadium will be forbidden. The busses make use of one lane of the road where the pedestrians could make use of the other lanes of the road. It will be very hard to implement this kind of solutions because the Brazilian authorities don't have the courage to enforce their traffic management plans on the citizens. So a situation in where all the roads around the stadium are closed for car traffic is impracticable. In this way it's hard to manage the traffic flows and to steer them into a preferred situation.

The further stimulation of the public transport, like the use of train and busses around the stadium is a sustainable solution. This because it's less harmful to the environment, it use less space, and it's safe in comparison with the use of cars. CET doesn't know the number of train or bus-users during the current football matches, so it's hard to say if there is enough capacity for transporting most of the sport fans during the big upcoming events.

There aren't any plans yet whose specially focus on smog or CO_2 reduction. Further promotion of bicycle use, and public transport would be good for reducing these emissions. Before promoting the bicycle use, first the infrastructure for bicycles has to be improved. The current infrastructure is fragmented and could not withstand a high number of cyclists, so it needs a lot improvements before it's a safe and good way of transport. It's up to the municipality if these environmental friendly plans will be implemented.

1.7. General conclusion

This study investigated three Brazilian projects: the Monorail in Manaus and the T5 Bus Rapid Transit system in Rio the Janeiro are two brand new infrastructure projects which are planned to be ready for use before the Olympic and Fifa World Cup. The third project is traffic and transport management in Rio de Janeiro. Throughout the report, special attention was given to the sustainability of the projects.

Manaus is planning a modern monorail system for the city, which will probably suffice in handling the peak demand during the Olympic Games. Also the accessibility of the transportation system is gooed, with additional BRT lines, almost all parts and key destinations of the city can be reached. The project is also environmental friendly; the monorail runs on electricity generated by natural gas, what is less polluting than generating electricity with other fossil fuels and the construction damage to the environment will be compensated into a reforestation fund.

The TransCarioca Bus Rapid Transit system is an improvement for the city of Rio de Janeiro, both from the traffic point of view as of the sustainable point of view, however it was possible to make a more sustainable system when money was not the key decision maker. Overall we can say that the BRT line is a good system, because it has lot's of benefits for the people and the environment.

During the Olympic Games and the World Cup several traffic management measures are taken into effect. The management plans we heard of were mainly to improve the situation around the Jose Havelange stadium. The plans were all a bit easy and not well thought trough, but it will improve the situation probably. Other plans were to stimulate use of public transport in the city during the mega events, this is in our opinion a good management strategy, but they should think about how to implement it.

This concludes our study of three traffic related projects which are carried out for the Olympics and Fifa World Cup. The above summarizes what we found out during our study tour in Brazil. Hopefully, many of the benefits will not only be for the prestige of the World Cup and Olympic Games, but will contribute to a better life in the years after. We are certain that the policy makers will try to make this happen.

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2. DEVELOPING THE BRAZILIAN ECONOMY

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2.1. Introduction

During the study tour 2010 'Booming Brazil' a study was dedicated to the expansion of the São Paulo Metro and the construction of the TAV between São Paulo and Rio de Janeiro. The topic 'Developing Brazilian Economy' already mentions the importance of these projects for the economy. People will be able to travel easier and faster, mobility and accessibility increases, which boosts the economy. However, not only the economical part is important, as our study tour theme is 'sustainability'. Therefore, as the economy grows, sustainability has to be kept in mind.

After the study tour, the preliminary report is transformed into this final report. The report contains more information to answer the research question, which is gathered during the onsite visits in São Paulo. Now this report gives an overview about the effects on the economy while keeping in mind the sustainability aspects after analyzing different literature, official websites and onsite visits related to both projects. The structure of the report is as follows;

Chapter 2.2 will give an overview about the scope of the research regarding both projects. Chapter 2.3 proposes the research questions that have been approached during the research. Chapter 2.4 addresses the expansion of the Metro in São Paulo considering strategic and construction issues as well as transport related aspects. Chapter 2.5 provides information about the TAV between São Paulo and Brazil. In chapter 2.6 conclusions are made regarding the elaborated research and focusing on the sustainability of the project. In addition, a small comparison between both projects will be given. In chapter 2.7 the sources are given.

2.2. Scope

The scope of this research is to analyze to what extend the Metro Expansion in São Paulo and the High-speed Train from São Paulo to Rio de Janeiro contribute in a sustainable way to the development of the Brazilian economy. In order to do so, strategic, construction and transport aspects will be analyzed.

The complexity of the Metro Expansion lies in the different strategic approaches for the different lines. This research considers motivations for expanding the lines, the effects that they will both have on the different transport modalities and the city. Special importance is paid to the strategic issues and the metro accessibility for low-income people.

A high-speed rail link is best suited to city pairs where their distance apart is less than 500km to 600km; beyond this distance, air travel becomes competitive and the relative market share of high-speed rail declines. The expected modal split with demand will be approached to explain a cost-benefit analysis in order to make conclusions about the economic advantage and sustainability of the high-speed train.

2.3. Research questions

This research will look how civil engineering projects try to keep up with the demand for a better infrastructure, to help to boost the economy. Therefore, the main research question will be:

- To what extend do these two projects contribute, in a sustainable way, to the development of the Brazilian economy?

Due to the main topic of the Study Tour, sustainability, the Triple Bottom Line (Pro-

fit, Planet, People) will be studied. How the financial performance (Profit) take into account ecological (Planet) and social (People) performances. In order to answer this main question, both projects will be discussed.

2.4. Metro expansion - São Paulo

2.4.1.About the project

The São Paulo Metropolitan Region (SPMR) has about 19 million inhabitants spread irregularly over 8,000 square kilometres. Over the decades, rapid urbanization has resulted in uncontrolled urban sprawl with associated traffic congestion and increasing travel distances, exacerbated by social problems including crime and unemployment. Of the 26 metropolitan regions in Brazil, SPMR has the highest population density (2,245 inhabitants per square km) and the fourth highest share of people living in slums (9%). The problems and costs of traffic congestion in SPMR affect both passengers and freight logistics. This contributes negatively to the economic development and competitiveness prospects of the region, and tend to have a disproportionate impact on the poor. (Sustainable Development Department. World Bank , 2010)

Although urbanisation plans have been implemented in some areas, São Paulo has developed quickly without major planning. The lack of full physical and tariff integration between the bus, metro and the suburban trains has over the years discouraged low-income users from using rail. This has led to an over-reliance on less efficient and less environmentally-friendly road-based modes, including buses and automobiles, and contributes to the heavy congestion experienced in the SPMR. Low-income urban households, as the main users of public transport, bear the brunt of the low-quality of the service and consequently suffer from (Sustainable Development Department. World Bank , 2010):

- Extreme overcrowding of trains (more than 8 passenger/square meter) due to shortage of capacity at peak hours.
- Long work journeys (2.5 hour day from the metropolitan periphery to the urban centres) with often more than two modal transfers.
- High costs for transport resulting in the need to spend as much as 20% of income towards fares, particularly for informal workers who do not receive a transport subsidy.

In order to solve these issues, the São Paulo State Government is expanding the rail-based system in the city. Various acquisitions have been planned till 2010, as part of the extension projects. The plan outlines projects to increase the current 327 km metropolitan railway network to span 500 km by 2020 (Global Mass Transit Report, 2010). At this moment, the system consists of CPTM, Metro and EMTU, including:

- 327 kms of railway.
- 147 stations.
- 7'8 million passengers per day.

Another way to show the urge of expansion is to compare São Paulo's current metro system with another system of similar age and city size. São Paulo's 36 year old system consists of 65km of rail tracks. Mexico city's metro system, for example, was founded in the same period and meanwhile consists out of 200 Km of rail tracks.

2.4.2. Strategic issues

The strategy in Brazil is to support actions, policies and investments that will encourage economic growth and social development in a context of macroeconomic stability. The emphasis is on efficient resource allocation, increased efficiency in the public sector and the appropriate targeting and delivery of

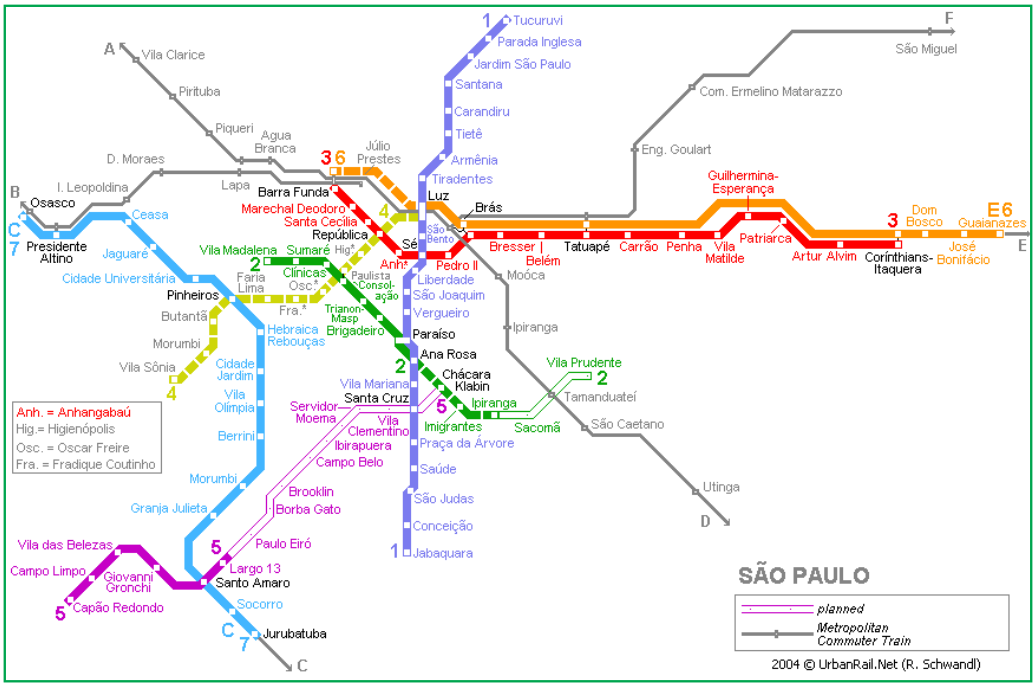

Figure 2.1: São Paulo Railway network after expansion of lines 2, 4 and 5 (Schwandl, 2009)

support systems to the low income population.

The main goals of this expansion project are:

- Increasing capacity

Capacity cannot be increased anymore with current infrastructure. During the last years, the government has been boosting public transport usage to reduce kilometres travelled on the road. Therefore, new lines are under construction to provide a better alternative for private transport.

- Linkage between lines and other modes of public transport

The railway system was not well integrated in the city because of a lack of linkage between lines. By building new integration lines, the formerly isolated lines were interconnected as an important step to close the metro network. These expanded metro lines will reach both high density employment areas and residential areas. As 6 to 7 million people need to travel from the outskirts to downtown daily, this expansion and integration will have a positive impact on their quality of life. Travel times are heavily reduced up to 25%.

- Improving accessibility for low income groups

Low-income users are the most affected by poor public transport services. Their chances to access better employment, health and education facilities are higher if accessibility, availability, acceptability and affordability of public transport services are improved by extending the metro and user accessibility to stations.

Planning

The total investment of the project is 21 Billion Reais. One of the most important challenges of the expansion is the coordination among the three different levels of power in

São Paulo:

- City of São Paulo
- Province
- Federal Government

Consolidating the efforts strengths the coordination between the State and Municipalities of the SPRM. It is key to the success of the strategy adopted by the State. This plan focuses on increasing the use of public transport by developing a long-term transportation plan and prioritizing according to capital budget. This policy appears to be effective since recently we see a trend of increasing public transport usage leading to a decline of private vehicles on the road. Nowadays, the public - private mode share is 55% - 45%.

In order to deal with cost-recovery and funding issues, the following aspects are addressed through technical assistance and policy component:

- Better integration of the public transport network;
- More private sector participation;
- Oversight of the use of the Bilhete Unico Integrado (BUI).

Some lines are being developed by means of a Public-Private Partnership (PPP) model in order to increase the participation of the private sector. For instance, a concession model has been preferred for lines 4, 8 and the airport express, because of the following reasons (Governo de Stado de Sao Paulo, 2010):

- The reduction on the State Government capital expenditure because the concessionaire will effect investments and so allowing the State Government to invest in other priority projects;
- The need of guarantees from the State Government to the private partner and vice-versa;
- The necessary share of the risks with the private party to make the concession possible;
- Judgment criterion for the bid: higher reduction on the pecuniary payment.

Benefits

The primary benefits of the expansion are accessibility and mobility, passenger time savings, and time savings to road users through congestion reduction. There is also a set of secondary benefits including pollution and accident reductions, local economic stimulus and transfer of technology. Nevertheless, these are probably small relative to the primary benefits and are difficult to quantify.

A social-economic impact study developed by Companhia Metropolitano de São Paulo (2010) shows the direct and indirect benefits from the implementation of the expansion:

- The work will improve the traffic and reduce the travelling time;
- The region will attract investments from the private initiative and the value of the real estate will increase;
- The easy access will create commerce poles and other economic activities;
- more than 17,400 work positions will be created in several segments;
- With less automotive vehicles in transit, the air quality is improved;
- Number of traffic accidents will be reduced.

According to the official numbers provided during the company visit, the expected returns will be (in million R$/year):

- Reduction time: 368,2
- Accidents: 311,6
- Pollution: 111,6

Main identified risks of the expansion

The main identified risks of the project related to the expansion are (Governo de Stado de Sao Paulo, 2010):

- Demand: risk of the projected demand not to come true;
- Demand: the system have to be able to deal with the increased demand;
- Exchange: risk of an exchange depreciation that affects the capacity of payment of debts due to imported equipment;
- Completion: risk of the civil construction not to be ready in accordance with the timetable, or not fulfilling the specifications;
- Integration with inter municipal bus lines: risk of having competition between two modes;
- Delays in the completion of the works;
- Construction accidents and operational safety.

2.4.3. Construction topics

The conceptions (Companhia do Metropolitano de Sao Paulo, 2010)

In the elaboration of the projects it was intended to improve both the aesthetic and formal solutions to the utilized construction methods, creating functional spaces with a design of great beauty. The intention of the design is to minimize the environmental and urban impacts on the involved regions and taking the greatest possible advantage of the spaces resulting from the adopted construction method, especially the start shafts of the construction work.

Material and Space (Companhia do Metropolitano de Sao Paulo, 2010)

In order to create a more pleasant environment inside the underground stations several materials and visual communication were used in shapes that were defined by the construction method applied. Within this concept, chromatic studies were performed for the utilization of colours of floors, coverings and ceilings that would work as identification elements of the stations.

In the lighting project, different light intensities were chosen, raising the value of the structural forms and the architectural elements, without reducing the safety and comfort principles that are always present at the buildings of the subway system. Measures that aim at the energetic efficiency have been taken mainly in the new Metro Stations such as Alto do Ipiranga, Sacoma, Tamanduatei and Vila Prudente of Line 2, with adoption of an architectural project that valorises the natural lighting and installation of equipment provided with technology with smaller consumption potential, such as escalators with demand flow sensors. (Companhia do Metropolitano de São Paulo - METRÔ, 2009)

Environmental treatment

The Companhia do Metropolitano de São Paulo has developed an Environmental Action Plan. It is designed to keep track of the environmental impacts and respective treatment measures conceived. The management actions are based on the environmental studies and reports carried out for the obtainment of the prior and installation licenses of the aforesaid lines. (COMPANHIA DO METROPOLITANO DE SÃO PAULO–METRÔ, 2004)

Overall and in the long-term, the expansion is expected to have a positive impact on the environment. Congestion and air pollution are currently some of the most important environmental problems facing the metropolitan region. Providing a high quality and safe transport alternative, especially for

long trips, will help contain the rapid increase in motorized trips and related environmental impacts. The expansion will help quantify these long-term environmental impacts in terms of modal 'retention' or shift and the associated emission benefits. (Sustainable Development Department. World Bank , 2010)

Air pollution, noise, traffic congestion, and road accidents are major environmental issues to be addressed in the SPMR. The reduction of the environmental impacts of urban congestion and noise pollution in the urban area could be done through:

- The allocation of responsibilities across government levels for the enforcement of the law and definition of tougher standards;
- The use of cleaner and quieter systems;
- Where appropriate, the use of non-motorized transport;
- Improved traffic management and control;
- The strengthening of traffic safety education and the enforcement of traffic regulations.

The proposed improvements on Metro and CPTM will most likely reduce the number of bus-kilometeres in the corridors where they are happening and consequently will reduce vehicle emissions. The existing municipal legislation, by which vehicles with plates ending with a certain number cannot circulate during peak periods of one day of the week continue with some success. This has reduced the number of vehicles per day by 600,000 during those peak periods providing some reduction in congestion and emissions. Both Metro and CPTM are now preparing plans to reduce their carbon dioxide emissions using trains with regenerative braking, changing the type of lights they use at stations, control centers and workshops (Companhia do Metropolitano de São Paulo - METRÔ, 2009).

Reduction of pollution goes hand in hand with congestion reductions as one of the most sought-after outcomes of transport system integration in developing cities. The World Bank (2002) explains how in dense developing-country cities, valuations of the "total economic damage of air pollution" can top 2 percent of GDP – and these costs tend to be borne disproportionately by low-income groups. CO_2 emissions have global impacts, but these too will be more strongly felt by developing countries. The World Bank (2002) estimates a cost of 5-9% of GDP for developing nations if global CO_2 levels double. In general, the transport sector is the source of a large share of emissions. In Mexico City, 40% of CO_2 emissions come from the transport sector (Allen, 2010).

In table 2.1 (Allen, 2010), it is shown how the implementation of the Metro System in Santo Domingo can reduce the CO_2 emissions in a 3,7%.

Possible negative effects of the expansion

The most substantial negative environmental impacts will occur during the construction phase and are temporary. They affect the local physical environment around 5 future underground stations and one new 1.5 km tunnel, in particular creating an increase in emissions, effluent, noise and vibration levels, and can also compromise buildings located in the immediately surrounding area. The disturbance caused by excavation and pumping works on the tunnels, shafts and underground station facilities could significantly impact neighbouring buildings. (Sustainable Development Department. World Bank , 2010)

In the State of São Paulo, the environmental licensing occurs in the SMA (Secretariat

Estimates of Metro Emissions Reductions	
Total Potential Distance of Trips Diverted per day (km)	147,786
Total Potential Fuel Saved Daily from Diverted Trips (gallons)	6,676
Total Potential CO_2 Emissions Reduced from Diverted Trips (tons)	139
Average Daily Fuel Consumption of the Metro (gallons)	3,1
Average Daily CO_2 Emissions from the Metro (tons)	69
Estimated Net Daily Reduction in CO_2 Because of the Metro (tons)	70
Estimated % Reduction in CO_2 because of the Metro (%)	3.7

Table 2.1: Estimates of Metro Emissions Reductions in Santo Domingo Metro. (Allen, 2010)

of the Environment) by means of DAIA (Department of Environmental Impact Assessment), which analyzes the environmental studies of projects potentially or effectively causing significant environmental impact, subject to licensing with an environmental study. (Companhia do Metropolitano de São Paulo - METRÔ, 2009)

Sustainability

The sustainability of the expansion results will depend on:

- Continued ownership and priority given to the urban transport sector by the State administration;
- Timely implementation and funding of rehabilitation and maintenance interventions to keep the infrastructure and equipment in good condition;
- Maintenance of integrated tariffs such as the BUI, which benefits primarily the low-income segments of the population.
- Congestion, road accidents reduction and reduced emissions: the shift to rail-based transport is likely to reduce and/or contain congestion and road accidents and improve air quality by decreasing the number of bus-km travelled once municipal and inter-municipal bus routes are rationalized.

The State has demonstrated its ownership of the project and support to the sector in the last 8 years by giving priority to investments in this area. The timely implementation and funding for infrastructure and equipment suffered during the periods of fiscal space restriction, but even then, the State provided the funds necessary to maintain the infrastructure and rolling stock or has sought mechanisms to provide the funds.

The BUI (Bilhete Unico Integrado) is likely to continue because both the State and Municipalities have understood how important it is for the low-income segments of the population. For instance, for line 4, the State is in charge of capital investments and the lines will be operated and run through a public-private partnership by a concessionaire at a tariff agreed in the contract. São Paulo Metro, as a whole, only receives compensation for special fares or tariffs (e.g. elderly, students) imposed by the State and there is a guarantee in the event the State fails to pay its dues. Therefore, the financial and overall sustainability of the project and institutions is likely. (Companhia do Metropolitano de São Paulo - METRÔ, 2009)

Due to the high demand in public transportation in São Paulo, the following question may raise: why do not State and Municipalities increase the price of the metro ticket if they have that high demand? One of the goals of the expansion, according to the Sustainable Development Department of the World Bank 2010 is to make the metro

system accessible for the whole community; therefore, they will try to keep the prices affordable.

2.4.4. Traffic and transport topics

Land use interaction

Catchment area

Once the new metro stations are in use, the buses get a new function of feeding the metro stations instead of transporting passengers from origin to destination. This will shorten the bus itinerary remarkably. The positive effect is that the new situation will increase the accessibility by foot and by car of the São Paulo metro for people that live in the catchment areas of those stations. A negative effect could be an increase in transfers for passengers who need to access the metro by bus. (World Bank, 2010)

The new metro line for will further expand the catchment area because integration with the current network. It is estimated that it serves 79% of the metropolitan poverty. Bringing poor people in a convenient way in contact with job centres would increase their living standards. Furthermore, it is estimated that the impact of line 4 will enhance the economic and social dynamics of its catchment areas, and will stimulate the development of larger suburban regions. This, in turn, will help reducing the inequality gaps between the different areas in the city. (M. Barone & J. Rebelo)

Societal impact

In order to trigger a change in society, the quality of urban transport will be improved by an improvement of accessibility, availability, acceptability and affordability of public transport, as stated before.

Mode shares

In the current situation, each day 39 million person trips are made within the SPMR. The shares of the different transport modes in São Paulo are as follows (World Bank, 2010):

- Walking 33%
- Private vehicle 37%
- Bus 23%
- Metro 4.5%
- Light rail 2.5%

In the current circumstances, 78% of the people traveling by metro need to transfer to another metro line or another mode of transport. This is a large disincentive for the metro systems and one of the reasons to expand the system. By the end of 2006, another major victory was realized by integrating the bus, metro and light rail systems with each other. One integrated ticket system was implemented which led to attracting more passengers from the road to the rail. One of the purposes of the new line 4 is to further integrate the different modes of public transport, as it links with all existing metro lines and several important light rail lines, heavily used by commuters.

The completion of Phase 2 of metro line 4 is expected to reduce the number of vehicle kilometers by road-based modes. Mainly buses will drive less kilometers because of shortening their itineraries while the metro expansions are finished.

One question that could rise is the affection of the Metro Expansion to the bus companies operating in the city. The buses will provide a new function as feeder for the metro system, so that, even if there are some lines that will notice the shift from the bus to the metro, other lines will start operating, entailing an improvement in the bus system.

Accessibility of low income

Public transport has become increasingly

more expensive. Ticket prices for buses doubled over the last 20 years, while fare prices for trains more than tripled. Consequently, many members of the low-income segment are unable to use multiple means of transport because the cost of an integrated fare remains beyond their reach. (World business council for sustainable development, 2009)

Poverty in São Paulo is characterized by unemployment and its location in the most peripheral areas of the city with a lack of public transport supply. The poor population is the farthest located from the job centers, giving them almost no job opportunities. Therefore, line 4 may be of strategic importance in the inclusion of such groups. The wide network integration created by this new metro rail will serve a very large catchment area. This will increase accessibility of the low-income workers to the most dynamic labor markets in the city, with cheaper and shorter trips. In the surrounding areas of line 4 there are approximately 1.2 million jobs, of which 30% are low skilled, as well as health and education facilities. Therefore, it is estimated that about 24% of line 4 users will be passengers living below the poverty line, a proportion that far surpasses their present participation in other metro lines (13%).

To make all these benefits accessible to the poor, it is essential that fares on the metro system be lower or equal to what buses charge today, especially since the road-based public transport system will be partially restructured to feed the metro. (M. Barone & J. Rebelo)

Operational performance

The São Paulo metro system had to deal with a fluctuating number of passengers in the beginning of this decade. The government is continuously working on improving the operation of the metro system. Apart from quantitatively expanding several lines, also some smaller measures are continuously taken in order to make the metro more attractive in a qualitative way for both business and leisure travel purposes. In order to improve the quality of the service, effective headway between trains has decreased remarkably. Furthermore, comfort of trains increased by reducing the number of passengers allowed on board.

Demand
The demand will be illustrated by providing the example of the situation in Line 4. After the implementation of phase I of this line, it attracts 704.000 passengers per day. After phase II comes in operation, the company expects 970.000 passengers per day. Many commuters belong among this number, as they can easily transfer from the light rail, which covers the outskirts, to the metro. With a capacity of more than 1.000.000 the metro line should be able to meet demand, however at high occupancy rates.

Accessibility
According to the sustainability basics, accessibility should replace mobility. Currently, it takes on average one minute to walk to a car, while it takes 6 or 7 minutes to reach a bus or metro station. The expanded metro lines should decrease this number drastically. Another important factor is travel time: currently average travel time of an average car journey is 27 minutes, while a trip with public transport takes on average 57 minutes. With an integrated public transport system, these numbers should change as well. (World business council for sustainable development, 2009)

Universal access of the operation became a permanent focus of Metrô de São Paulo. Examples are modifying internal layout of the trains, special phones for hearing impaired and equalizing pavements.

Maintenance
Much attention is paid to the maintenance of the network. The organization strives for a maximum availability of equipment and devices that contribute to a reliable operation. In cause of faults, the maintenance area works on a prompt reestablishment of functions, while on the other hand preventive activities take place in order to maintain a reliable system. Recent efforts developed a complex backup structure consisting of maintenance plans, logistic planning and scheduling of materials.

Public and operational safety
In recent years, the number of incidents in trains and around the stations decreased remarkably. Several measures are taken to improve public safety, for example the deployment of metal detectors and investments in training the staff. Furthermore, close cooperation with the fire brigade took place in order to handle efficiently in case of an emergency.

Customer service and communication
Communication and marketing objectives are (COMPANHIA DO METROPOLITANO DE SÃO PAULO–METRÔ, 2004):

- Maintain a good relationship with the population
- Strengthen the company brand image
- Stimulate the use of this safe and efficient mode of transport
- Reduce the time users spend in the system

To increase customer service, several cultural and social initiatives are implemented in the metro system. For instance, a free library art works on train stations. Furthermore, the metro service got involved in cultural projects, educational campaigns and social actions.

To enhance communication to the travelers, a wide range of information providing measures are implemented, particularly digitally. Through the internet, users can interact using the electronic communication channels.

Commitment
By showing commitment to the community, the company makes itself socially responsible. The company nowadays collaborates with social, leisure, entertainment, health and cultural initiatives. By showing children the importance of the subway to the quality of life in the city it fosters the relationship with future users. (COMPANHIA DO METROPOLITANO DE SÃO PAULO–METRÔ, 2004)

2.5. High-speed Train (TAV-Brasil) – São Paulo

2.5.1. About the project

The current transport system between Rio de Janeiro and São Paulo dysfunctions mainly from imbalances in its modal split, which results in a collapse of the network, including highways and air services (with regard to the terminals and the use of airspace). The transportation demand associated with imbalances in its modal split, produces high levels of saturation, which tends to worsen with the expected increase in economic activities in its area of influence. Therefore, the strategy of the Brazilian government to accelerate the growth of the economy is to develop a high quality rail service between the economically most important cities of Brazil. This consists of the deployment of a high-speed rail line between Rio de Janeiro - São Paulo - Campinas, complementing the road and air transport, using the technological solutions adopted in the major countries of Europe and Asia. The TAV project provides a unique opportunity to facilitate future development of the Rio-São Paulo region and to ensure a high performance link in terms of regularity, reliability, punctuality and com-

fort for passengers. The TAV project is part of the Growth Acceleration Program (PAC) from the Brazilian government, to stimulate the economy (Ministry of Transport, 2010).

For twenty years Agência Nacional de Transportes (ANTT) is studying the possibilities and design of a high-speed rail link as in countries like France, Japan and Germany. They need this information from abroad, because till ten years ago there was no passenger transport by rail over such big distances at all in Brazil. According to the latest plans, TAV will run between Campinas, São Paulo and Rio de Janeiro and the TAV alignment developed fulfils an aspiration to connect the airports of Viracopos, Guarulhos and Galeão to their metropolitan areas. The total estimated distance between Campinas and Rio de Janeiro is 511 km; with the distance between São Paulo and Rio de Janeiro approximately 412 km. A non-stop journey time between the two cities is estimated at approximately 1 hour 33 minutes. Journey times will vary depending on the number of stations stops, with a high-speed long distance service between Rio de Janeiro to Campinas taking up to 2 hours 27 minutes.

Scope

High-speed rail is best suited to city pairs where their distance apart is less than 500km to 600km; beyond this distance, air travel becomes competitive and the relative market share of high-speed rail declines.

The principal characteristics of high-speed rail are (HALCROW, 2009):

- competitive city centre to city centre journey times compared to air achieved by high-speed running;
- very high train capacity with between 450 and 750 seats depending on configuration and length;
- new dedicated fully grade separated alignments operationally independent from existing conventional railway infrastructure, in most cases;
- frequent clock-face services with limited station stops to achieve competitive journey times;
- high levels of passenger comfort including executive and economy classes and catering services;
- high performance and punctuality; and

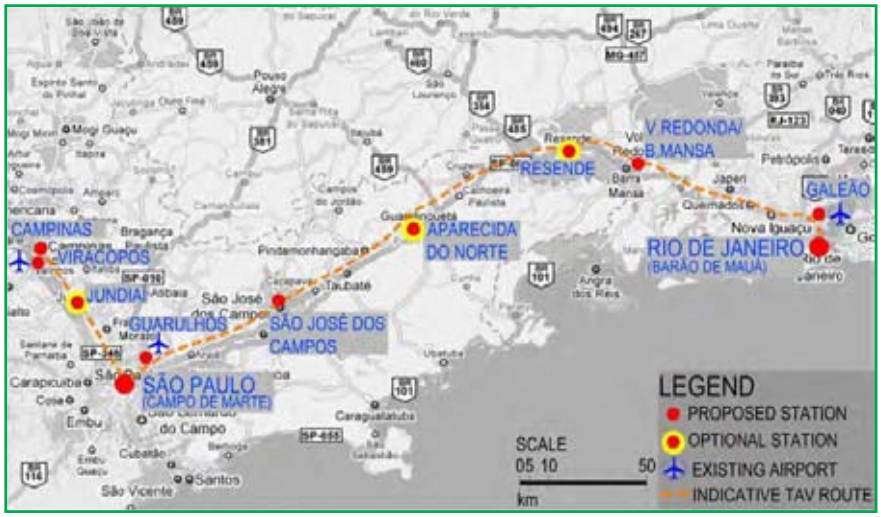

Figure 2.2: TAV traject

- conveniently located stations, often with better accessibility compared with airports.

With the TAV project, the Brazilian government aims at (Federal Government of Brazil, 2010):

- Reducing the emission of busses and private cars
- Reducing the pressure on the existing road and airport infrastructure
- Boosting regional development, with intense generation of direct and indirect jobs
- Reducing travel time
- Reducing accidents and congestion on highways and in urban areas
- Boosting technological development of the Brazilian transportation system

2.5.2. Construction topics

From a construction point of view, there are several interesting topics to focus at. In the light of this theme, developing the Brazilian economy, it is interesting to zoom in on the economical effects of the high-speed rail link. To what extend does the TAV contribute to develop, in a sustainable way, the economy?

In order to do this, the cost and benefits of the project will be analyzed. The costs and benefits can be seen as social, environmental and economical costs (people, planet, profit). Next to that, the financing and tendering of the project will be discussed.

Costs of TAV

The costs are divided in capital expenditures (CAPEX) and operating expenditures (OPEX). The capital expenditures are the investments made for constructing TAV, the operating expenditures are the costs to operate the TAV during the life span. Both CAPEX and OPEX can be divided in social, environmental and economical costs, or a mixture of these.

CAPEX

CAPEX includes the construction, obtaining the rolling stock and implementation of all systems and subsystems for the project. The total capital expenditures are estimated at €14 billion. Civil engineering works contribute for almost 60%, and social-environmental works contribute for approximately 11%. The other costs involve mainly the rolling stock, system elements of the railway track and services as project management, design etc. The plan is to drill tunnels under the urban area with a total length of 46 km and a total cost of €1,6 billion (12%) The drilled tunnels have a minor impact on the direct environment, since affected parties do not have to be resettled (HALCROW, 2009).

It is, from a sustainable point of view, interesting to zoom in on the social-environmental costs of approx €1,5 billion. These costs are calculated by the consultancy firm Prime Engenharia commisioned by the Inter-American Devloment Bank. Approximately 15% of this €1,5 billion is caused by land acquisition and the largest part, over 40% by indemnification of constructions, owned by private parties. Just a small amount, less then 1%, is estimated for resettlement of low income families. In total, 5000 families have to be resettled. Prime Engenharia concludes that this is a modest amount of a project of this magnitude, but explicable by the effort to establish a route that relieves the urban areas by implementing a tunnel and minimizing the displacement of population (Prime Engenharia, 2009).

Another notable item is the environmental impact of TAV. Until yet, there is no study that calulates the effects on the environment in detail. Prima Engenharia doesn't

have accurate information to calculate the costs of environmental compensation and they just use a rule of thumb to do this. It is not clear if this rule of thumb is appropriate for the TAV project, also not after visiting Brazil. Nevertheless, they do have some calcualtions of forest compensations. They calculated the amount of forest that has to be replaced by the TAV project. There are also calculations for noise reduction along the TAV track. These environmental aspects in total account for 20% of the social-environmental costs and for 2% of the total CAPEX (Prime Engenharia, 2009).

OPEX

The operational costs of TAV Brazil involve maintenance costs of the infrastructure, organizational costs, maintenance of rolling stock and additional costs. The graph in figure 2.3 shows the estimated operational expenditures during the appraisal period of 40 years.

The total amount of operating costs over 40 years is estimated at €8,3 billion. Due to the expected increasing demand throughout the years, the operational costs will increase as well. Calculations show that the rolling stock of TAV already in 2017 reaches its maximum capacity during peak hours. This problem can only be solved by buying new trains and marketing strategies as price discrimination to encourage travel in off-peak hours. Concurrently with more trains, energy costs, maintenance costs, staff costs etc. increases as well. In 2022 and 2030 happens the same but next to buying new trains, also the frequency of the trains can be raised and train service turnaround times can be shortened. Note that these capital investments are not included in the CAPEX of the HALCROW study. Furthermore, the proposed layout of the TAV and capacity studies are

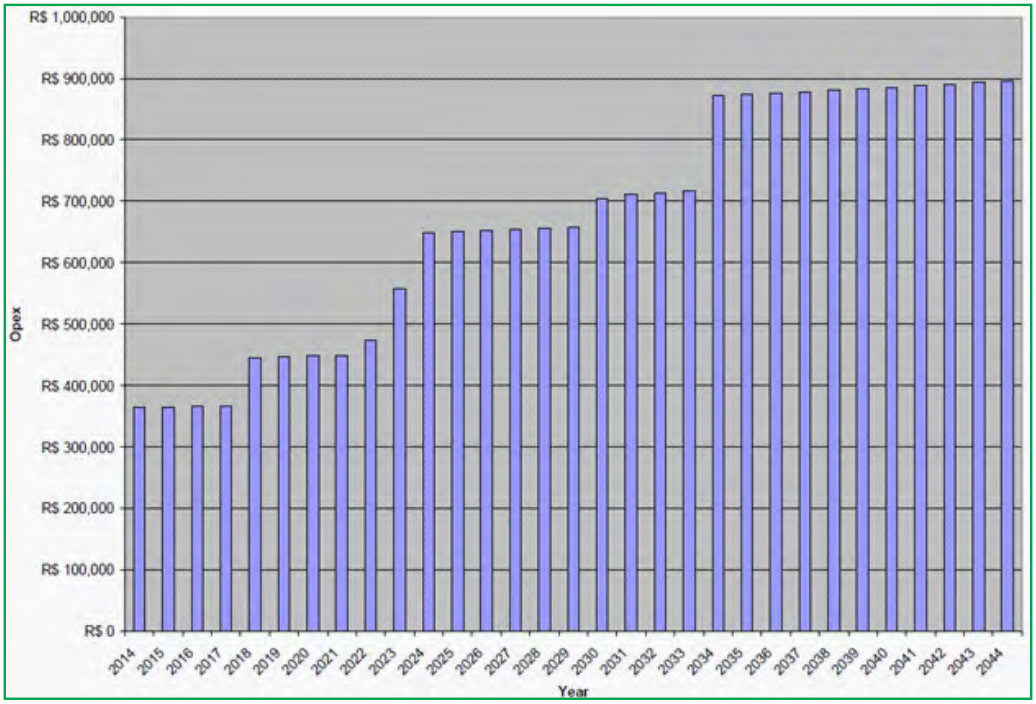

Figure 2.3: OPEX 2014-2044 (R$k constant) (HALCROW, 2009)

quite contradictorily as the capacity study show that in 2038 the track capacity of TAV will be too low handle the peak hour demand. Additional track capacity is required to solve this problem, which is not included in the CAPEX (HALCROW, 2009).

From a sustainable point of view, it is interesting to look at the energy consumption of TAV. Estimations show a energy consumption of approximately 2,5 billion kWh in 2014, which is 0,6% of its total usage for the whole country (402 billion kWh). In the light of sustainability it is good to note that 85% of the energy production in Brazil is provided by hydro-electric plants. This means that TAV theoretically could run on a renewable energy source and therefore could be more sustainable than a bus, car or plane. Could be, because a hydro-electric plant doesn't have to be that sustainable in ecological terms. For example the Balbina Dam (see chapter 'Contradictions in the Amazon').

Benefits of TAV

The benefits of the TAV project are elaborately discussed in the HALCROW report and used here. HALCROW uses a transparent spreadsheet-based model which is consistent with best practice and draws on the structure approved by the World Bank for the financial and economic appraisal of major infrastructure projects. The total benefits estimated over an appraisal period of 40 years are estimated at approximately €35 billion.

The benefits are very broad. They can be divided in economical, social and environmental benefits, or combinations of those. All kinds of benefits, from travel time savings, decongestion benefits to reduced carbon dioxide emissions and real estate development are included in this study. It should be noted that these benefits account for the Brazilian economy in general and not especially for the TAV project itself. That means, that the parties that make the expenditures doesn't necessarily earn the benefits.

The next paragraphs points out the benefits shortly (HALCROW, 2009).

Economical

- **Travel time**: Significant time savings will accrue to travelers who currently drive or travel by bus and who would divert to TAV, for both the substantial short-distance regional flows and longer inter-urban flows. Air travellers who switch to TAV generally also benefit from a marginal improvement in journey time but, more importantly, will gain from an increase in productive working time during the TAV journey: these benefits are added to the savings accruing to former road users.
- **Decongestion**: Diversion of passengers from road to TAV will reduce congestion and journey times in the corridor for road users who do not divert to TAV (non-users). This generates economic benefits due to time savings for vehicles remaining on the road network.
- **Operating costs decrease**: TAV will produce significant overall savings in vehicle and aviation operating costs, as travelers divert from road vehicles or air to the more efficient high-speed rail TAV service. Note that these operating costs of the TAV omit these benefits.
- **Investment cost delayed/avoided**: The domestic airports of Rio de Janeiro and São Paulo are constrained in terms of capacity, by terminal building capacity and runway and airside capacity. Their urban location restricts the expansion of airside capacity. Investment in TAV will reduce and delay the need for investment to upgrade the two city centre airports.
- **Induced demand/regional development**: The introduction of TAV can be an op-

portunity to renew and/or strengthen the regional and urban economy and to improve the prestige, image and attractiveness to investors of the urban regions. The benefits can be measured by the level of induced traffic generated. These travelers on average benefit from half the travel time savings which accrue to travelers who transfer from existing modes.

- **Real estate development**: In line with the regional development, the real estate around the stations of TAV will develop as well. Land prices are likely to rise. It is more attractive to settle down close to the stations due to the increased accessibility of the location. A perfect example in Brazil is Curtiba's Bus Rapid Transit system, which has a strip of skyscrapers along the BRT line.

Social

- **Improved quality of ride and ambience**: The TAV provides a safe and convenient way of travelling. Travelers enjoy the ambience of modern transport. Business travelers can use their travel time as productive work time. It is difficult to express this in monetary terms.
- **Accidents decrease**: Diversion from road to rail generally leads to a significant reduction in accidents as rail is a much safer form of transport. Road accidents are a function of traffic volumes and traffic speeds, as well as the number of conflicts between road users. For example, urban areas generally have relatively high accident rates despite relatively low average speeds because of heavy traffic volumes and the number of junctions. At the moment Brazil suffers from poor road safety, with around 40,000 deaths a year as a result of road accidents. By contrast to road travel, accidents on segregated high-speed rail such as TAV are extremely rare. HALCROW assumes a zero rate of accidents for the appraisal period of 40 years. It is unclear if deaths caused by suicide attempts are considered as well.

Environmental

- **Carbon dioxide reduction**: TAV will generate environmental benefit by reducing carbon dioxide emissions. As the carbon dioxide emission of a train is generally lower than a car or plane. On top of this reduction comes the fact that TAV has the potential to run on hydropower electricity.
- **Reducing air pollution**: TAV can reduce air pollution as a result of private cars, busses and planes, especially in the crowed urban areas. Due to shift from road and air traffic to TAV, fewer vehicles are on the road.

Assumptions

Several benefits are discussed above. It is very difficult to express these benefits in monetary terms. HALCROW tried to do this, but they had to make many assumptions. For example, they fixed the currency exchange rates to the year 2009, they assume a steady amount of GDP growth etc. Also, they use their estimated demand and revenue analysis, which has many uncertainties in it. In Brazil they told us that bus and airline companies will not be compensated for their loss of revenues due to TAV, but how will the airline companies react to these developments? And they executed site surveys to examine the choice behaviour of possible TAV passengers, but will they do what they are expected to do?

They assume an appraisal period of 40 years in this study. 40 years is long time, especially a strong developing country as Brazil. Until now, high-speed trains only exist in developed countries. Benchmarking of TAV is done between these high-speed train systems, but can you compare Brazil to, for example France or Japan like that?

Another point, the constructions should start in 2010, and be finished before the World Cup in 2014. It is clear now that this will not be the case. The TAV will not be finished in 2014, hopefully in 2016, before the Olympics. This is also confirmed by the Brazilian government (Morris, 2010).

These are just some examples of the uncertainty that are present in studies to TAV. In general we can say that they overestimate the benefits and underestimate the costs. An optimism bias is usually present in this kind of plans. A striking example comes from the Netherlands where they build a new metro line in Amsterdam. They underestimated the costs and overestimated the benefits, in order to make this project beneficial to the public. Several aldermen had to leave because of this scandal, but the construction still proceeds and will be finished by 2017.

Tendering and financing

The Brazilian government tenders this project as a concession contract for 40 years. The concession consists of the exclusive right to operate TAV, as well as designing, building, financing and maintaining the TAV. This will be accommodated in an integrated DBFMO contract. A special purpose company (SPC) will be founded for this project. This SPC is a legal entity that exists only for this project. Both the government and a private party (consortium that wins the tender) are shareholders of this entity. Both parties bring in a certain amount of money to finance the project. The Brazilian development bank BNDES, the main state-run funding agency, will provide 60% of the finance. Another 10% will come from the Eximbank, a public credit agency for import and export. This money is mainly meant for the rolling stock. The other 30% should be provided by a private party (Ministry of Transport, 2010).

The Brazilian government aims at lowest public funding as possible, but has to invest a vast amount of money in order to make the financing attractive enough for private parties to take risks and responsibility for the implementation of the service and its future operation. Risks are accommodated in a legal construction; the only public risks are construction risks and the risk of not meeting the expected demand. Financial guarantees will be given by the government at start of the project. This will slowly decrease over the lifespan of 40 years of the project.

The criteria to win the tender are quite simple: the one who requires least public funding, the one who charges the lowest fare to the end user and the one that has the lowest price per kilometer track wins the tender. Moreover, the government requires prequalification in some minimum technical requirements. For example: bidders must have technology and experience in operating high-speed trains. Next to that that 60% of the components used in the construction process shall be of national origin, with transfer of technology for local assembly (Revista Ferroviária , 2010). This is, from a sustainable viewpoint very positive, as transportation costs and environmental burden decrease.

2.5.3. Traffic and transport topics

For the traffic and transport part of this chapter there will be a research about the market, the model split, the capacity and the expected frequency of transport. Furthermore there will be checked how stakeholder participation and future expansions are taken into account.

Demand

The region of Rio de Janeiro, São Paulo and Campinas is the most important economic region of the country. The states of Rio de Janeiro and São Paulo contain 30% of the Brazilian population and 45.5% of its GDP.

The total population of the area of influence is over 36,422,964, mainly concentrated in the metropolitan regions of São Paulo and Rio de Janeiro. Population has grown substantially in the past 40 years, particularly in São Paulo and Campinas, increasing the potential market for TAV. The TAV provides an opportunity to connect the cities to support further economic growth. (HALCROW, 2009)

GDP in Brazil has grown strongly in recent years. GDP growth is strongly linked to demand for travel, due to additional travel demand from business trips, while leisure travel increase as residents are more able to afford leisure travel. The states in the area of influence have average household incomes well above the national average, which is R$ 9,300. The high GDP/capita in the São Paulo region reflects the greater proportion of financial services here compared to that of Rio de Janeiro. The surrounding regions of Rio de Janeiro and São Paulo have higher GPD/capita than the metropolitans itself. The TAV route will connect the regions with high levels of GDP per capita, especially in the corridor from Campinas to São Paulo. (HALCROW, 2009)

Model split

The recommended modeling approach to estimating high-speed rail ridership is to use revealed preference (RP) and stated preference (SP) survey techniques together with Logit models. Logit models are commonly used in transport planning to estimate market shares i.e. diversion rates from air to rail, car to rail, and bus to rail and so on, and are therefore ideally suited to modeling the introduction of TAV. The methodology used in this TAV study is consistent with that used for other high-speed rail projects, notably in the UK and Spain.

Overall there will be 33,6 million transfers a year between the different cities. Without TAV 14% uses air transport, 35% bus transport and 51% private car transport. With the introduction of the TAV 7% will use air transport, 13% bus transport, 26% private car transport

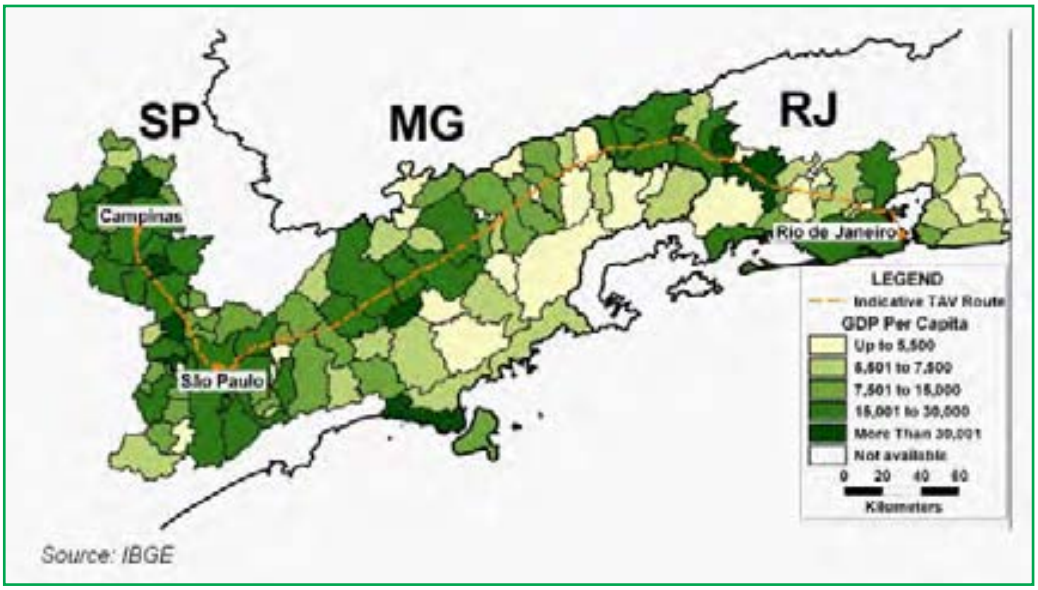

Figure 2.4: GDP by administrative area (HALCROW, 2009)

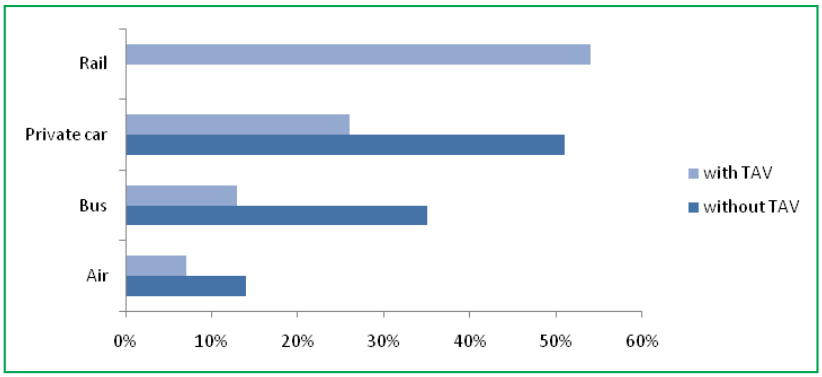

Figure 2.5: Model Split without and with TAV (HALCROW, 2009)

Table 1-2: Passenger demand, Rio de Janeiro - São Paulo 2014

	Without TAV		With TAV	
	Passenger Demand ('000)	Mode Split (%)	Passenger Demand ('000)	Mode Split (%)
TAV	–	–	6,435	52.89%
TAV Executive	–	–	4,938	(40.59%)
TAV Economy	–	–	1,497	(12.31%)
Air	7,333	68.34%	3,907	32.11%
Car	1,757	16.38%	960	7.89%
Bus	1,640	15.28%	865	7.11%
Total	10.730		12.167	

Table 2.2: Model split Rio de Janeiro – São Paulo (HALCROW, 2009)

and 54% rail transport to travel between the different cities.

The main goal of the introducing the TAV in order to reduce emissions caused by busses and private cars will succeed. The TAV will cover a large part of the demand. At least on short term perspective, because the demand will grow anyways. In the beginning the emissions will be reduced due to a shift to rail transport, but on the long team demand will increase. So road transport (and their emissions) will increase a well. The emissions will only be relatively reduced, compared to the situation without TAV.

A particular model split for transport modes between Rio de Janeiro and São Paulo shows an estimated demand of 10.7 million trips in 2014. Without TAV 68% of transport is done by air, 16% by private car and 15% by bus. The air shuttle, which has a 15 minute frequency, a 55 minute gate-to-gate travel time and currently 71 daily flights in each direction, dominates the market for time sensitive business passengers. Due to its location close to the CBD's of the two cities and internet check-in it provides a great flexibility to the traveler. (HALCROW, 2009)

Introducing TAV increases the market between the two cities to 12.2 million trips of which the TAV has an estimated ridership of 6.4 million passengers and market share of 53% of the total market. In the air/rail market the TAV's market is 75% in the off-peak

and 55% in the peak. In 2044 TAV ridership is forecast to increase to 24.9 million between the two cities. (HALCROW, 2009)

The largest flow by volume is between São Paulo and Campinas at 12.4 million passengers. The TAV is successfully here in diverting demand from car from 56,8% to 16,0%. Also at another short journey that has a high work trip purpose, Rio de Janeiro – Volta Redonda, the TAV successfully diverts demand from car to TAV. As mentioned before this is only on short term perspective as demand will increase eventually.

The largest station by demand volume in 2014 is São Paulo Campo de Marte at 27,5 million passengers a year, or approximately 75,450 per day. The second largest station is Campinas with 15,1 million passengers a year. Passenger volume is important when considering station capacity and design. (HALCROW, 2009)

Capacity

TAV will have a very high capacity compared with other transport modes; for example, Eurostar services between London and Paris can accommodate 750 passengers per train compared with an Airbus A320-200 series with 148 seats, used on internal short haul flights. However, the capital cost of high-speed rail is very high (around €40m per km), but it creates very high capacity and is therefore most economical when trains are running at capacity when there is high demand. High-speed rail therefore lends itself to city pairs with high existing demand, as is the case between Rio de Janeiro-São Paulo and São Paulo-Campinas. (HALCROW, 2009)

Congonhas airport is presently close to runway capacity. It can accommodate 23 landing/take-off operations per hour under instrument conditions and up to 34 operations under visual conditions. The airport is operating above maximum capacity of instrument conditions. So any deterioration in weather leading to the need for instrument landing causes disruption to flights. One solution for the capacity issues at Congonhas is to reroute flights to other airports i.e. to Guarulhos to release landing/take-off capacity, improve operational performance and to allow the increase of flights to Santos Dumont. At Santos Dumont there are 16 landing/take-off

	Rio de Janeiro – Volta R	Rio de Janeiro – SJdC	Volta R – SJ dos Campos	Volta R – São Paulo	Volta R - Campinas	SJ dos campos – São Paulo	SJ dos Campos - Campinas	São Paulo – Campinas	Total
Mode Split without TAV (%)									
Car	82,8%	38,1%	47,1%	70,8%	50,0%	65,6%	39,3%	56,8%	60,4%
Bus	17,2%	61,9%	52,9%	29,2%	50,0%	34,4%	60,7%	43,2%	39,6%
Mode Split with TAV (%)									
TAV	76,1%	74,8%	74,3%	66,7%	78,4%	71,1%	63,5%	72,9%	72,1%
Car	16,3%	10,3%	6,7%	28,6%	13,7%	15,7%	7,8%	16,0%	15,4%
Bus	7,6%	14,8%	19,0%	4,7%	7,8%	13,2%	28,7%	11,1%	12,5%
Revenue (R$/year, in thousands)									
	105,284	21,585	17,374	17,940	4,740	246,326	63,945	386,006	863,201

Table 2.3: mode split between the regions (HALCROW, 2009)

operations per hour, while it has the same capacity as Congonhas. So under the most severe conditions there is still room for 30% possible flights. Galeao and Guaralhos have room for flights between the cities, but generally concentrate on international flights. (HALCROW, 2009)

The cities of Campinas, Rio de Janeiro and São Paulo all suffer from congestion. The increasing private car ownership will increase the number of private cars wishing to use already congested urban highway capacity. Accessibility to both the proposed TAV stations and airports will therefore become an increasing factor in mode choice in future years. There are plans to increase highway capacity and to improve local public transport. (HALCROW, 2009)

Fares

HALCROW determined revenue optimized fares for TAV. Based on the express model, with considered lower fares for TAV than air and model split more sensitive for price than time, a combination of R$200(economy)/ R$325(executive) for peak fares and R$150(economy)/R$250(executive) for off-peak represented the highest revenue.

In 2001 airfares within Brazil were deregulated and are now priced based on what the market will bear. The precise nature of the competitive response from the airlines to the introduction of TAV is difficult to model, as journey times and capacity are fixed. Price competition is most likely to happen. Hence it is reasonable to assume that the airline will lower their fares at the margin in response to TAV. An airfare reduction of 10% will result in almost 4% fewer economy class passengers using TAV, but only 3% fewer executive class users. Economy class travelers are more price sensitive and therefore more willing to change mode to save money rather than time. Bus and air companies will not be compensated for loss of passengers, because the introduction of the TAV will reduce pressure on the existing system by generating more capacity and the demand will practically grow anyways.

Participation process

There is no information about the participation process of the TAV project. It is not clear how the affected stakeholders can par-

	TAV	Air	Bus	Car
Access Time/Cost	Varies by Zone in model	Varies by Zone in model	Varies by Zone in model	Varies by Zone in model
Journey time (in Vehicle Time - IVT)	1 hour 33 minutes (based on indicative alignment and simulation)	55 minutes assumes no delay (airline published time)	6 hours (based on 85km/h operation)	5 hours
Check-in (assume this is valued at IVT)	5 minutes locate platform and board, find seat, 4 minutes to exit station. (NB assumes no security checks)	50 minutes to check in, clear security, board, disembark, and walk to gate. 5 minutes to exit airport to locate taxi queue (add 10 minutes to collect bag for NW trips)	10 minutes, locate bus, pay, board etc. 5 Minutes to exit bus station	None
Total Journey time	1hour 33 minutes IVT 5 minutes Embark 4 minutes Disembark 1 hour 42 minutes	55 minutes IVT 10minutes Embark 5minutes Disembark 1 hour 50 minutes	6 hours IVT 15 minutes embark/disembark 6 hours 15 minutes total	5 hours
Delay (not modelled as stochastic delay)	5 minutes of delay. HSR is extremely reliable based on international benchmarks	Both domestic airports have very poor performance. 30 minutes of delay time. Maybe higher. Not assumed to deteriorate or improve over time	30 minutes. Not assumed to deteriorate or improve over time	30 minutes. Not assumed to deteriorate or improve over time
Frequency	20 minutes at peak 40 minutes off peak	30/15 minutes depending on airline	15 minutes	n/a
Peak Fare (Economy)	R$200	R$400 (based on GOL operation including taxes)	R$87	R$137.12 (inc tolls and VoC)
Peak Fare (Executive)	R$325	n/a	n/a	n/a
Off Peak Fare (Economy)	R$150 (above bus fare but cheaper than air)	R$180 (based on GOL operation including taxes)	n/a	n/a
Off Peak Fare (Executive)	R$250	n/a	n/a	n/a

Table 2.4: Key Assumptions for express model Rio de Janeiro – São Paulo (HALCROW, 2009)

ticipate in the decision making process. For example, are the 5000 families that have to be resettled willing to move? And do they have rights to dispute the plans? Do they have the possibility to participate in this process? But not only inhabitants, also companies along the route must have a stake. To what extend are these parties involved? From cases in The Netherlands, we learn that if you involve affected stakeholders in the process, you can create commitment and understanding. It is worth to invest in this kind of involvement, in order to get the ideas in the same direction. It can be sustainable to involve the stakeholders, as for example social problems related to inhabitants can be considered in a project as well. Without scientific knowledge it is likely to think, based on other projects in Brazil, that the level of participation will be low.

Future plans

In the future there are plans to expand the TAV to Curitiba and to Brasilia. It is even possible to expand the rail link to Belo Horizonte, connecting all the big cities in south-west Brazil. Despite the forecast that TAV tracks will reach its maximum capacity in 2038, there are no plans yet to expand the rail link between São Paulo and Rio de Janeiro in order to create more capacity.

There are also some plans which may affect the TAV usage. There is a plan for high capacity transports systems between Barra Funda station in São Paulo and the city of Guarulhus, decreasing journey times between Guarulhos Airport and São Paulo making it more attractive. A plan for a light rail from airport Congonhas to the metrosystem of São Paulo. Plans to connect the highways of Rio de Janeiro outside the city, so that congestion will decrease. Same for São Paulo with a highway ring around the city. These plans make the other transport modes more attractive and so its possible that it would impact the TAV.

2.5.4. Criticisms

Not everybody is happy with the proposed high-speed train. There are some criticisms on the TAV project, summarized below. It is not clear how the Brazilian government will deal with this. It is inappropriate to ask these kind of sensitive questions to the people in Brazil.

- The airport Campo de Marte in São Paulo is nowadays used for traffic helicopters and small planes. Due to the TAV, this station will be rebuild and adapted to the TAV. As a result of this the air services have to be reduced to helicopters only. The Brazilian Association of General Aviation (ABAG) is against this proposal, as this airport is the fifth largest airport of Brazil, serving general aviation in São Paulo. Using the international airport of São Paulo isn't an option, as there is no room for small planes there. The National Agency for Land Transport (ANTT) selected Campo de Marte as a station of TAV over another option, the Terminal Barra Funda, in the west, which would not have space to house the courtyards of the trains (Gonzales, 2009).
- Professor Eduardo Fernandez Smith, legislative consultant for the economy, says that the TAV project is not economically feasible, since the flow of passengers required for the project to succeed, according to government study, would be 32 million people, compared with total of 8 million trips between the two capitals in 2006. Moreover, in addition to quadruple in a few years, the flow should occur only by the tracks, discarding the use of planes, buses and cars (Dia Online, 2008).
- There is a feeling, that the TAV project is a waste of public money in just one project, while urgent social problems remain unsolved, such as health, education and public safety. They argue that it

is more important to break the queues in hospitals than with check-in queues at airports (Wikipedia, 2010).

- At location they told us that the public opinion about this project is mixed. People in São Paulo think the TAV project is a good thing, because it will boost local development. On the other hand they afraid that it will attract more passengers to city that's already too big, since transport from São Paulo will be much easier en quicker. People from Rio de Janeiro are positive about the TAV project. They think the introduction of the TAV will bring companies back to Rio de Janeiro who left the city after it lost his reputation as capital.

2.6. Link between both projects

After visiting both projects, a question arose: regarding the linkage between these two railway modes, how should the planners deal with the connection to the airport? Both rail modes are expanding and have plans to connect to the international airport of São Paulo.

One possibility would be expanding the metro to the airport. The expansion of the metro should serve as a means to integrate better the transport modes in the city. Facilitating the linkage between the city centre and the airport would reduce the current congestion in the roads facing the airport. It would be positive for the passenger using the TAV travelling between the cities. One of the main reasons to take the TAV is to connect both downtowns minimizing travel time. An extra stop at the airport would delay these trips.

On the other hand, some planners propose to create a TAV stop in the airport in order to transfer some passengers from São Paulo airport to the Galeaos airport in Rio de Janeiro. According to Infraero, the São Paulo airport is already overcrowded: its capacity is 12 million passengers per year while it is currently processing over 17 million per year. This option would benefit both cities, improving the quality of service in São Paulo airport.

The same discussion is going on in the United Kingdom. They are planning a high speed rail link between London and Birmingham. Some politicians propose a direct connection to the Heathrow airport, since the airport is reaching its capacity and a high speed rail connection will relieve the pressure for domestic journeys. However, a high speed rail connection makes the airport better accessible for the surrounding region, which attracts even more passengers. But the region simultaneously profits from its increased accessibility. The main argument against the airport connection is the travel time between the cities. The main purpose of this high speed rail link is to give direct access into London and not via London. This is a difficult discussion and it is yet not clear what the outcome will be (Freemark, 2010).

In France they connected in 1994 Paris and Lyon with the TGV, including stops at both city airports. At Lyon's airport station only 400.000 passengers a year transferred, compared to a typical city station that transfers around 2,2 million passengers (for example Avignon TGV station). The explanation for this low ridership can be that passengers on the same TGV line also have a connection to Paris' Charles de Gaulle airport, which is France most important airport hub. This situation is not likely to happen in Brazil since both Rio de Janeiro and São Paulo have large international airports (Freemark, 2010).

Also on the high speed rail link between Paris and Amsterdam (Thalys), there are stops at both international airports. The air service between those cities has significantly redu-

ced due to the high speed rail. Because of this, airline companies made an agreement with Thalys for the rail service. AirFrance actually books seats on Thalys trains. But this is maybe no option for TAV, as they indicate that airlines will not be compensated, since the demand will grow anyway (United States Government Accountability Office, 1994).

Many companies will be located between São Paulo and Rio. It is expected to develop the region and create additional stops between both cities. A stop in the airport would be desired for likely passengers arriving by plane to São Paulo. Therefore, it is probable that the companies in the region will support this option. This option would also be favorable regarding the development of the Brazilian economy. However, travelers only have to change one (metro) to get a connection to TAV. Since a main purpose of TAV is to minimize the downtown travel times, a stop at the airport is not favorable. It is difficult to determine if there is a better option. The following table summarizes some advantages and disadvantages of the connection of São Paulo's airport to the metro or TAV.

Based on Table 2.5, we analyze the pros and cons in order to conclude which is the most appropriate choice for the stop at the São Paulo airport. Making the TAV stops at the airport would develop the economy of the region. It is preferable for both, private and public administrations to spread the financial activities all over the region, instead of keeping them in the already overcrowded São Paulo. Nowadays, there are some companies located in the area like Embraer. The possibility to stimulate the business activity in the area would create employment and

		TAV			
		Yes		No	
		Pro's	Con's	Pro's	Con's
Metro	Yes	Relieve pressure on existing airports Alternatives offered to travelers	Share demand of passengers Large investments	Minimal city-to-city travel time Affordable solution to downtown area High frequency	Accessibility of surrounding region doesn't improve directly Invest in new airport terminal Long travel times
	No	Relieve pressure on existing airports Increase accessibility of surrounding region Boost economy	Increasing city-to-city travel time Attracts even more passengers from surrounding region to already crowded airport	Avoiding a conflict Minimal city-to-city travel time	The airport should be accessible by either metro or TAV Taxi is a bad alternative

Table 2.5: Comparison TAV or Metro to São Paulo airport

attract more citizens to live and work in the region. Thus, this solution entails a long-term planning.

Regarding the short-term issues, a metro stop at the airport would be beneficial for users going to downtown from the airport: waiting time would be reduced. Besides, travel time from downtown to downtown would decrease by using TAV.

As the main question of our research focuses on the development of Brazilian economy, we consider that a TAV stop at the airport would stimulate the creation of new companies and would serve the region better. Spreading the economic activities would create more jobs in the suburban region. According to the data provided in the visits, around 6 to 7 million people that live in the outskirts have to travel to the city center every day to work. Avoiding these trips, would be sustainable: we would be reducing pollution and the undesirable concentration of industry.

In order to compensate for the alternative solution it would be possible to make some trains skip the airport stop and run directly from downtown to downtown.

2.7. Conclusion

The Metro Expansion will keep up the demand for a better infrastructure in the inner city of São Paulo. The TAV project is an ambitious project of the Brazilian government to improve the connection between Rio de Janeiro, São Paulo and Campinas. Both projects will relieve the pressure on the existing transport system and will prepare the most important cities of Brazil for the future. Both projects will boost the national and regional economy and attractiveness. The upcoming World Cup event and the Olympics are main drivers for these projects. However, this research aimed at, in relation the topic of this study tour to investigate to what extend this project will contribute, in a sustainable way, to the development of the Brazilian economy. Therefore, the aspects people, planet and profit will be discussed here.

2.7.1. Metro Expansion

People

From the point of view of the people, the expansion of the metro is supposed to make the metro more accessible for low income population. In order to do so, they are making new stations accessible by changing the purpose of the bus lines. Instead bringing people from A to B, the bus will serve as a feeder to the metro stations. This way, people who do not live close to the metro stations can use the metro as well. Increasing the connections is beneficial and creates employment.

A potential negative effect for the people could be the increase of the prices in the surroundings of the metro stations.

Planet

The project will be very sustainable in the long term. The CO_2 emissions will be reduced. People will change from car/bus to metro, therefore it will increase sustainability. Besides, public administration is investing in research to develop the ecologic bus or a Green Station that minimizes the energy waste.

Profit

The project will create employment, not only during the construction but also during the operation of the Metro Lines. A lot of labour will be needed because of the creation of the new metro and bus lines, new business and real estate around the affected areas.

2.7.2. High Speed Train (TAV Brasil)

People

It is not clear how and if participation of affected stakeholders exists. By involving the stakeholders, social problems related to the inhabitants for example, can be considered as well. This helps to make the TAV project successful from a social sustainable viewpoint. Concurrently, a vast amount of money is invested in this project, but social problems as wealth disparity, criminality, and health problems remain unsolved. To what extend is this still sustainable? Next to that, how are decision makers politically influenced? Do they want this project executed as a matter of prestige, regardless the (social) costs? These are some (sensitive) questions that remain unanswered, even after our visit.

Planet

The TAV project is quite sustainable from an environmental viewpoint. The project reduces the amount of air and noise pollution, especially in the crowded urban areas. Carbon dioxide emissions will reduce as well and the energy needed for the train can be provided hydro-electric dams. Also the requirement of the government to produce 60% of the construction material at local scale, contributes to a sustainable development. Due to the growing future demand, the number of planes, cars and busses is not expected to decrease on the long term. However, this can be sustainable since without the TAV the number of planes, cars and busses would be even higher.

Profit

It is commonly recognized that a high-speed line like TAV will boost the national and regional economy. Examples outside Brazil show the same effects. The value of land and real estate around the stations will increase. The line will induces employment and contributes to the accessibility and attractiveness of the region. However, the HALCROW study is elaborated, but not complete. A real trade-off of costs and benefits misses. Therefore, it is difficult to conclude whether this project can be feasible or not. Usually they overestimate the benefits and underestimate the costs. It is not clear how they deal with this issue. A conspicuous item is the fact that according to demand studies the maximum capacity of the TAV will be reached in 2038. Expanding the system with new tracks is the only way to solve this problem. It is unclear how they will deal with this.

Based on our preliminary and onsite research, we can conclude that both projects will contribute to the development of the Brazilian economy. Both projects have several sustainable elements, but it remains difficult to conclude whether these projects contribute in a sustainable way to this development. In general we can conclude that the Brazilians first arrange their basic transportation needs before thinking of sustainability. In the Netherlands, we are probably one step ahead; we are optimizing what we have. But in Brazil, they first need to have something to optimize.

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3. CONTRADICTIONS IN THE AMAZON

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3.1. Introduction

Brazil is a growing economy, which develops rapidly; it is on its way becoming more and more important in the world economy. Because of that, the country has taken several initiatives to improve the economy and the overall quality of life. This can be seen through the whole country, also in the Amazonas.

The Amazon is one of the most species-rich regions on earth. The Amazonas state however has to cope with major human expansion, (urban) development takes place on a large scale and the state has turned into a major industrial centre. These developments are reflected in several initiatives which have been taken the last years. For example, in Manaus, which is capital of the Amazonas state, a large bridge over the Rio Negro is in construction to boost the socio-economical situation of the region and to connect Manaus with Iranduba, another main city of the state. Also, twenty years ago, a large hydro-electric dam has been built in the Uatumã river, to generate electricity and to show the world how powerful Brazil as a nation can be.

These two projects in particular have been the subject of some discussions about whether they are sustainable or not. Some people have their concerns about whether the projects will destroy the rain forest, while others think economic growth is more important than the environment. This is a very interesting discussion for research in our study tour; it is interesting to find out whether these projects are sustainable or not.

Therefore, the main goal of this particular Micro Study has been formulated as to find out whether these projects bring sustainable changes or not. In other words, we try to answer the following research question: "how does the project change the environment and to what extent are these changes sustainable?"

In order to answer this research question, sustainability is defined in the next chapter. After that, a system oriented approach is used for both projects. The project and the area around the projects are considered as a system. This systems are described using different parameters and key aspects related to the projects. The systems before, during and after the construction of the projects are examined and finally compared with each other in respectively chapters 3.3.1, 3.3.2 and 3.3.3 concerning the bridge and chapters 3.4.1, 3.4.2 and 3.4.3 concerning the Balbina Dam. In this comparison, extra attention is paid to changes in parameters. For example a change in the amount of people before and after the realization of the project is examined. Using the change in the parameters and the definition of sustainability, a conclusion is made in chapter 3.3.4 and 3.4.4 concerning respectively the bridge and the dam. The research is done by studying literature, information on the internet and by on-site visits.

3.2. Sustainable development

In this report we use the following definition:

"Sustainable development means development, which meets the needs of the present without compromising the ability of future generations to meet their own needs." (Brundtland et al., 1987). In this the needs of the present and future generation consist of three different aspects (Elkington, 1998). These are:

- people: all people affected by the projects. Parameters about the sustainability relating to people are for example the amount of people living somewhere, amount of jobs created during or after the construction, living standards of people and the experience of freedom. A negative change of these parameters (for example someone loses his job because of a project) this is considered unsustainable.
- planet: the effects on the environment. Regarding planet, it is easier to describe aspects that are considered unsustainable instead of those which are considered sustainable. Indicators of unsustainable development are the amount of deforestation, amount of species, type of land use and the amount of CO_2 emission.
- profit: the effects of goods and services. In case a project isn't profitable at all it is considered unsustainable. Parameters relating to profit are reduction of travel time, maintenance costs etc.

The given parameters are examples and might differ for both projects. Besides that, it might be impossible to find (exact) parameters for the three different aspects. At that moment, the parameters are estimated and the sustainability is discussed.

This definition of sustainability is chosen because it represents not only the current situation, but takes also the future situation into account. The whole life-cycle of a development is taken into account which is important because, for example, a cheaper product can be more sustainable at the moment than a more expensive product (aspect 'profit') but might require more maintenance and is therefore less sustainable. Furthermore, the topic of the ability of the future generation to meet their own needs is a hot item at the moment.

Figure 3.1: System border

3.3. Rio Negro bridge

In this we section we try to answer the following research question: "how does the Rio Negro Bridge change the environment and to what extent are these changes sustainable?"

In order to answer this research question, we think of the area as a system. First we analyze this system without the project. After that we describe some key aspects of the project, after which we analyze the system with the project realized (the values of the key parameters). Then we compare both systems, to find out which changes are made and to make a conclusion about the sustainability of these changes. The research is done by studying literature, information on the internet and by an on-site visit.

3.3.1. System of Manaus, the Rio Negro and the area

This section describes the results of the analysis of the system without the bridge. We describe several aspects of this area like Geography, Economy, Transport and Welfare. The first step is choosing the borders of the research area and defining the system. This is done in figure 3.1, which depicts the boundaries of the research area (system) of the Rio Negro Bridge. The Rio Negro is a bridge (still under construction), connecting the city of Manaus with several cities on the

other side of the river, such as Iranduba and Manacapuru. The bridge might influence further development of the cities, water transport, et cetera in this system.

Geography

The geography of the research area is very different from the Dutch geography, as it is in the middle of the Amazon tropical rainforest. Because of the rainforest, the area is relatively isolated; the closest city to Manaus with a similar size is Belem and is more than 1,000 kilometers away as the crow flies.

Main types of land-use in the system are 'urban area', 'forest', 'water', 'roads' and 'industrial area'.

Region (urban areas)
Major cities in the research area are Manaus, Manacapuru and Iranduba. Manaus is the capital of the Amazonas state. It's a large metropolis; the city has more than 2 million inhabitants in the metropolitan area (Wikipedia, 2010). The city of Manaus grows rapidly in terms of inhabitants: in 1950 the number of inhabitants was 279,000, in 2000 1,400,000 and in 2009 1,739,000. Manaus is also expanding in terms of size: the city deals with urban sprawl, which means that the city expands very rapidly, creating problems like long transport distances to work, high car dependency and higher infrastructure costs per person.

Manaus is allowed to expand in just a few directions, because most rainforests around Manaus are protected by law. Therefore most expansion occurs in the north of the city (Wikipedia, 2010). Neighbourhoods close to the bridge are Compensa (73,000 inhabitants) and Santo Agostinho (18,200 inhabitants). The harbor of Manaus is located on the bank of the river, which is in the south of the city (Wikipedia, 2010).

One of the other two cities in the research area is Iranduba, a small town 25 kilometers from Manaus, on the other side of the Rio Negro. The number of inhabitants is 40,436 (2005). The other city, Manacapuru is located a little further, about 95 kilometers from Manaus and 70 kilometers from Iranduba. The city has 85,000 inhabitants (Wikipedia, 2010).

Rivers
Important to the region are the two rivers, including the Rio Negro (south of Manaus). Manaus is located where the Rio Negro flows into the Amazon River, the second largest river in the world. At the height of Manaus both rivers are more than 2 kilometers wide. The river has economical value to the area, as it is used to import and export goods.

Both rivers have a lot of sandbanks and other minor difficulties. Rio Negro means Black River, but the color of the river is not really black. The dark color comes from humic acid from incomplete breakdown of phenol-containing vegetation from sandy clearings (Wikipedia, 2010).

Climate
The average temperature in this region is about 30 degrees Celsius during the whole year. There is a tropical climate, with both a rainy and dry season for both half a year. The precipitation is about 167 cm per year, varying from 20 cm in January till 6 cm in august (Wikipedia, 2010). Because of this variation the water level of the Rio Negro fluctuates by about 15 meters.

Flora and fauna
The system is located in the the Amazon rainforests. This rainforest is one of the world's most species-rich and have great biodiversity: more than one third of all species in the world live in the Amazonian rainforest. New

species are discovered almost on a daily basis, for example a new turtle species has just been discovered near the Balbina Dam. In this system land use type forest is considered to be very important, as the Amazon rainforest deals with the problem of (illegal) deforestation.

According to (Ricardo) the Rio Negro is extremely acidic and poor in nutrients. Yet, several (both larger and smaller) species have their habitat in the river. However these species are characterized by the small number of representatives. In order for the fish to survive they have to obtain a large part of their food from organic matter which can be found on the banks of the rivers. Also the Rio Negro has numerous turtle beaches. The river supports a large fishing industry.

Parameters
Parameters for sustainable development regarding geography are land-use and deforestation; these are all related to the planet component. Land-use can also affect the people-component, a change in urban land-use for example.

Economy

As the capital of the Amazonas state, Manaus plays an important role in the Amazonian economy. Manaus is a commercial city. This is reflected in for example the Manaus Free Trade Centre, a large commercial and industrial centre which is very important for the cities' economy, as many large companies produce electronic devices here (Russo).


Figure 3.2: A road in Manaus

Rubber used to be the main industry of Manaus. However nowadays timber, Brazil-nuts, petroleum refining (oil is brought to the city by barge), soap manufacturing and the production of chemicals are important for the city. Other local industries include brewing, shipbuilding and the manufacture of electronics equipment. (About.com, 2010).

Besides those industries, tourism is very important for the city. Because of its location in the rain forests, Manaus attracts a lot of tourists and is known for its ecotourism. The rainforest and the wildlife are major attractions of the area; for example, many tourists take boat tours to the Meeting of the Rivers (where the Rio Negro and the Solimoes River meet) or take jungle tours. This also makes the land use 'forest' important.

The Rio Negro forms the link of Manaus with the rest of the world. The Port of Manaus is the main transport hub of the region: both import and export take place by boats over the river. Also, the river is supporting a large fishing industry (Ariau Amazon Towers Hotel, sd).

Parameters for sustainable development regarding the economy are job generation (employment), GNP and economical activities. These are all related to profit. Job generation and GNP do also effect the people component.

Transport

Transport in the region is very characteristic. The city of Manaus lies very isolated in the rainforest. Within the city, the main transport is by car and public transport. Because of its geography, the main transport in the region is by ferry. Long distance transport is

mainly by air and water.

City transport
In Manaus there are about 400,000 vehicles. A large part of those are pick-up trucks, used by merchants to stock their stores. Also a lot of commuters use the car. Traffic congestions are recurrent but not restricted to peak hours.

The use of bicycles in the city is very small. Public transport represents a more fundamental role in the city. For example Manaus has a great structure of bus lines (300). Daily about 700,000 to 800,000 people go by bus. The main avenues do have special bus lanes. A problem is congestion with busses. Traffic jams with almost only busses are common.

Also a monorail will be built in the city with a length of 20 kilometers. This monorail will connect the north of the city with the south, and is planned above the main avenue between these two parts of the city. The bus system will be connected to the monorail system with passenger terminals.

Regional transport
Because of the few roads in the Amazon region, inland waterways are very common. Transport is mainly by ferries (called 'balsas'). Nowadays, the main transport mode to cross the river is these balsas. Even the main road BR 319 (from the state Rondônia to Manaus) crosses the Amazon by ferry.

Another way of regional transport is by bus, this considers mainly the inland connections. The main road from Iranduba to Manacapuru is the AM-070.

National and international transport
Transport from Manaus to other metropolis cities in Brazil is mainly done by air and water. Manaus has one of the most modern and best quality airports of Brazil. The annual number of passengers is about 1.4 million. Manaus has the third Brazilian cargo handling airport.

National transport by road is limited. Only few roads lead to Manaus, the BR 319 (from Pôrto Velho, Rondônia) and the BR 174 (to Boa Vista, Roraima).

Because the few roads and the long distances, and the strategic location at the Rio Negro, Manaus has a very large harbor. This is the third largest export port of Brazil, and serves the states of Amazonas, Pará, Roraima, Rondônia and Acre.

As stated, the area is very isolated. The fastest distance to Belem (a city similar to Manaus) by car is more than 3,000 kilometers, with a travel time of 40 hours (Google Maps, 2010).

Parameters
Parameters of sustainable development regarding transport are travel time (related to profit) and CO¬2¬-emissions (related to

Figure 3.3: Ferry dock of Manaus (left), Ferries to Manaus (middle and right)

planet).

Welfare

Life expectancy in the city is more than 63 years. 77% of households are served by mains electricity, 65% by sewage and 87% are served by garbage collection. 69% have water supply.

Manaus used to be a city with one of the highest crime rate of Brazil. Drugs, prostitution and rapes were specific problems of Manaus. The circumstances have improved a lot, especially in the city centre. In the city is a high social inequality. Neighborhoods close to the centre are generally wealthier and more remote neighborhoods tend to be poorer, and more lacking of infrastructure and urban housing. In 2006 the housing deficit in the city was about 68,000 housing units. This means that about 300,000 people do not have access to formal housing. The rapid economic growth is a reason of the large inequality.

Parameters of sustainable development regarding welfare are the degree of education, health and employment. These are in this case all related to the people-component of sustainability.

3.3.2. Key aspects of the bridge

Driving factors

The bridge is a project of the state government of Amazonas, aiming to induce a series of interventions in the cities along the Rio Negro, for example to improve the current transport system which deals with a long travel time (travel time from bank to bank is 30 to 40 minutes (by ferry)).

In a broader context, the Government wants development in Brazil with solutions for citizens and respect for nature, says the judiciary of Brazil (Portal Amazonia, 2009). President Lula says that the construction of the bridge is one of the initiatives of "Sustainable Amazon Plan". "The bridge will provide a new and practical option for growth in Manaus and will open thousands of jobs and enterprises," said Amazonas governor Eduardo Braga (Portal Amazonia, 2009).

Also a bridge over the Rio Negro to Manaus is an old aspiration of the population of both Iranduba and Manacapuru.

Location & dimensions

The bridge is located in the south of Manaus, where it is in the neighbourhoods of Compensa and Santo Agostinho. It will connect the city with Iranduba where it lies on the so-called 'Tip of Ouvidor'. In the middle of the river, a 158 meter high mast is located on the 'Isle of Chameleon'.

With a total length of approximately 3,600 meters the bridge over the Rio Negro is the second largest river bridge in the world. It has a width of 20.70 meters with four lanes of traffic (two lanes for each direction) and a pedestrian lane on both sides. The bridge will have 74 pillars and the average spanning between the pillars is about 55 meters. The largest span is in the middle of the bridge, where a large mast supports a span of 400 meters (200 meters on both sides) with steel cables. The bridge is quite high: in the dry season the bridge is at 70 meters high, relative to the water level and 55 meters high in the wet season.

Figure 3.4: Location of the bridge (red dots)

The bridge (the crossing of the river) itself costs about 450 million US dollar, however the project comprises not just this. Also the bridge has to be connected to the local road system. In Manaus, some 300 houses have to be removed, in order to connect the bridge to the 'Shipyard Brazil Rio Negro'. Hereby the aim of the project organization was to demolish as few as possible houses (SRMM / UGSPUL, 2010). On the other side the Iranduba side of the river, the bridge ends up at the existing ramp for ferries. Therefore no trees have to be cut on the Iranduba side. However, the connection with local roads requires an extension of 11 km, costing about 62 million US dollar.

When the bridge is completed, it is estimated that it exists of 14,500 tons of steel and 138,000 cubic meters of concrete. This equals the construction of 25 buildings with 20 floors.

Public opinion

Brazil is a democratic country, just like the Netherlands. This means that people are free to demonstrate and object to new constructions. Generally, in Brazil people have their opinion heard if they are disagreeing. In the northern regions of Brazil the government has traditionally a fairly strong position. People do not demonstrate against or criticize the government as quick as in The Netherlands for example. This means that the government gets things done earlier than in the rest of Brazil (Sena, 2010).

To create the bridge some 300 houses will be demolished in the neighbourhood of Compensa (Manaus). It seems that there was hardly any resistance against this demolition as permission for the work was given after the study on the neighborhood impact (Portal Amazonia, 2010).

There is some political discussion in according to the bridge. Former PMDB (a Brazilian political party) senator Gilberto Mestrinho says: "This work, the bridge will connect anything with anything. I think three or four new ferries and a decent port will improve the crossing" (Portal Amazonia, 2009).

In Manaus, we spoke to some local people about their opinion of the bridge. Most people indicated to rather invest money in inequality in the city than in the bridge. However they didn't think the Rio Negro Bridge is a bad investment. For example our jungle guide, who is quite familiar with the population on the other side of the river, was very positive about the bridge (Jorge Jungle Guide, 2010). Further, forum reactions on the internet are mainly positive about the bridge. People think the bridge is a symbol of welfare and economic progression.

The Rio Negro Bridge was an old aspiration of the population of the municipalities of Iranduba and Manacapuru. Therefore the public opinion about the bridge in these cities will be relatively good.

3.3.3. System with the bridge

The realization of the bridge over the Rio Negro will change the system as described in the first part of this document. Because the bridge is still under construction, most of the changes described are yet uncertain, especially the actual numbers aren't known yet. We distinguish short-term and long-term impacts. Short-term developments can be observed within a few years (i.e. 3 years). Long-term developments will impact the system after several (20) years.

Short-term

Geography

The bridge not only creates a new road on the map. To connect the bridge to the local road network, about 300 houses are demolished in Manaus. Inhabitants are said to be

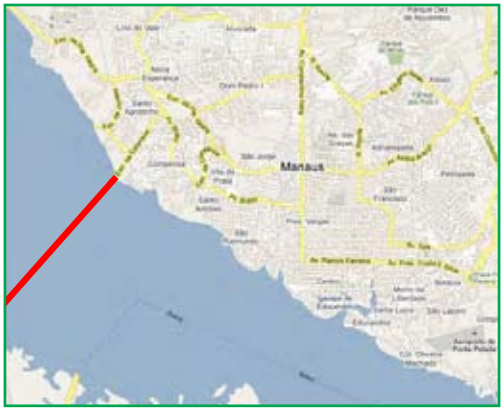

Figure 3.5: Location of the bridge in a road map (Google Maps, 2010)

moved to "better houses". This implies that a change of land-use occurs ('urban area' becomes 'road' at the location of this connection, 'forest' becomes 'road' at some parts of the Iranduba side of the river).

Besides these changes, we do not expect large short-term changes on land use or other geography. Large scale deforestation will not happen on short-term, as a large part of the road from the bank to Iranduba already exists and most urban development are expected to occur on long-term.

Transport

Most important, the municipalities of Iranduba and Manacaparu can reach Manaus by road. This will significantly improve logistics of the municipalities: travel time between these cities is reduced significantly, to 5 minutes. It is also possible to walk and cycle on the bridge (Amazonas.am.gov.br, 2010). There won't be a toll charge on the bridge; this makes it possible for everyone (both poor and rich people) to use it (Blog da Floresta, 2010).

Short-term developments in city transport can be a different traffic distribution. The driving direction to the bridge can get much busier. The impact of this effect is hard to estimate, because it is the first bridge across the Amazon River in the city. Now only few people move regularly from the Iranduba region to Manaus or otherwise. We expect this amount of people to grow steadily.

The impact of the bridge on regional transportation will be bigger. The absence of toll will result in a strong decrease of ferries between Manaus and the Iranduba region. However, the bridge won't affect the ferries between other banks, like between Manaus and the BR174. In addition to that, most of the balsas can be used somewhere else in the region (SRMM / UGSPUL, 2010). We think more people will move from the region to Manaus. Because of the shorter travel time, the attraction to Manaus will be bigger and the amount of traffic will increase.

The impact of the bridge on national transport will be marginal, as the bridge just connects Manaus to Iranduba and Manacaparu (after which there's the Amazon forest). It doesn't connect Manaus to the BR174.

Economy

On short-term, most economical benefits are expected for the cities of Iranduba and Manacaparu. The bridge will stimulate the economy of these cities, because the travel time to Manaus is much shorter; industries can easier deliver their products in the region and otherwise. The export market for the cities will be bigger (Amazonas.am.gov.br, 2010). Also, people can more easily try to find a job in Manaus. For Manaus' economy, the bridge doesn't change very much. The economy of Iranduba and Manacaparu will not only grow because of the above. The cities can expect more tourists in the next few years, as stated by the Amazonas government (Amazonas.am.gov.br, 2010).

During the construction of the bridge, more than 1700 people are provided of a job. 500

of them are managers, the rest are i.e. masons and carpenters (Jusbrasil, 2009). According to the constructor, 3200 workers are directly involved with the construction, and 8000 workers are indirect involved. At the time of the company visit, 2200 workers were directly involved and 3600 indirectly (SRMM / UGSPUL, 2010).

Welfare
On short-term, the impact of the bridge on peoples' welfare is marginal. Welfare is something that grows steadily. Impacts on welfare are often observed after several years. However, fact is that people from Iranduba and Manacaparu can travel easier to Manaus. They can go to schools or offices in Manaus more easily. For these people, chances will grow.

Long term developments

In this section the long-term impacts of the bridge will be discussed. Because no factual data is available yet (the bridge is still under construction) these are mainly prognoses.

Geography
Because of the bridge it is expected that both Manaus and Iranduba will expand in terms of inhabitants. Besides that, also expansion in terms of size has been foreseen: according to Aitchison (2009) the bridge will relieve urban sprawl Manaus is currently dealing with, by creating a new industrial zone in Iranduba. This implies a change in land-use (forest to industrial and/or urban area) on a large scale; in order to make room for new parts of the cities (on the south side of the river) some part of the rainforest has to be removed. It is yet uncertain at what rate and on what scale this deforestation/ urban development will occur.

Besides deforestation, an industrial zone has impact on both flora and fauna, as it is expected to be devoted to the metallurgy sector. This is considered heavy industry and is often blamed for pollution.

Transport
Benefits in transport in the area are in the reduced average travel time. However when both Manaus and Iranduba significantly expand in south side of the bridge, these benefits will decrease because the amount of traffic will also grow significantly. Therefore the bridge will be utilized to its maximum traffic capacity. This in turn decreases travel time. However in comparison to the situation without a bridge, travel time will still be much shorter.

Other changes in the transport system are similar to the short-term changes. The bridge provides a link between both sides of the river and stimulates further (urban) development of the region.

Economy
A main benefit of the bridge is urban development (Amazonas.am.gov.br, 2010). The bridge will provide more traffic in the southern area; this means a better accessibility of the harbor. Most economical benefits are discussed in the 'short term developments' section. These benefits are similar in the long run and maybe even larger. This is reflected for example in the expansion of the metallurgy sector. As we stated before, it is expected for the metallurgy sector in the region to expand. When this happens, jobs are created, which benefits both the regional and national economy.

The bridge also provides lots of publicity for Manaus. Not only in Brazil, but in the whole world companies will know the city because of the bridge. This could result into economic advantages like foreign investors.

At last, the bridge is also expected to stimulate tourism for both Manaus and the cities

on the other side of the bridge (Amazonas.am.gov.br, 2010).

Welfare
The development of the region has several positive influences. However, in the past, the rapid growth of the economy has enforced the large inequity Manaus deals with. It is yet unknown whether and how this bridge will influence the future situation in the long term.

The future situation of Iranduba and Manacaparu is expected to be much brighter. People of these cities get more chances to commute to Manaus, or visit that city for other purposes. The bridge will stimulate local business and the cities will feel more connected to Manaus. Tourism will be bigger in the whole system.

3.3.4. Conclusions

Sustainability

In the sections above, we presented some information about (expected) influences the bridge has, both on short term and long term. In this section we try to find out to what extent these changes are sustainable, with the definition we described in the second chapter of this report.

People
The bridge is an old aspiration of the population of Iranduba and Manacaparu. The realization of the bridge will enlarge the future chances of these people. They can travel easier to Manaus for work, study or other purposes. So the degree of education and healthcare and the employment-rate will improve. Looking at Manaus, the bridge won't have much influence on the people there. In terms of land-use 300 houses will be demolished; however the people are said to be moved to better houses. As far as we could find out, there is hardly any criticism on the bridge.

On the one hand, in terms of people, we think the Rio Negro Bridge is not quite sustainable in the short term, as 300 houses have to be removed. Yet, on the other hand, during and after the construction a large amount of jobs is created, which is positive. Also in the long run, the bridge could be considered more sustainable, as the bridge provides a (brighter) future for some people. Especially for people from Iranduba and Manacaparu.

Planet
On short-term, the bridge won't have large effects on the planet (land use or flora and fauna). For example, the road from the bank to Iranduba already exists, so no deforestation has to take place.

On the long term, the bridge could have a large negative impact on the environment. The largest risk of urban development is large-scale deforestation. Besides traffic and metallurgy industry could cause exhaust fumes and carbon dioxide emissions. This exact impact is unknown, these changes are considered unsustainable. So both in terms of land-use (deforestation) and CO¬¬2-emissions the planet-component is unsustainable.

Profit
Despite the high costs the bridge has a positive effect on the economy in the system. Urban development and international publicity are the main benefits as well as some relief of urban sprawl for the city of Manaus. The bridge itself also provides lots of jobs during and after construction. The reduce of travel time provides economical opportunities for the population of Iranduba and Manacapuru. Also new economic activities could arise.

The changes in the system can be conside-

red sustainable, especially because of the job-generation and reduce of travel time.

Altogether
Regarding the Profit aspect, the bridge certainly has some advantages for both the present and future generations and could be considered sustainable. However, regarding the Planet aspect it could be considered not so sustainable, because of the risk of deforestation and the emission of greenhouse gases in the long term. On the People aspect, it's a bit harder to determine sustainability, as it's not that positive for some people in the short term, but it could be considered positive in the long run as it enhances future perspectives.

It should be clear that it's very hard to conclude with either 'yes' or 'no'; it's not possible to say the changes because of the bridge on the system are sustainable or not. The effects of the bridge could be considered sustainable in one way, but unsustainable in another. This is where the contradictions are: one can say the project is great (because of economical development), while another thinks it's not (because of the risk of deforestation). It's about priorities and finding a balance between the different aspects.

Remaining questions/discussion

During this research we were not able to find all the information we looked for. Upfront we set up some questions for the company visit in Brazil. However, the project presentation was about construction methods et cetera (most questions we asked weren't in the scope of the construction firm). This means that some questions regarding our research are still unanswered. For example, we still don't know how the project organization dealt exactly with the 300 demolished houses in Compensa. The influence of the bridge on the inequity is still unknown, and we also don't have a concrete estimation of the benefits and the influence on the traffic jams in Manaus.

3.4. Balbina Dam

The Balbina Dam is a large hydroelectric dam in the Amazonas. To find out whether the influence of this project on the area is sustainable or not, we did the same as for the Rio Negro bridge. Our main question here was:

To what extent is the influence of the Balbina dam on the surrounding area sustainable?

First, we describe the area as a system, second we describe the project itself. Then we describe the changes the projects imposes on the system. After that, we discuss to what extent these changes are sustainable.

This part of the report is based on the cited literature, on information found on the internet and at the visit of Brazil. In Manaus, we visited a research institute called INPA (Instituto Nacional de Pesquisas da Amazônia), where we were given a critical presentation about Balbina from Philip Fearnside. We also visited the dam itself and talked with a representative of the energy company (Eletrobras Manaus Energia). Besides the information from Manaus, we visited the University of São Paulo and talked with a professor in water engineering (Monica Porto).

3.4.1. System of the Uatumã Rivier and the surrouning

Before the Balbina Dam was build, the system and the surroundings of the Uatumã river were quite different from the current situation. The Balbina Dam is situated approximately 150 kilometers northeast of Manaus, in the municipality of Presidente Figueiredo. The location is in the Brazilian part of the Amazon rainforest. The dam is located in the Uatumã river, which is a tributary of the Amazon and Rio Negro rivers.

The dam influenced different aspects in and around the Uatumã river. In the figure below, the borders of the research area of the Balbina Dam are shown.

Geography and climate

The local relief of the area is slightly undulated and the land is extremely poor, not favorable for agriculture. The area around the Uatumã river is the wettest region on earth and is subject to marked annual seasonality of temperature and precipitation. The climate is tropical, warm and humid. The mean rainfall, temperatures and evapotranspirations between 1978 and 1984 are shown in table 3.1.

Uatumã river

The river responds to this seasonality with a time lag of several weeks. During the wet seasons, the water levels of the Uatumã river can rise 7.5 to 12 meters. Some information related to the river is shown in table 3.2.

The minimum in November and maximum in June shows the time lag compared to the minimum rainfall in August and maximum rainfall in April. The solid suspended matter of 13-16 mg/l means 1.5 – 5.5 tons of solid matter per hour which means that there was a lot of sedimentation and erosion in the river (Walker, Miyai, & Amaral de Melo, 1999).

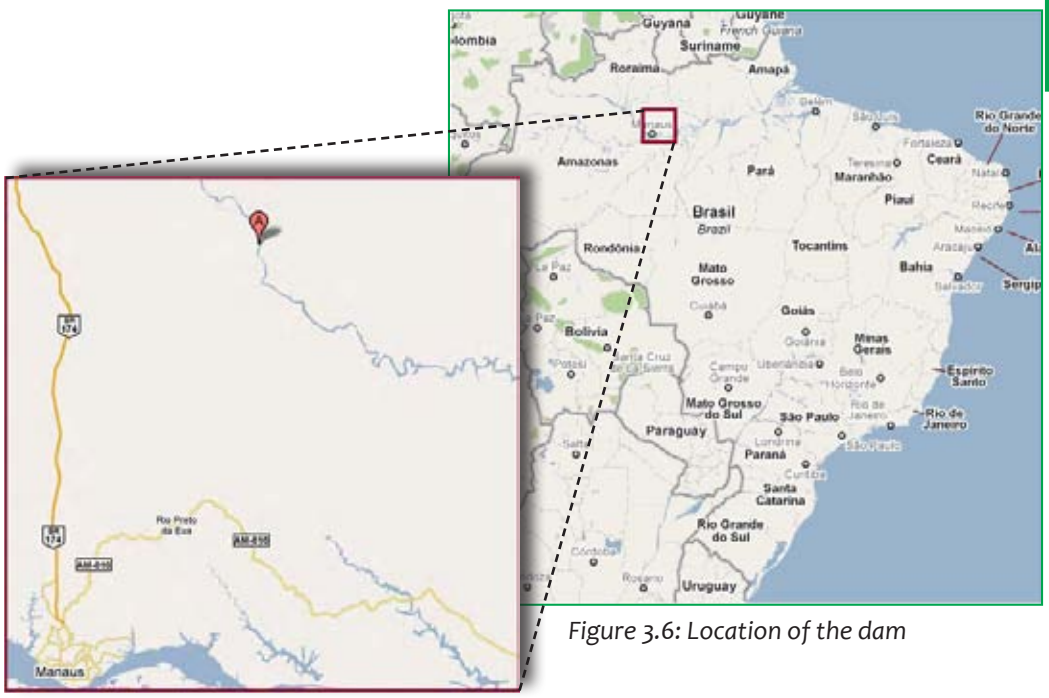

Figure 3.6: Location of the dam

	Mean monthly minimum	Mean monthly maximum	Mean annual
Rainfall (mm)	107 (August)	353 (April)	2294
Temperature (°C)	20.9 (March)	37 (November)	
Evapotranspiration (mm)			1200-1500

Table 3.1: mean rainfall, temperatures and evapotranspirations 1978 - 1984 (Walker, Miyai, & Amaral de Melo, 1999)

	Minimum	Maximum	Mean
Discharge (m^3/s)	197 (November)	1127 (June)	570
Flow (m/s)	-	1.1 (June)	-
Depth (m)	-	10 (June)	-
Solid suspended matter (mg/l)	-	13-16	-

Table 3.2: hydrological information Uatumã river (Walker, Miyai, & Amaral de Melo, 1999)

Manaus
The most important city in the research area is Manaus because the Balbina Dam should provide electricity for Manaus. In 1970, Manaus had 622,733 inhabitants, but the amount of inhabitants was growing rapidly. By 1990, the population was grown to 1,025,979 inhabitants (Wikipedia (EN)).

In the 1970's, Manaus had many power plants that burnt oil. But due to the oil crisis of 1973, the government had to look for other energy sources.

Fauna
The Uatumã River is known for the peacock bass fishing during the month of September to December. The Uatumã River is one of the hotbeds of peacock activity in Brazil (Larsen, 2010). Figure 3.7 shows our local guide who actually caught a peacock bass during the tour, which illustrates that the fish is well-known in this area.

In the Amazon there are several million animal species. One fifth of the world's bird species live in the Amazon in only one fiftieth of its land surface. Insects form the largest animal group. One tree stump in Bolivia was found to house more ant species than the whole of the United Kingdom. Besides that there are 3,000 known species of land vertebrates and 2,000 known species of fresh water fish (ten times as many as in the whole of Europe) (New Internationalist, 1991).

Flora
The Uatumã River is a nutrient poor, acid blackwater river. However, the Ca2+ levels are higher than other blackwater rivers in

Figure 3.7: The Amazon riiver (left) and its fish (right)

the Amazon. These somewhat better nutrient conditions of the Uatumã river and its tributaries allowed for the growth, accumulation and dispersal of aquatic macrophytes which are absent in the Rio Negro and most of the Amazon blackwater tributaries (Walker, Miyai, & Amaral de Melo, 1999).

As mentioned before, the Uatumã river runs through the Amazon. The Amazon makes up one third of the world's remaining tropical rainforest and contains 30 per cent of all known plant and animal species. These 30 per cent consists of 80,000 known, and at least 10,000 unknown species of tree. The Amazon has a density of between 100 and 300 tree species per hectare of forest (temperate forests have between five and ten) (New Internationalist, 1991).

People

In the influenced area of the Balbina Dam, the territory of one indian tribe, Waimiri Atroari, is located. In 1985 there were nine settlements. These settlements were located near the National Indian Foundation (FUNAI) Posts. During the first years fatal epidemics followed after FUNAI workers visited the Indian villages. Therefore, the Indians interpret the white people as being acts of sorcery directed against them. Entire villages were eliminated and the residual Indians started to expel the invaders. The sudden change of behavior reinforced the prejudices of the Indians as 'bad', 'wild' and 'animals'. The Waimiri-Atroari Attraction Front (FAWA) captured the Indian tribe with the purpose of recreating their society to redeem them from their past and change them into "civilized Indians" (Baines, 1994).

The population of the Waimiri-Atroari was originally 6,000. Because of expeditions of settlers and explorers up the Rio Negro and Rio Branco, the population decreased to 3,000 in around 1975. The president at that time created a reserve for the Indians, with a size of approximately 1,1 million ha, which originally was 8 million ha. The reserve was intended to be a secure place for the Indians, however, the new BR-174 road intersected directly the Waimiri-Atroari Reserve. The construction of the roads and the violations, even with firearms and bombs, at the same time caused the population to decrease to only 1,000: two-third of their population was lost in two years (Cummings, 1995).

In the beginning of 1979, the Paranapanema Mining Company invaded Waimiri-Atroari territory. In 1981 a presidential decree dismembered about one-third of Waimiri-Atroari territory to favor Paranapanema, thereby canceling the Indian reserve and turning the remaining part into a "temporarily prohibited area." In 1982 the mining company encroached again, constructing a private access road linking the BR-174 highway to the dismembered area. FUNAI authorized the highway's construction after it had already been started (Countries and Their Cultures).

The economic activities of a settlement are based on hunting, fishing, agriculture, and gathering wild fruits. Men are responsible for hunting. Fishing and gathering fruit is a undertaken by both sexes and often the whole family may go out fishing or gather fruits. The greatest division of labor occurs in agriculture. Men are the ones who fell trees, burn them, and clear the gardens, while women are the ones who harvest the crops. They both take part in planting the gardens. The crops include bitter manioc, sweet manioc, several types of sweet potatoes, yams, and certain fruits (Instituto Socioambiental, n.d.).

When the planning for the Balbina Dam started in 1981, only less than 600 Waimiri-Atroari Indians remained. In 1983, due to increased pressure on their lands and greater influx of disease, the population dropped to 350 (Cummings, 1995).

Just before the flooding of the Balbina reservoir, only a very little amount of Indians were living in the actual flooding area.

Economy

As the capital of the Amazonas state, Manaus plays an important role in the Amazonian economy. Manaus is a commercial city. This is reflected in for example the Manaus Free Trade Centre, which is a large commercial and industrial centre. The centre is important for the cities' economy, as many large companies produce electronic devices here (Russo).

Rubber used to be the main industry of Manaus. However nowadays timber, Brazil-nuts, petroleum refining (oil is brought to the city by barge), soap manufacturing and the production of chemicals are important for the city. Other local industries include brewing, shipbuilding and the manufacture of electronics equipment. (About.com, 2010).

Also, tourism is very important for the city. Because of its location in the rain forests, Manaus attracts a lot of tourists and is known for its ecotourism. The rainforest and the wildlife are major attractions of the area; for example, many tourists take boat tours to the Meeting of the Rivers (where the Rio Negro and the Solimoes River meet) or take jungle tours.

The Rio Negro forms the link of Manaus with the rest of the world. The Port of Manaus is the main transport hub of the region: both import and export take place by boats over the river. The river is more and more considered to be productive and supporting a large fishing industry (Ariau Amazon Towers Hotel).

As mentioned before, the economic activities of the Waimiri-Atroari are based on hunting, fishing, agriculture, and gathering wild fruits.

Transport

There is a highway from Manaus to the municipality of Presidente Figueiredo: the BR-174. The highway runs all the way to the border of Venezuela. It crosses the area of the Amerindian tribe Waimiri-Atroari. The highway is in this area closed at night. The highway is shown to left. There is also a paved road to the Balbina Dam (AM-240), which is shown to the right (Férias, 2010).

3.4.2. Key aspects of the dam

Location & dimensions

The Balbina Dam is situated in the Amazon rainforest, approximately 150 kilometers northeast of Manaus. The municipality in which it is located is called Presidente Figueiredo, a municipality with an area of

Figure 3.8: Highway BR-174

25,422 km² and a population of 26,282 (IBGE, 2009). The dam is located in the Uatumã River, which is a tributary of the Amazon. An important characteristic of the river is the fish population in it. An Amerindian tribe lives in the neighborhood of the dam: the Waimiri-Atroari.

More about the location can be found in the latter chapter.

The dam has a height of 33 m and is 2,920 m long (Wikipedia, 2010). There is a water pressure of 22 m. It consists of five generators that can generate a maximum of 50 MW each, which was intended to meet the total demand of Manaus and her surroundings (Cummings, 1995). Balbina (250 MW) is together with the dam of Tucuruí (8,600 MW) responsible for the energy supply of the energy-isolated city of Manaus. In 2014, there will be a connection with the whole Brazilian system.

Figure 3.9: Balbina Dam

The dam is made of concrete (Pires de Camargo et al., 1984) and had cost $ 700 million and several delays in 1988, while the cost estimation of the dam was only $ 383 million (Fearnside, 1989).

Driving factors for the project

The Balbina Dam was already initiated in the early 1970s. The construction of the dam started in 1985, after the governmental decision to build it. The owner of the dam is Eletronorte, the Brazilian state electric utility for the Amazon region. This company, now known as Eletrobras Amazonas Energia, is a subsidiary of Eletrobras, the biggest company of the electric power sector in Latin America. It was a public company that had an energy monopoly in the northern part of Brazil, but it is now privatized. However, still 52% of the shares are owned by the federal government (Eletrobras, 2010).

There were several official and unofficial reasons why this decision was taken, despite of the several studies that showed that construction of the dam was questionable (Fearnside, 1989). The official explanation of the government was that the dam was needed to foresee in the growing demand for power in Manaus. This power demand was approximately 220 MW a year in 1987 and was expected to be 420 MW a year in

1996 (Fearnside, 1989). Furthermore, the oil prices at the time (the 1970s) were at a very high level, so the government was looking for other, cheaper, ways to generate energy.

However, besides the official explanation, there were other reasons for building the dam. There was done a viability study in 1975 – 1976, though the final decision was not based on technical grounds, it was a political one: the decision came directly from the Brazilian president's office (Fearnside, 1989). At that time, the military political party was in power, both at national and Amazonas level. They wanted to "'shake off' the image of a country dominated by forest and Indians" (Cummings, 1995). There are several indications of that time that people were fired at the energy company and the government and new people were put in place, because of resistance against the dam. Also, there were doubtable actions done by the government concerning the contracts (Fearnside, 2010).

So, the dam was probably not only built for the need of energy, but also to fulfill the wishes of the economic and political elite, who wanted to show that the government invests in the Amazonas region. Several alternatives, for instance a better location, were available.

3.4.3. Effects of the dam on the system

The Balbina Dam affects the system that is described before. In this chapter, the effects on the systems are described. Much research is already done on these effects, and these reports are used to describe these effects.

Short before the dam was closed, Eletrobras used a lot of propaganda to promote the dam. Some examples of propaganda are shown in figure 3.10.

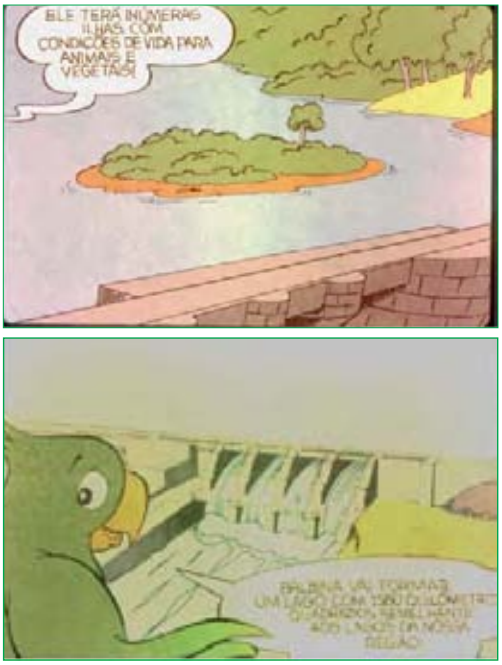

Figure 3.10: Propaganda

The text in the upper figure stated: "He will have innumerous islands with living conditions for animals and vegetation". The text in the bottom figure stated: "Balbina will form a lake of 1580 square kilometers, similar to the lakes of our region".

These statements give a positive view on the impact of the dam. The short- and long-term changes below shows the real impact of the dam on the whole system.

Short-term changes

The Balbina Dam was closed on the 1st of October, 1987. Directly after this closure, the effects on the Uatumã river where visible: the river ran dry. The great fish population in the river died because of the water shortage: instead of a river with water and fish, there was only a large amount of dead fish left. This effects affected the people downstream the river immediately, because they are for living dependent on the water in the river and the fish in it.

Upstream the river, before the dam, the water level began to rise. The small amount of people that were living there until the last possible moment had had finally to move. The rise of the water level caused animals to die and trees set under water. In the short term, the water depth was increased to 46 m.

It cost a year to fill the lake, a year in which the river was dry. After this year, the dam opened and suddenly the river had water again. This sudden opening of the dam caused floods downstream.

Long-term changes

The effect of the development of the Balbina Dam was enormous. Since the valley was wide and shallow, the dam flooded a huge area, 2,360 square kilometers, including significant parts of the demarcated reserve of the Waimiri-Atroari. The shallow reservoir has since been shown to emit huge amounts of methane and nitrous oxide, both very powerful greenhouse gases (Cunningham, 2008).

Constant research is done in the years after the closure. However, according to Fearnside (2010), only little action is taken.

Effect on Uatumã River

The water quality in the Uatumã river, downstream the dam and in the lake, became very bad. Reasons for this are the decay of the plants and trees in the area and the geography. The effects are strengthened by an extra rise of the water level, as is explained in the next paragraph.

In only a small part of the inundated area (2% according to Fearnside (2010)), the trees were cut. The energy company (Eletrobras Manaus Energia, 2010) stated that this was because of troubles with the cutting company, while the University of São Paulo said this was because of the political time pressure and costs for cutting. The idea was to cut the trees after the flooding. However, due to a disagreement, about the costs and the new owner of the harvested wood, between Eletronorte and the cutting company the trees were not cut at all (Eletrobras Manaus Energia, 2010). Due to the decay of the trees, the amount of oxygen in the water became very low and the water became acidic. The water downstream is also of a bad quality, because the water for the turbines comes from deep in the lake (22 m, Eletrobras Manaus Energia (2010)) instead of from the surface. At this depth, the oxygen level is even lower. However, this effect is somewhat compensated by sluicing the water in the river.

Also, the water does not flow a lot, because

Figure 3.12: "The conditions of the environment will be strictly checked by constant research and studies"

Micro Study

there are between 1,500 and 3,000 islands in the lake among which the water is standing still. This is also bad for the water quality and the amount of oxygen. It is remarkable that these islands where initially planned as good living conditions for animals and vegetation, as can be seen in the propaganda picture in the beginning of this section.

Fearnside (2010) stated that Balbina is situated in an area that was million years ago subject of volcanic eruptions. These eruptions caused the presence of mercury in the river and in the lake. As long as there is enough oxygen in the water, the mercury will bind with the oxygen and is not toxic. But because the oxygen level decreased over the years, the concentration of pure, toxic mercury in the lake increased. Significant amounts of mercury are now found in the whole food chain, fish as well as people, and cause problems with the people around Balbina who eat fish and use water from the lake (Weisser, 2001).

Effect on Geography and Climate

The dam flooded a total of 2,360 km² of rainforest, instead of the 1.580 km2 which was mentioned in figure 7b. The water depth at Balbina was initially planned as 46 m, but the energy generation was too low. The energy company decided to increase the level to 50 m and a little later tot 50.10 m. Nowadays, also during our visit, the water level is at a maximum of 51 m. This makes the lake even bigger. The flooded area is very large, because of the flat geography. The choice for this specific location was based on an assessment using only the top of the trees as an indicator for the slope of the region which resulted in a more flat area chosen than expected (Porto, 2010). Nowadays, the energy company agrees that the lake has become too big (Eletrobras Manaus Energia, 2010).

The ratio of energy generation and the size of the flooded area is one of the worst of Brazilian hydroelectric power plants: only a small amount of energy is generated, while a big area is flooded (Kemenes, Forsberg, & Melack, 2008). For example, the Tucuruí Dam flooded almost the same area, but has 32 times the capacity of Balbina (Cummings, 1995).

As said before, many trees were not cut. This decision led not only to a bad water quality, but also to a great emission of greenhouse gases. Millions of tons of methane emission from dead trees were emitted ((O)eco, 2009). The emission is equivalent to 73,000 tons of carbon dioxide. The greenhouse gas emission from the dam have proven to be ten times higher than those of thermoelec-

Figure 3.13: Photo taken by us at the Balbina lake

tric installations, including those that burn coal, considered the most polluting fossil fuel (Kemenes, Forsberg, & Melack, 2008). A big amount of the greenhouse gases is emitted by sluicing the water in the river. The water pressure changes from 3 atm to 1 atm, which emits greenhouses gases extra. All hydroelectric dams emit greenhouse gases, but Balbina does it more than the other. Greenhouse gas that is emitted is mainly methane. Methane is 21 – 34 times worse for the environment than carbon dioxide (Fearnside, 1995).

Effect on Manaus

The Balbina Dam is built to supply energy for Manaus, but the effect on Manaus's energy supply is small. The energy capacity of the dam is, as said before, 250 MW. They expected a 420 MW energy demand for Manaus in 1996, but the dam could only provide about 25% of this demand (Fearnside, 1989). Nowadays, Manaus is using about 1.700 MW which cannot be supplied by only the Balbina Dam. Therefore Manaus also receives energy from the Tucuruí dam which has a capacity of 8.600 MW.

Effect on Fauna

The effect of flooding the area on the fauna in the rainforest is very big. The rich amount of animal species that lived in the area are drowned. Eletronorte said in their propaganda (figure 7a) that a large amount of animals could live on the new islands. However, the islands have not got the appropriate living conditions so the islands are uninhabited. Fearnside (2010) told even that the energy company tried to save some animals by themselves because of compassion.

Nowadays, an animal preservation center is founded at Balbina, financed by Eletrobras Manaus Energia. In this center, visited by us, there is taken care of several animals that live in the Balbina area, including several bird species, turtles and manatees. Many of these animals were killed by the flooding.

Effect on Flora

As said before, the effect on the flora, the plant and tree species are very big. The fauna in the area of Balbina is all drowned. Besides that, after the land was drowned, the water level fluctuates which make new grass grow (when water level drops) and drown again (when water level rises). The drowning of the new grass creates a lot of new greenhouse gasses (Fearnside, 2010). There is also deforestation because of the construction of the road to Balbina.

Effect on People

The population of the Waimiri-Atroari Indians has been reduced between 1974 and 1987 from approximately 3,000 individuals to 374 individuals. Especially the new diseases to the population, caused by the contact with Brazilian society, and the flooding by the Balbina Dam caused this large decrease in population size and had a negative impact on their villages and agricultural activities. The Waimiri-Atroari were becoming dependent on mining activities, resulting in the breakdown of their traditional productive and economic systems. (United Nations Environment Programme, n.d.)

The Indians which were encountered during the construction were slaughtered. As a revenge, the Indians killed construction workers, government Indian agency workers, and even priests. Eventually the Brazilian government together with the electricity company Eletronorte was forced to negotiate with the Indians. (Brazilmax, 2004)

To 'compromise' the Indians, the Waimiri-Atroari Programme was established which was financed by Eletronorte, the energy generation company for the North of Brazil. The aim of the program was to achieving

more equitable economic and cultural relations between the Waimiri Atroari community and the Brazilian society, to guarantee the Waimiri-Atroari Indians exclusive exploration rights over their territory, to improve the Waimiri-Atroari´s general living conditions in consonance with their own aspirations and to increase the understanding of the socio-political environment in Brazil. (United Nations Environment Programme, n.d.)

Due to the program, some improvements are made (United Nations Environment Programme, n.d.)

- The Waimiri-Atroari has got an official registration and recognition of their lands. However, 311 km2 of it was flooded by the Balbina Dam. (de Oliveira, 2009)
- A 7.5% per annum average growth in the Waimiri-Atroari population over 10 years.
- 100% vaccination coverage, zero level of tuberculosis, interrupted transmission of malaria
- Establishment of 14 "schools" within the Waimiri-Atroari territory with indigenous teachers, built and conceptualized by the Indians, and where teaching revolves around Waimiri-Atroari culture and history.
- 30% literacy rate, with reading and writing taught in the native language and Portuguese as the second language.
- Establishment of small seedling nurseries and agro forestry systems.
- Aquaculture projects with river turtles and fish.
- Surveillance posts have set up to protect a group of Indians (the Pirititis) who have not yet come into contact with Brazilian Society.

So the living conditions of the Indians are improved but their way of life has changed a lot. Right now the Indians have got an official registration and recognition of their lands which actually means that the Indians are kept as 'prisoners' inside their area and other people are kept out.

In the years after the closure, Balbina got criticized a lot. There were several demonstrations. The people argued that they paid for something bad (Fearnside, 2010).

During our visit, we visited a project done by Eletrobras Manaus Energia (before called Eletronorte) to involve the people from the municipality of Presidente Figueiredo. Children of the primary school in this municipality visited the animal preservation center at Balbina. According to Eletrobras Manaus Energia, this is done to compensate the people by the loss of a part of their municipality. Three other projects regarding education and preservation of the environment at Balbina are also done at this moment.

Effect on Economy

The effect on the economy is high. Eletronorte made a initial cost estimate of $ 383 million. However, when the dam was finally built, the costs increased to $ 700 million (Fearnside, 1989). Fearnside (2010) states that the maintenance costs are very high. However, Eletrobras Manaus Energia (2010) said that the investment was high, but at this moment, this investment is completely deprecated. They say Balbina Dam can now foresee in the maintenance and is making profit.

The effect on the economy is more visible when it is compared to the energy capacity of the dam. For the Balbina Dam, the ratio of costs and energy capacity is $ 3000/kW. This ratio is very high compared with other dams in the Brazil: the Tucuruí Dam has a ratio of $ 675/kW (4.6 times less than Balbina) and the Itaipú has a ratio of $ 1206/kW (2.6 times less than Balbina). The costs of Balbina are even

higher, because this calculation concerns energy capacity; the real energy generated is only the half of this capacity (Fearnside, 1989). However, the energy generation rose in the last years and is coming close to the capacity of 250 MW, as we saw at the company. During our visit, Balbina was operating at capacity.

Another economic effect is the loss of forest. Because the trees are drowned instead of cut, potential economic benefits of commercial logging are lost. However, the trees can still be cut underwater, which is much more complex. These trees also could have been used to generate energy from biomass. Other losses are the rubber, rosewood and pharmaceutical plant species in the area (Fearnside, 1989).

3.4.4. Conclusions

In the sections above, we presented some information about (expected) influences the dam has had, both on short term as long term. Just like for the bridge we try to find out to what extent these influences are sustainable, with the definition we described in the second chapter of this report. This conclusion is based on the literature, the information on the internet, on the visits in Brazil of INPA, Eletrobras Manaus Energia and the university of São Paulo and our own opinion about the project.

First, a chart is given which shows the mutual relations between several parts of the system and the parameters. Because the title of our report is "Contradictions in the Amazon", we will after that discuss the contradictions we found in this project. In the third part of this conclusion, the relation between the research question and sustainability is described.

Relations

The chart in figure 3.14 gives the mutual relations between several parts of the system and the parameters. A description is given after that.

The chart starts at the top with the government. They saw Balbina as a prestige project to show to Amazonas state. This government laid time pressure on the project, which had a negative influence on the studies before. Another reason for Balbina, the official one, was the energy demand for Manaus.

To influence the local people, the government started with propaganda, which influenced the opinion of the local people positive.

The closure of the dam in 1987 had several impacts. The first one is the lake; closing Balbina had a positive effect on the size of the lake. Because the river ran dry downstream, the fish mortality over there increased. Also, the costs of Balbina are given a place in the chart. These costs had a negative influence on the opinion of the local people, because it was their money spent.

The size of the lake had several impacts on the system. First, energy was generated because of the water level. This energy generation became bigger when deciding to raise the water level extra, which increases the size of the lake.

Because of the lake, the underwater flora and fauna died and there came underwater decay. This decay was even bigger because there were almost no trees cut, because of the strong time pressure of the government. The effect of the decay was, as said, the increase of flora and fauna mortality.

The decay also influenced the water quality in a negative way. The size of the lake, which causes the creation of many little is-

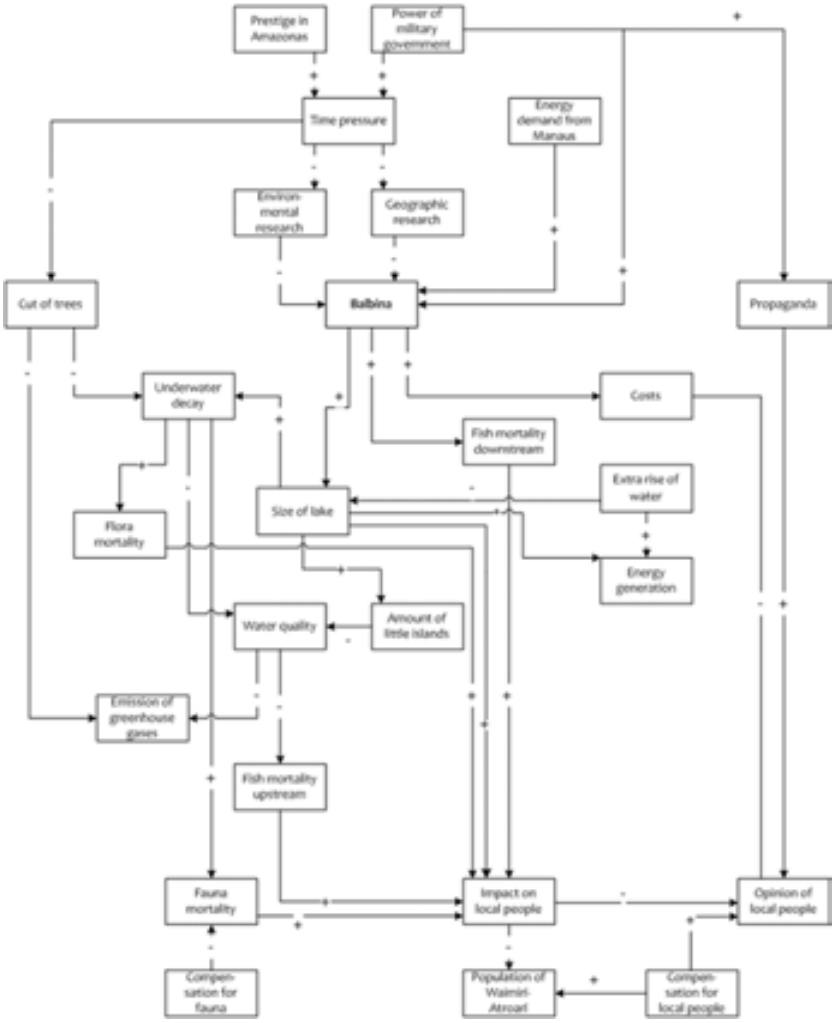

Figure 3.14: relations, + means a positive relation, - means a negative relation

lands among which water is standing still, also influences the water quality on a negative way. The bad water quality increases the emission of greenhouse gases, together with the decay of the dead trees.

The fish mortality, both upstream and downstream, has a strong relation with the impact on the local people, who are depending on the fish in their daily life. Also, the other fauna mortality, flora mortality and the size of the lake had impact on the local people. This influenced the opinion of the people negatively and was bad for the Waimiri-Atroari population.

Nowadays, some compensation is done by the energy company. Both the compensation for the people and the fauna influences the local people and the fauna positively.

Contradictions

The interests of the energy company and the government at that time contradict with various parts of the system. The most important contradictions are shown in this paragraph. Many other contradictions can be found in the chart in the latter chapter.

Area of local people – Area of Balbina lake
The local people lost a big part of their origi-

nal area to the lake. The land use of the area nowadays (water) is contradicting to the area before the dam, which was living area of the Indians.

Amount of fish – Water quality Balbina lake
As said before, the water quality of Balbina became worse after building the dam, because of the decay of trees and the stagnation of the water among the little islands. This water quality is bad for the amount of fish, it resulted in much fish mortality, and so is the Balbina lake contradicting with the amount of fish.

People of Manaus – People of area around Balbina
The people of the area Balbina, mostly Indians and the inhabitants of the municipality of Presidente Figueiredo, were in several ways affected by building Balbina. However, the people of Manaus now got energy from a new source. So, the interest of the people of Manaus, which is power supply, is contradicting with the interest of the local people, which is no impact on their livelihood.

Amount of flora and fauna – Area of Balbina lake
In the area which is now flooded because of Balbina, much flora and fauna lived there. Because of the inundation, this flora and fauna died. So, the Balbina lake contradicts with the flora and fauna life.

General impact of Balbina – Interest of energy company
The general impact of Balbina on the people and the environment around Balbina is contradicting with the interest of the energy company, who wants to make generate energy and make profit with the dam.

Sustainability

People
For the people in the municipality of Presidente Figueiredo and the Waimiri-Atroari Indians, the dam is not very sustainable. A big part of their living area is irrecoverable harmed by the 2,360 square kilometer flooding. Although several projects for these people are undertaken the last years, for instance the recognition of the Indian land, the project has overall had a great impact on the people. The impact influences the future generation in a negative way.

Planet
As described before, the effects of the Balbina Dam on the system are large. Although a hydroelectric power plant seems a sustainable energy at first sight, without using fossil fuels, the reality in Balbina is different. Many environmental aspects are not taken into consideration when deciding to build the dam, including the effect of greenhouse gases, the water quality, the flooded area and the impact on flora and fauna. Compensation is done by the energy company, who agrees with the opinion that the lake is too big. Examples of this compensation are education about the environment and the establishment of the animal preservation center.

Profit
The investment costs of Balbina were very high. But, according to the energy company, the dam is at this moment profitable. This does not say that over the lifetime of the project, the dam has been profitable. This is not known yet. Besides that, the dam could have been more profitable when placed at a better location.

Our overall conclusion is that the dam has been a mistake. When they would have done good research before deciding to build, a lot of negative effects of Balbina would have been averted. Reasons for the bad decision are the enormous power and prestige of the military government.

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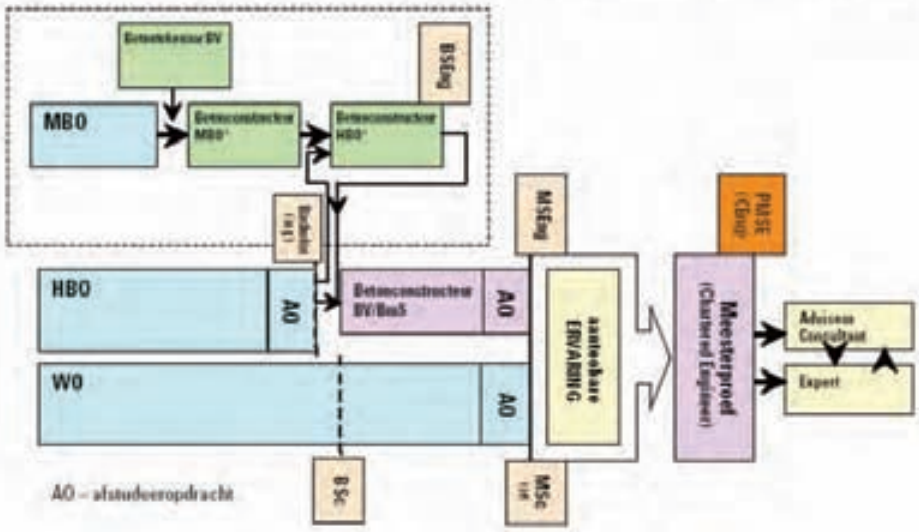

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4. SOCIAL SUSTAINABILITY

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Tim van de Kruijs
Hendrik van Meerveld
Auke Terlouw
Niels Vossebeld

4.1. Introduction

This report is part of an educational program of the "Booming Brazil" study tour. The main goal of the study tour itself was to exchange knowledge about the central theme, to complement the research undertaken for the preliminary research and to verify the results of the preliminary research done in the Netherlands. The educational program consists of three studies: a macro, meso, and micro study. The micro study involves looking specifically at organizations within Brazil and how they operate. This research is set up in the form of case studies based on the projects that we have visited during our trip to Brazil. There we had the opportunity to see the projects our self and ask questions during site visits to validate our studies concerning the project and its relation to our main theme. With the in-depth knowledge gained from the case visits we supplemented a preliminary report. This report is written for the participants to help them develop a clear understanding of the role of sustainability and civil engineering in social projects in Brazil.

This report is part of the micro phase of the program and specifically asses the central theme "social sustainability". Social Sustainability is the idea that future generations should have access to social resources the same or better than current generations. The Brazilian society differs a lot from the Dutch society, therefore first the social background in Brazil is explained. Then, our research approach is explained in more detail. Next, both cases are discussed. Last, the conclusions are drawn.

4.2. Social background: Brazil

This chapter will present a first view on social issues in Brazil. This gives a first idea of what problems have to be dealt with.

4.2.1.Brazilian society

The modern Brazilian society cannot be reduced to a stereotype Latin American society, a wealthy landed elite versus masses of poor peasant and workers. In the twentieth century the system of social classes evolved from this Latin American stereotype system to a Brazilian system which consists of four social classes; the high class, the formally middle class, the informally middle class and the lower class.

The high class people have more property and prestige and therefore have access to government services, such as health, education and sanitation. This class lives in chic neighbourhoods, usually centrally located, go to high quality private schools, drive in cars and shop at malls.

The lower class lives in favelas or distant housing projects, take long bus trips to work, go to public schools or drop out and shop at smaller supermarkets or local shops. The population which lives below income national poverty line is 21.5%, about one-fifth of the country's total population (United Nations Development Programme, 2008).

The middle class can be split into formally employed workers and informally employed workers. This class has its origins in the nineteenth century, in which this section of Brazil's population was neither slave-owners nor slaves. The formally employed workers consist of a technical work force like clerks, professionals, teachers and highly skilled workers. Its position is based more on knowledge and skills than on property. The informally employed workers consist of self-

employed businessmen. In 1990 this sector accounted for nearly half of economically active population (Coutsoukis, 2004). People in the middle classes tend to have lower-income persons or families depend on them for employment and health emergencies.

The stereotype Latin American system of social classes, which was originally based on property, has evolved in such a way that individuals who have special technical skills or know-how are able to earn reasonable incomes. Besides these two classes of propertied or skilled individuals lies a significant mass, which is maybe a majority, that is excluded in the sense of limited participation in markets and have poor access to government services, such as health, education and sanitation.

4.2.2. Problems in the Brazilian society

Wealth and power are very unequally divided in Brazil: more than half of the national income goes to the richest 10% of the population. These small elite determine the economic and political guideline of the country, which leads to oppression, discrimination and eventually to social exclusion of the less fortunate social groups. In this part we will have an overlook over the classes and their hierarchy and the biggest problems within the Brazilian society.

Many problems in the Brazilian society can be related to the high crime rates. This problem mostly relates to the lowest social classes. Life-threatening crime can be traced back to this drug trade and alcoholism in the lowest social classes. Brazil poses high rates of violent crimes, such as murders and robberies. The homicide rate is very high with 25,2 homicides per 100,000 inhabitants (Wikipedia, 2010). This number has declined the last years from 35,7 in 1999. Crime hotspots are the border zones and the favelas in metropolitan areas.

In the major cities carjacking en express kidnappings are common. With carjacking local citizens but also visitors are targeted by criminals. With express kidnappings individuals are abducted and forced to withdraw funds form ATM machines to secure their release. Also petty crimes like pick pocketing and bag snatchings occur often in outdoor markets, in hotels and on public transport.

New legislation has brought stricter punishment to domestic abuse and driving under influence. Human trafficking and slavery are still reported annually, usually associated with sugarcane plantations involved illegal immigrants from Asia and Latin America.

Also the quality of sanitation is poorly in Brazil and mostly not good accessible for the lower classes. There are in Brazil just 115 physicians per 100,000 people (the Netherlands 315), and only 75% of the population is using improved sanitation (in the Netherlands 100%). 10% of the population can't use an improved water source (Kelmann, 1998).

Another problem is the human rights violations during capture and custody of suspects. On the other hand, criminal charges have been described as extremely lax, allowing violation criminals an early return to society. The justice system is slow, mainly because of loopholes that allow for numerous appeals. It is said that a majority of crimes are not solved (Wikipedia, 2010).

4.2.3. Conclusion

In this chapter of the social background of Brazil we have seen that the society consists of all kinds of racial and ethnic groups, but discrimination in general is not regarded as a major problem in the Brazilian society. However, Brazil is an unequal society in which extremes are seen in both wealth and pover-

ty. Many problems are related to high crime rates, violation of human rights and the fact that lowest income groups are underserved as it comes to basic needs like sanitation and supply of water.

4.3. Research

In the previous chapter, we have seen that Brazilian social life from modern developed countries. This means that our 'western and Dutch way of thinking' might also differ from the way Brazilians think and act. This means that in Brazil, the aspects of social development, sustainability and the role of civil engineering will probably be different. These differences are mostly visible in urban areas. These differences will play the central role in our research.

4.3.1.Research goal & questions

Our research goal is:

"To find out what the role is of civil engineering in sustainable social development in cities of Brazil".

Linked to this is our main research question:

"What is the role of civil engineering in sustainable social development in cities of Brazil?"

This main question can be answered through answering these to sub questions:

a) How is sustainable social development addressed in Brazil?

b) How is civil engineering used to reach this sustainable social development?

The next section will describe our research approach to assess these questions.

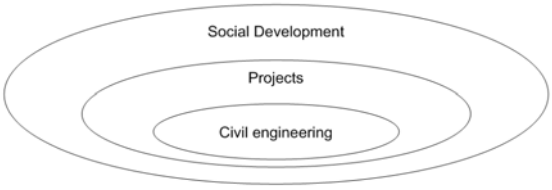

Figure 4.1: Layering of the research, extracted from Tijhuis (Tijhuis, 1996, p. 120).

4.3.2. Theoretical approach

To answer the research questions and have valid conclusions concerning sustainability and the role of civil engineering, in-depth project knowledge is necessary. In the next section the theoretical approach needed to gain this in-depth knowledge will be explained. After this, the project cases studies are introduced.

Our research has a layered structure. It focuses on the role of civil engineering in projects related to social development and the influence of these projects on the sustainability of social development in the cities.

These three parts are layered and 'nested'. Civil engineering plays a certain role in projects that play a certain role in (sustainable) social development. We have illustrated this in Figure 4.1.

As mentioned, in-depth project knowledge is necessary, because these projects exist due to several reasons and this can tell us what could be the role of these projects in social development. The second reason insight in-depth project knowledge is needed is that it could describe the role is of civil engineering within these projects.

To gain in-depth project knowledge, we will need to focus on the three areas: project environment, project organisation, and implementation of project plans. These tree areas are interrelated. These three areas are assessed by Tijhuis (Tijhuis, 1996), in his 3C-model. An extraction of this model is used in this specific research. Within the project environment, there is contact with different

parties that have specific problems, goals, interpretations, etc. This strongly influences the way in which agreements are made and how projects are designed and organized. It is the contract aspect that is looked at here. Ultimately the project organization will implement measures to solve the initial problems. The implementation will show successes, as well as new problems and remaining challenges. This is the conflict phase of the 3C-model and issues found here can be related to the project organization or to the project environment. The used 3C-model is found in Figure 4.2.

4.3.3. Case studies

The case studies we use are PROSAMIN and IBISS. With these cases we try to answer the research question with use of the 3C-model and find out what the role is of civil engineering in sustainable social development in cities of Brazil.

In an effort to tackle destitution in the country, the case studies aimed at increasing the living standards of these people and increasing safety in the cities where they reside are being started throughout Brazil. This research project focuses on two such cases which we visiting during the study tour. The cases assessed are IBISS and PROSAMIM. Some indicative information about these two projects is provided in Table 4.1. Both of these projects are related to problems in urban areas, two big cities in Brazil. PROSAMIM is a project that aims at social, urban and environmental restoration which aims at relocating people that live in the river banks in the city of Manaus. IBISS wants to contribute to the development of a society where social inequality is combated and human rights are respected. They aim at improving the life of the poorest people in the favelas of Rio de Janeiro. These projects and the problems they are dealing with are typical for Brazil. These projects can give a good guideline to answer the main research question: "What is the role of civil engineering in sustainable social development in cities of Brazil?" They are both in some way connected with civil engineering aspects, and both projects deal with (sustainable) social problems.

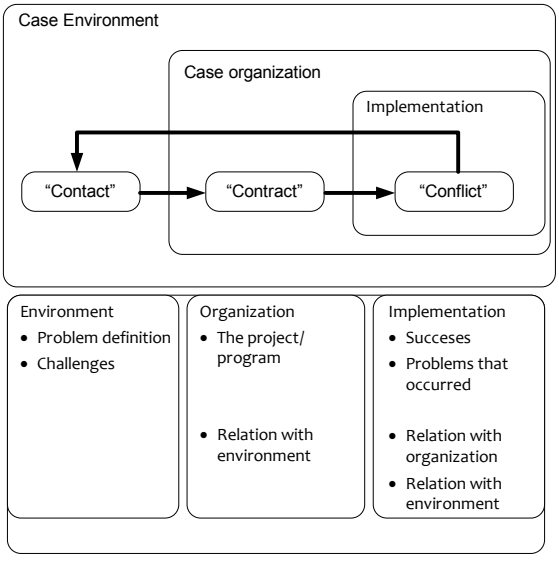

Figure 4.1: Contact, Contract, Conflict within their respective fields of attention (Tijhuis, 1996, p. 121)

4.3.4. Conclusion

The 3C-model is a suitable tool, because the 3C-model is useful to interpret how the assessed projects are organized, why and how they are organized and why successes and problems befall. Given the goal of this research we will use gained in-depth findings about the projects to formulate conclusions about the aspect of sustainability and the role of civil engineering within these projects. The well-known "triple bottom line" or People-Planet-Profit triad is used to discuss sustainability. Finally, findings about both projects will enable us to answer the main research question.

The next chapters will provide findings on the two case studies. In each case, the pro-

	PROSAMIM	IBISS
Starting date	2003: "official kick-off" of PROSAMIM I.	1989: IBISS was founded.
City	Manaus	Rio de Janeiro
Principal (type)	State of Amazonas (governmental)	IBISS (NGO)
Investors	For phase I: Loan of the Inter-American Development Bank (140 million USD) and investment of the state of Amazonas (60 million). Phase II will require a IADB loan of 154 million USD and a state contribution of 66 million USD.	Mainly donations of private persons and organizations.
Number of people directly affected	PROSAMIM I: ~21.300 families. PROSAMIM II: ~15.500 families.	Hundreds of people attending IBISS programs
Type of organization	Project, by executing a one-time program.	Process, with different ongoing programs.

Table 4.1: comparative table with indicative information of the two project cases

ject environment is explained first. Secondly, the implementation of the project is discussed. The chapter concludes with some case specific conclusions were the aspects of sustainability and the role of civil engineering are described.

4.4. Case study I: IBISS

IBISS will be the focus of our research to social sustainability in the favelas of Rio de Janeiro. First, the project environment is explained to indicate the diversity of problems encountered. Second, the project organization is described and the goals of IBISS are stated explicitly, after which we will discuss several projects and their long-term effects and give a conclusion about the sustainability of the organization.

4.4.1. Project environment: Rio de Janeiro & the favelas

About one fifth of the more than twelve million inhabitants of Rio de Janeiro, survive in very poor circumstances. They live in one of the 700 favelas, which lack facilities and are often ruled by organized crime. Most favelas are built against the hillsides of Rio. These areas, that would probably be top building locations in developed countries, because of spectacular (oceans) views. These areas are characterized by difficult building conditions and bad transport facilities.

Violence

In many favelas, there are daily victims as a result of police using force or deadly confrontations between different drug gangs. Favelas form communities that have their own set of rules. The favelas are run by drugs lords who make it almost impossible for outsiders to invest in the area and the inhabitants of a favela. For most people, it is not safe and most of the time not even possible to enter a favela without being stopped or killed.

Lack of access to basic facilities

Governmental organizations are not accepted in the area and are often repressed with force. While the government tries to fight these power circles actively (but not with much result), they hardly make any progress in the positive development of the area. While some favelas do have access to running water and electricity, they all lack basic healthcare and good education facilities.

Figure 4.3: Favela Rochina, the largest favela in Latin America

Figure 4.4: Police violence is common in favelas

Children in the favelas

Children living in favelas easily end up involved in this criminal world and frequently die at a very young age as a result of this. Armed conflicts are the most important cause of death for children between fourteen and nineteen years of age. Between 1987 and 2001 almost 4000 underage children died due to fire arms. (Trouw, 2007). These children hardly have any chance to participate in society and do not receive much education. For some, the only opportunity to survive is to join one of the drug gangs in the ongoing war. When we visited the IBISS project to gain more in-depth insight it is told that is a vicious circle that cannot be broken easily without support from the outside.

Conclusion

The problems in the favelas of Rio de Janeiro maintain a strong vicious circle of violence and lack of basic facilities and proper education. To ensure a sustainable solution for these areas, the problems should be tackled based on good relationships and a peaceful development, starting with providing children and youngsters with fair chances. In Figure 4.5 the main conclusions about the environment of the case study IBISS is summarized.

4.4.2. Project organization

For a complete overview of the project organization, two aspects will be assed to gain in-depth knowledge of the project organization. The projects organizational history will be addressed to take a look at how the organization started and how it affects the situation of today. Next the organization goals will be reviewed to learn what they try to accomplish in the future.

Figure 4.5: Environment of case study IBISS

4.4.3. Organizational history

The abbreviation IBISS stands for "Instituto Brasileiro de Inovações em Saúde Social" or "Brazilian Institute for Innovations in Social Healthcare".

The IBISS organization was founded in 1989 by Nanko van Buuren. His primary goal was to give the inhabitants of the favelas in Rio de Janeiro a chance to break out of their situation. Over twenty years later, IBISS has grown into a large non-governmental organization with good contacts with the Brazilian government. Its figures are approved annually by government accountants. Ministries and governmental organization also provide financial and practical aid. A lot of small (pilot) projects are undertaken in the favelas, helping thousands of people to improve their daily life. Projects that are successful in a particular situation are lobbied to be absorbed in regular local policy.

With a small staff and more than six hundred employees that originated from the target groups, IBISS actively works in a number of the most violent favelas of Rio de Janeiro. Over the years, Nanko succeeded in gaining the confidence of the target groups of IBISS. The neighborhoods associations and the individual inhabitants respect and embrace the targeted way of working IBISS shows. Even drugs lords, who rule most favelas, have respect for his work and for him as a person.

IBISS is financially supported by a lot of funds and private donors. These funds are primarily attracted by the IBISS Foundation in the Netherlands, which promotes the work of the organization and searches for funds and donors. More than half of the budget IBISS spends is received from the Brazilian government. (IBISS, 2010)

Organizational goals

The mission statement of IBISS as an organization is the following:

"In a sustainable way, IBISS wants to contribute to the development of a society in which social sicknesses such as leprosy and tuberculosis are eliminated, social inequality is combated and human rights are respected. IBISS aims to stimulate its target groups, in a way that motivates them to improve their current situation on their own."

The main target groups of IBISS are:

- People who have to survive on the street in violent favelas;
- Victims of exploitation (child labor, drugs trafficking or prostitution);
- Victims of violence (police violence, sexual violence or violence within the family);
- Carriers of social sicknesses (AIDS, tuberculosis and leprosy);
- Mentally and physically disabled people.

With more than sixty projects in Rio de Janeiro, IBISS tries to reach a broad part of these target groups. In order to improve the situation of its target groups, IBISS tries to find new methods to help these people. They do this through a number of different pilot projects. To train their own employees for newly developed methods and to stimulate the application of these methods, IBISS set up the internal training centre Ipê Geral. This centre also tries to train informal leaders from the different projects and favelas to ensure a sustainable growth.

IBISS works in the following "areas":

1. Street work: Helping street children, homeless people, garbage collectors and prostitutes;

2. Shelter: Sheltering and accompanying children and young people;
3. Community projects: Developing projects and programs to improve the position of the inhabitants of favelas in society;
4. Community building: Developing a solid infrastructure in socially excluded favelas for neighbourhood improvement;
5. Special groups: Looking after the interests of organized groups of garbage collectors to reach sustainability;
6. Preventative healthcare: Developing new forms of prevention to try to stop social diseases (leprosy, tuberculosis and AIDS);
7. Care for the disabled: Supporting slum inhabitants with a handicap, which are victims of plural exclusion;
8. Programs: Helping people build their own future in specific projects;
9. Framing and Education: Training IBISS' employees and informal leaders to interpret to the objectives of IBISS in an effective way;
10. Human rights and advocacy: Fighting for the rights and interests of the target groups through participation in councils and forums.

Since IBISS works with target groups that are excluded by society, a "normal" approach is often not sufficient. By constantly investing in the development of new ideas and working methods, IBISS tries to reduce social exclusion. It uses a holistic approach in which care, assistance, education and advocacy go together. This means that people are seen in their totality and in relation to their surroundings.

IBISS distinguishes itself from other organizations by daring socially excluded groups to take the task of improving their situation into their own hands. IBISS acknowledges the desire to change and growth and thereby trusts in the strength of the target group. Using small targeted projects, people gradually get motivated to take initiatives themselves.

Advocacy is a very important part of IBISS' working method. For this reason IBISS also collaborates closely with projects of legal assistance for victims of violence and exploitation. It is a challenge to stimulate the target groups to work on their own future and to eventually take part in society as full citizens. By bringing up the new approaches that IBISS developed within forums and councils, a contribution is provided to the formulation and determination of new public policies.

In the field of defending human rights, IBISS cooperates closely with legal advice projects for victims of discrimination, violence and exploitation. For real position improvement to occur, it is absolutely necessary that human rights are respected. (IBISS, 2010)

4.4.4. Projects

IBISS participates in and initiates various kinds of projects and programs. Most projects are neighborhood-based and are tuned for a specific favela, while the programs are implemented at multiple favelas at the same time. All actions of IBISS aim at bringing social services into before unreachable places. This is done most of the time by training employees to implement a specific method. Professional civil engineering is not an important part of the IBISS organization, but civil knowledge is often used to make the implementation of other projects possible. (IBISS Foundation, 2010; IBISS, 2010)

Neighbourhood-based projects

In every favela IBISS is working in, the organization tries to enhance the living conditi-

ons for the inhabitants. They buy or build classrooms, recreation buildings, sports facilities and playgrounds to grant people access to education, sports and cultural activities. But IBISS also revises water supply net and sewage pipes and connects favelas to the power net in cooperation with electricity provider LIGHT. This way, people can prove they have an address by showing their energy bills to the government, which enables them legally to receive facilities for education and medical care.

Project Preventive Health care

The main focus of IBISS's healthcare projects is to build bridges between people who are socially excluded and existing government services. This is done through medical pre-posts in favelas, where diseases are recognized at an early stage. From these pre-posts, patients are referred to official healthcare, which they otherwise would not reach. Pre-posts are manned by workers who have followed the The Curso Agentes de Saúde (The Health Care Worker's Course). They make home visits, observe living conditions and make sure that patients receiving treatment complete it. If necessary, healthcare workers will refer patients to specialized services outside the community. This way, the gap between residents and public health care is bridged.

Program 'Participar'

IBISS believes that disabled people should be fully included in society instead of being cast aside or treated as 'problem cases'. 'Participar' is a program that assists mentally disabled people in participating in IBISS projects or other public facilities located in their neighborhood, through specific attention and special accompaniment.

IBISS encourages mentally disabled people from the community to participate in activities at the Espaço IBISS. This centre hosts many socio-educational programs as well as extensive sport facilities like a swimming pool and a gym, all suited to facilitate disabled people.

IBISS has Participar on a three year trial-run in order to acquire more positive experiences, which it wants to present at the Council for the Care of the Disabled with the goal of replacing existing policies and changing the financial framework.

Programs 'Soldados Nunca Mais', 'Minas' and 'Sou Menina e Mae'

There are more than 5.500 young people working as child soldiers in Rio de Janeiro's raging favela drug wars. They are recruited by drug mafias, work as heavily armed soldiers, protecting the "boca de fumo" (drug sale points) against invasions by police or rival drug gangs. This very dangerous form of child labor often employs children as young as eight, many of who die young and violently during clashes with police or rival gangs. More than 80% of child soldiers do not live past their 21st birthday.

IBISS plans to eradicate this extremely dangerous form of child labor. In collaboration with youth group leaders from violent favelas, it developed the program 'Soldados Nunca Mais' (Child Soldier Never Again). This project strives to prevent children from this hard-to-reach group, from entering into the drugs trade and encourages those already involved to get out. Activities such as football, percussion, graffiti and hip hop are used as alternatives taking attention off drug trafficking and getting the youth involved in society again. Some groups of ex-soldados have already established profitable businesses with this, varying from a very successful percussion band or hip hop group to a clothing line. Through the extensive football training school, many talented youngsters get the chance to be scouted by large clubs

from Brazil and even Europe.

'Minas' (the Portuguese word for girlfriend/wife within the favela) is another program to help young people caught in the drug world. IBISS research in more than 350 favelas has shown that "beautiful virgins" are seen as "belonging" to drug bosses. Although there are cases where the drug boss "takes" a virgin, usually the young girls offer themselves to the drug boss in order to gain status within the favela. The Minas are still children (eight to fourteen years old). It is estimated that there are more than 200 girls acting as wives to these drug bosses and more than 500 as girlfriends to the drug soldiers.

Quite often, the drug bosses make their Minas pregnant against their will. This results in young teenage mothers, with unwanted babies. This in turn means the Child Care Council is faced with more and more cases of abandoned children. The IBISS program 'Sou Menina e Mae' ('I am girl and mother') helps these young mothers, which are often abandoned by their lovers when they become pregnant. The program helps the mothers to raise their babies in a proper way and make a living for themselves. The 'Minas' and 'Sou Menina e Mae' projects are strongly interrelated.

Garbage collecting

Another example of a bridge between socially excluded people and government services is the establishment of trade unions for prostitutes and garbage collectors. Without IBISS initiating this trade union, they would not be able to fight for their rights in society.

The garbage collectors unite in Movimento Nacional dos Catadores de Materiais Recicláveis (MNCR), which speaks for more than 300,000 "catadores" (recyclers) from all over Brazil. Primary goals of MNCR are to fight discrimination against catadores and to receive official recognition for their work, which is of great importance for their working environment. The MNCR also fights for better working conditions and facilities such as daycares and schools, so the children of garbage collectors do not have to accompany their parents to work in the landfills.

Human rights and corruption

The largest problem in the favelas which is not poverty related is the violation of human rights by the police. Most favelas are often invaded by violent police raids, which cause a lot of innocent victims. Research by IBISS has shown that a lot of 'Milícias', groups of (ex) police officers extort people to "provide safety" and lease themselves as assassination crews to drugs lords. This enormous corruption problem makes inhabitants distrust every police action, which makes the police the enemy of most faveladors, not only the ones involved in organized crime. IBISS tries to decrease this behaviour by publishing their research findings about police corruption and violation of human rights in local media and to the government.

Conclusion

IBISS has many different projects within their organization. These projects comprehend different aspects of the environment. According the 3C-model the environment is closely related with the project organization. This is also the case with the previous described projects. The garbage collection is connected with the aspect of the environment of lack of access to basic facilities. The project human right and corruption in linked with the environment thru lots of violence. Also there are a lot of programs to improve the unsuitable environment for children like rograms 'Soldados Nunca Mais', 'Minas' and 'Sou Menina e Mae'. In Figure 4.6 the key aspects are of the organization are summarized.

4.4.5. Implementation and problems during the projects

All projects proposed and executed by IBISS have their problems and successes. Some of them are discussed in this section. First, some of the major problems will be described and thereafter accomplishments.

While implementing their methods and projects, IBISS always faces different kind of resistances. It could be faveladors, the government or even a geographic position that does not cooperate. However, in most situations money is the problem. IBISS struggles to get enough money from all of its sources to continue its projects.

Community participation

The first example is of 'Soldados & Minas' where IBISS proved that the sexual abuse of young girls exists within the drug mafia. However, IBISS hasn't published this data yet because this information is considered to be classified by the drug mafia. Secondly, in their education programme IBISS also serves bread and milk to children who show up at school in the morning. This gives them an incentive to come, because usually they will not get any breakfast at all. This way even parents who would rather see their child working have a reason to send them to school. Dispersion

Technical / geographical

Another example of resistance is about geographic positions, for example in the 'Soldados & Minas' project. If at all possible, IBISS wants a well prepared general children's hospital in Rio de Janeiro. Due to spreading of the favelas, this is not possible. Placing one hospital per favela would not be feasible at all.

Political / Government

The government often also represents itself as a barrier. In the 'Participar' project, IBISS has to convince the Council for the Care of the Disabled that other policies and a different financial framework are needed, by providing positive experiences with the project. Furthermore, the government lacks influence in the favelas when it comes to healthcare. IBISS had to design methods to reach those people before the government gave their support. In some favelas inhabitants are not registered with their address. This means that they formally do not live in Rio de Janeiro, which on its turns does not oblige the municipality to provide schools, healthcare and other basic facilities. When inhabitants get their own electrical connection, it is bound to their address. This makes them formal inhabitants of Rio de Janeiro and forces the municipality to build basic fa-

Figure 4.6: Environment and Organization of case study IBISS

cilities. Therefore it is not in Rio de Janeiro's best interest to make faveladors official inhabitants because providing those basic facilities will cost a lot of money.

IBISS's annual report mentions at least one sad incident every year. Up until now, every year some innocent participants have died because they got caught in the crossfire between drug gangs and police or suffered from failing healthcare. These examples show why there still is a lot to be gained by IBISS projects.

Success stories

Luckily, a lot of IBISS projects do have success and achieve their goals. Some nice examples are given in the next section.

The 'Participar' project made 30 mentally disabled young people participate in simple activities in the swimming pool. These activities stimulated the development of the children and give their families a needed break. Because of this success, IBISS plans to extend the program to include another 120 children.

The program 'Soldados Nunca Mais' is a huge success, perhaps even a bit too successful. All the children that get pulled out of drug gangs need a place to work. At this time, there are not enough jobs to fulfill demand. This means a probable setback for some of the children who got out of drug business.

Through the scholarship scheme Nosso Futuro (Our Future) hundreds of people were able to educate themselves. In 2002 two youngsters from one of the most socially excluded slums in Rio started to study at university. Today this amount has been multiplied by six.

We think that the large amount of example projects duplicated by other organizations and the clear improvements in living conditions for faveladors show that the approach IBISS takes really does work.

4.4.6. Conclusions from the IBISS case study

IBISS works on a project basis. It makes use of capable volunteers and employees to try out new methods, which bridge the gap between social excluded people and government services. Most of the projects IBISS initiates or participates in make use of placing people right in the middle of the community. This applies to projects that focus on education, child labor, child soldiers, disabled people and many more.

Civil engineering is of very little importance in the work of IBISS. Physical buildings or infrastructure are not often used to attain set goals. Civil engineering could be of importance in the future, when living conditions of faveladors increase. Increasing living conditions bring new needs, which could be fulfilled by making use of civil engineering.

When the 3C model is kept in mind, IBISS has a strong connection between the three different sections showed in Figure 7. The project organization is largely based on project environment. Challenges like low community participation and a resistive government are overcome by adapting the project organization in a way that adequately deals with those challenges. Implementation problems are most of the time due to the project environment, while sometimes the project organization itself was not sufficient.

Sustainability

We will address sustainability by looking at three aspects: People (social), Planet (environmental) and Profit/Prosperity (economic/financial aspects). In all aspects, we take into consideration how the future is taken

into account (not only looking towards the next couple of years, but also beyond). We will pay special attention to the aspect of People, since this is the major focus in the projects studied in this micro-study.

People
IBISS' focus is primarily on people. People in favelas who lack education, healthcare, safety and other necessities of life are its main target. IBISS makes governmental services accessible to people on a project basis. From a sustainable point of view, this is the right way of working. By supplying long term opportunities, IBISS tries to change habits and mindsets of faveladors. It helps people to stand on their own feet and take care of themselves. Most projects initiated by IBISS are focussed on children. It tries to supply them with opportunities to make themselves a better future. This is a very sustainable way of fighting poverty in the favelas.

Planet
The IBISS organization does not pay much attention to the environment. Their projects mainly focus at human beings and place their interests at front. While doing so, IBISS however does educate faveladors in basic knowledge about sewage and garbage disposal. For example, faveladors in some favelas are used to throw their garbage into an already over polluted river. With a little extra effort they could gather all their garbage at one place to get rid of it in a proper way, leading to less pollution and flooding. Placing human beings and their interests at front could lead to a conflict in sustainability on the long term, when human interests or the projects themselves grow to the disadvantage of the environment. This is however not clear yet and is not a primary goal of IBISS.

Profit
Most money received by IBISS originates from the Brazilian government and municipality of Rio de Janeiro. A lot of money also originates from the IBISS foundation. Income for this foundation is generated by private sponsors from abroad, which have a strong connection to the Dutch organization. IBISS does not have a sustainable money source of its own and cannot continue without money flowing in. It also does not have a sustainable money outflow in terms of profit, because the money that is invested in projects has no monetary results. There are however indirect results of growing prosperity, where children receive education and learn to support their own families on the long term.

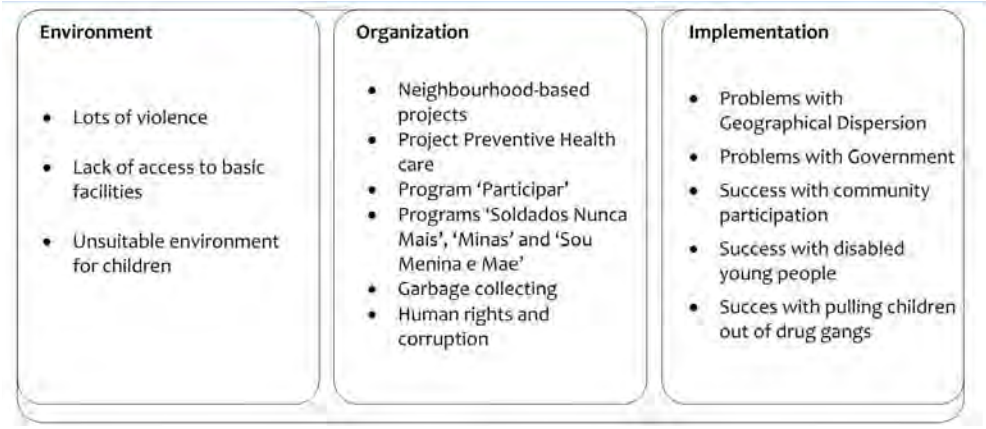

Figure 4.7: Environment, Organization and Implementation of case study IBISS

On the long term, there are some possible income sources that could be exploited more by IBISS. Some of the projects that have originated from the 'Soldados Nunca Mais' project for example, have turned into profitable organizations. The profit made is now invested back into these projects, but they could account for a partial money inflow for IBISS in more difficult times.

Conclusion

It is arguable whether the IBISS project in its entirety is contributing to a sustainable future, but one can at least say that IBISS tries to reach a more equal social situation in the favelas of Rio de Janeiro. It helps people to develop themselves and their way of living in a sustainable way, by providing them with any means possible but encouraging them at the same time to fight for their own future and develop their own prosperity. The project does not have a solid and sustainable income situation and does not clearly treat the planet in a sustainable way, so there is much room for improvement, but in the area of social sustainability their efforts are already quite effective. This effectiveness should however be considered within the borders of the IBISS projects and their area of influence, because all the problems that emerge around favelas can never be countered by a sole organization like IBISS.

Role of civil engineering

The role of civil engineering is very little in the IBISS organization. While there has been a project investigating possibilities of cycling in the favelas, this has not yet resulted in any measures in this area. Other civil engineering projects are done ad hoc and without proper knowledge or planning. Most projects focus on the people of the favelas and make use of existing constructions. It could be argued that civil engineering should be getting an increasingly important role in projects related to IBISS. In theory, as a result of the IBISS projects, people will become more developed, increasing the need for civil engineering. On the other hand, this is mainly a concern for the governmental organizations and not directly for IBISS itself, as their main focus is on social aspects. It could be further investigated whether civil engineering could support existing IBISS projects in a sustainable way.

4.5. Case study ii: prosamim

In this section, we will first discuss the problems facing Manaus and the Igarapés that have been explained in the chapter Background. We will continue with an explanation of the history of PROSAMIM, followed by an explanation of the project organization. After this, implementation and problems during the implementation are discussed. Finally, some conclusions concerning the project and the aspects of sustainability and the role of civil engineering will be formulated.

4.5.1.Project environment: Manaus & the river bank settlements

The city of Manaus in the State of Amazonas faces a few different problems, witch will be address in the following chapter:

- Growth-related problems
- Geographical problems
- Environmental and hygienic problems

The Igarapés (streams) spread through the city are inhabited by people from the lowest social classes. The State of Amazonas tries to provide the low-income population currently living in the river bank settlements access to a sanitary sewer system to improve the quality of life and health of this population and reducing the pollutant load dumped into the Igarapés.

Growth-related problems

The primary cause for the current problems in Manaus is growth related. However, the

Figure 4.8: Waste and pollution is common.

Figure 4.9: Living conditions in the Mestre Chico Igarapé

fact that there were no real policies dealing with the accompanying issues that arose was maybe even more influential. The Institute for City Planning in Manaus (IMPLURB) had no program to regulate existing settlements. There was no effective policy available to promote to the low income population the production of urbanized land for residential use at affordable prices. The Inter American Development Bank indicates: "Manaus grew very rapidly without adequate infrastructure. The city's population jumped between 1970 and 2003 from 300,000 to over 1.5 million due to the expansion of production-oriented commercial activities associated with the creation of a customs-free zone and development of public services and government operations" (IADB, 2006). In their program, PROSAMIM (2008) underlines that the rapid population growth in Manaus was not accompanied by necessary investments in infrastructure or by regulatory measures on the use and occupation of land. Combined with the lack of alternative affordable urban housing for groups with low incomes, this caused the uprising of informal settlements with substandard housing.

Geographical problems

Substandard housing in itself reduces the quality of life of the population of Manaus, but the geographical situation aggravates the problem (figure 4.10).

The informal settlements mentioned above particularly arose in the banks of the streams near the city centre. The Igarapés were close to the sources of employment of the inhabitants of Manaus with lower income and also close to public transportation, public services (education and health), as well as other social infrastructure available in the area. But, like the PROSAMIM (2008) organization explains in their program, living in the streams of the Rio Negro has major downfalls. The Amazon basically has two seasons: the dry season (June to December) and the wet season (January to June). During the latter, water levels of the Rio Negro will rise several meters and heavy rainfall is further causing problems like flooding and collapsing of buildings.

Environmental and hygienic problems

The causes of these problems are associated with a lack of environmental education and infrastructure collection. Residents dump all solid and liquid wastes directly into streams, providing poor sanitary conditions and impairing the flow of water, especially during the rains. The constructions built in the streams (housing, and narrow bridges and walkways) hinder garbage collection. The problem is the whole absence of public

Figure 4.10: Hydrographical map of Manaus. Clearly visible is that the streams (with infomal settlement) run through the entire city

policies in these places - inhabited by a population that has practically nothing and is excluded from society.

The people living in the river banks have a low self-esteem. This is generated by the lack of a correct address and the lack of a house that provides safety against the risk of collapsing after heavy rains and Amazon deposits. Almost all households in the areas at risk have bad electricity services and the household's mostly use surface water for their needs.

Comparison with the Netherlands makes clear that the drinking water systems and sewage systems in Brazil are underdeveloped. In the Netherlands, the development of the water system began in 1854, when Amsterdam was the first city with fresh drinking water from water pipes. This was initiated by movements that tried to prevent epidemics. Further, during the period 1890 – 1940 all Dutch cities where provided with sewage systems (Lintsen, 2005). In Brazil, municipalities were responsible before 1969. Although, water supply and sanitation was already on a certain level, during the growth of the huge cities in the 1970's it was necessary to change legislation. After these changes in legislation the coverage of the servi-

Figure 4.11: Emergency action to collect garbage, although done constantly, it has little effect.

ces increased substantially, but, as is clear in Manaus, not every household is served yet (Motta & Moreira, 2006). In Brazil, water management must be decentralized and undertaken in a participative process that includes government representatives as well as legitimate private sector and community representatives (ANA, 2010). The services of water supply and sanitation were provided to a private company (Aguas de Amazonas) by City of Manaus in 2002. Services collection and final disposal of waste is the responsibility of the Municipal Urban Cleaning and Public Services - SEMULSP, however, these services do not cover most areas affected. In the PROSAMIM (2008) program document is explained that currently various diseases arise from water contamination and garbage that sprouts from the sewerage of the city's factories and homes. The occurrence of acute diarrheal diseases had an increase of 73% from 1998 to 2002. In the same period, cases of hepatitis A increased about 44%. In 2002, 53% of malaria cases in Manaus were identified in areas with housing conditions found on the banks of streams.

Conclusion

The project environment of PROSAMIM in Manaus is one with an entanglement of issues: growth, geographical, environmental and health problems are entwined with one another and also closely linked to social issues. This problem therefore not only needs a civil engineering solution to cope with the first couple of problems, but will also need a solution that carefully takes the local population into consideration. In Figure 4.12 the environment of the case study PROSAMIM is summarized.

4.5.2. Project organization

In this section we will first discuss the organizational history followed by the project goals and how the project organisation is organized.

Organizational history

As discussed in project environment, the problems surrounding the Igarapés are quite different in nature. The occupied areas have a high environmental sensitivity and are not suitable for city development. The Igarapés in Manaus represent an environmental problem, a social problem and an urban-development problem for the city of Manaus.

The very first start of the project was the result of statement of the government of Amazonas: "the removal of families from risk areas, offering better housing conditions, the search of land for resettlement of

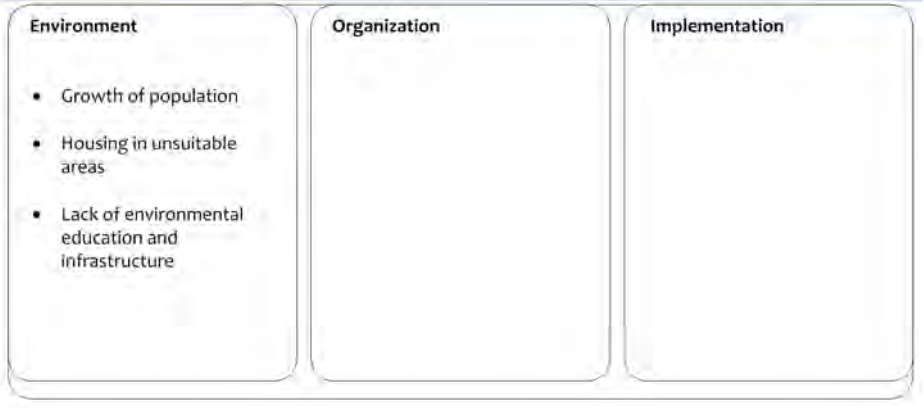

Figure 4.12: Environment of case study PROSAMIM

families near the area where they live, assisting in drainage solutions and, proposals for urban development and recovery of areas of historical interest were defined as area of operation of the program, the quota of 30 m flooding of the Rio Negro". This statement guided a multidisciplinary team of specialists in hydrology, hydraulics, sanitation, environmental, social and economic issues in developing a "Termos de Referência" (Terms of reference, or TOR). This TOR would then guide future studies and help others in proposing plans or solutions for the problem in the Igarapés. Important to mention is that - from this point forward - frequent consultations would take place with a variety of parties. The TOR would even demand that firms would hold meetings with communities (PROSAMIM, 2008). Involved in the (preparation) of the program were:

- Government of Amazonas state
- Manaus city council
- Non Governmental Organizations
- Civil Society Organizations of Public Interest

Several different plans were prepared and investigated by consulting firms, taking into consideration a future perspective of 30 years. An alternative was chosen on the basis on being the most attractive in economic aspects including technical, social and environmental aspects. This (first stage) program would then be developed in more detail in order to get approval from the Inter-American Development Bank (IADB). A new TOR was made to guide the following studies:

1. Plan participation of community
2. Resettlement Plan for Population
3. Plan Prevention and Control of Pollution by Wastewater Industry
4. Plan Institutional Strengthening and Sustainability
5. Social Communication Plan
6. Plan for Environmental Education.

These studies have lead to a plan for approval from the IADB in 2003 which would be the official 'kick-off' of the PROSAMIM program. However, it took until 30 November 2005 before the IADB approved the credit operation.

Organizational Goals

The main goal of the PROSAMIM program can be formulated in the following way: to improve the environmental, urban, health, and housing conditions of the population in the Igarapes' watersheds in Manaus.

4.5.3. Project

The actual PROSAMIM program consists of two different phases and a supplementary phase on phase 1. Difference between the two phases mainly concerns the area of influence, the area that is being improved, see Figure 4.13. We will first discuss phase I. Currently, a supplementary program on the same area as phase 1 is in execution. We will later shortly comment on phase II.

Phase I

The phase I program deals with the problems described in the cultural background above. Phase I has been approved in November 2005. Execution of the program started in 2006. Some main aspects of the program will be discussed below, within one of the three themes mentioned below. These themes are essential and interconnect with each other. It may be good to mention that the sources we used for this research use different ways to classify and explain the problems in themes, steps or pillars; we chose to use the three themes below. These themes cover the scope of the program and enable us to effectively discuss sustainability

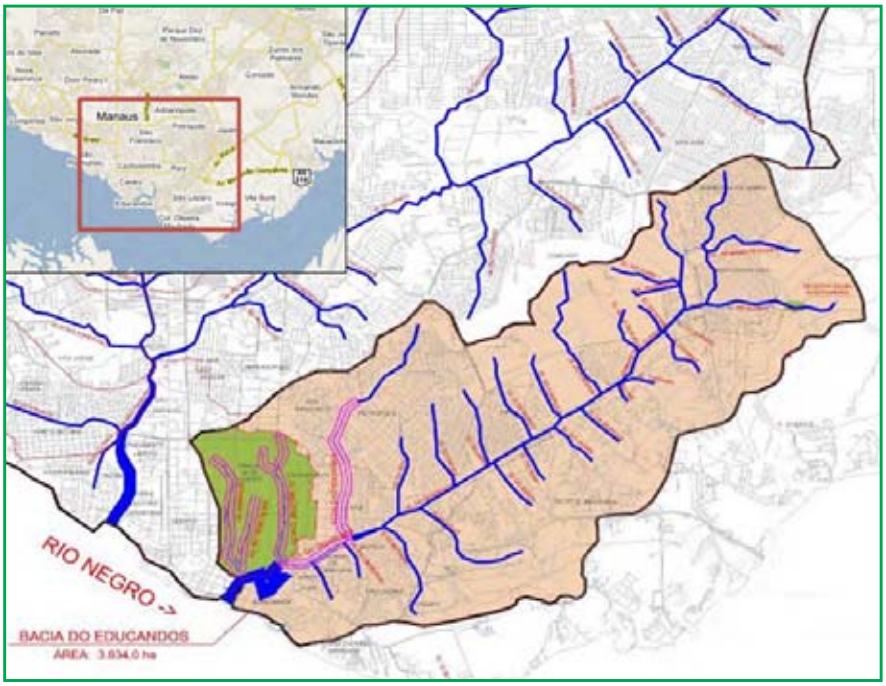

Figure 4.13: Indication of the different PROSAMIM phases. The streams in the large orange indicated area belong to the Igarape Educandos basin wicht forms PROSAMIM I. The streams that are indicated in green are the first that have been executed. The other blue-colored basin (upperleft part of the map) is the area for PROSAMIM II, concerning Sao Raimundo.

later on.

1. Sanitary Infrastructure
2. Social an Institutional Sustainability
3. Environmental Restoration.

Name Igarapé	# Families
Manaus	363
Bittencourt	154
Mestre Chico	534
Cachoeirinha	1.308
Quarenta	1.967
Total	4.326

Table 4.2: Igarapés involved in the sample of the first phase of PROSAMIM (PROSAMIM, 2008)

The investment program constituted out of three components (PROSAMIM, 2008) , these components are discussed in the next section. We, however, want to note that 6.349 families have actually been moved (PROSAMIM, 2010), this is a remarkable increase to the initial plans. The difference is probably created by the success of the program or possibly by a change of definition of what a family is.

1. Sanitary infrastructure

The sanitary infrastructure is essential in the improvement of health conditions although the environmental improvement will also play an important role. The latter is more for preventing flooding and free flow of water without pollution. The sanitary infrastruc-

ture then insures that demands of people (sanitation and drinking water) are finally met, which was previously impossible. Besides this goal, the realization of this part of the program is pretty straightforward: providing such main infrastructure such as constructing piping for drinking water and sewage. The sewage system is directed towards the Rio Negro but conditioning will take place.

2. Social and institutional sustainability

The social and institutional processes influencing the program have been studied extensively, to enable and improve operations and management of the program and to make the program more effective. It was of vital importance to achieve community participation. Major efforts where undertaken to, first, remove the people from the problem areas and, second, educate them once replaced in a house. In this way, they try to make sure that current social investments will have long lasting benefits. In order to do this, the program continuously uses media, engagement activities, and education. To get some experience for successful implementation a number of pilot projects where undertaken. These pilots, in fact, covered the whole variety of aspects of the program, but on a smaller scale. This was an excellent opportunity to show the programs purpose and to encourage people to participate.

3. Improvement of environment & urban development/housing.

This part of the program forms the largest cost source and consists out of the construction of macro and micro drainage of rainwater and protection against flooding. Next to drainage systems, channels were constructed or adjusted, and protection was provided against headwaters. In general, the area became more protected against flooding from the Rio Negro and can now cope better with heavy rainfall.

Also the (re)settlement of the urban population was important. Villa's were built according to stated rules about size and the number of occupants. These buildings are fairly distinctive, but do really form a great improvement when regarding the previous dwellings. The new housing situation is really different (new situation and sometimes location), therefore families were given assistance in adaption to their new environment.

There were several options for resettlement of families:

- **Indemnity**: An owner, who resides in a property with a value greater than R$ 21.000, received a cash compensation equivalent to the market value of improvement.
- **Bonus**: The tenant/landlord received a housing bonus worth up to R$ 21.000, for the purchase of residential property in Amazonas State.
- **Housing Units**: Houses are built in Central Manaus near the area undergoing improvements. Tenants or families leasing such a house, will receive a Housing Unit given that procedural rules are followed.
- **Housing Estates**: Public housing is located in the north of the city with a value of R$ 21.000. Tenants or families that had to give up there housed are ceded here under concession.

However, the case also showed that several families still want to stay near the area where they lived. For these cases, the program provided so-called "auxílio moradia" (housing allowance). This would be a monthly allowance to pay the rent of a house until construction of new housing would finish.

Next to this, parks and boulevards were

Figuur 4.14: Before and after pictures of the area around the Benjamin Constant bridge

constructed in the area of recovered land (which used to be under water due to lack of drainage and channels). These constructions where made to prevent the same problems emerging, like occupation of the banks directly next to streams. Further, it enables future generations to build extra infrastructure (roads etc.) and make space for maintenance (e.g. for channels, reservoirs, drainage systems), if needed.

All this helped in rehabilitating buildings in and around the streams in Manaus for residential and commercial use, improving the overall quality and wealth of the area. Next to ensuring improvement of health and safety, these developments will also contribute to the quality of the rest of (inner) Manaus and therefore also aspects like economic growth.

Stakeholders and shareholders

Many different stakeholders and shareholders are involved during the execution of phase I. The most important parties are mentioned below:

Major principle and funder

- Government of the state of Amazonas – responsible for implementation of program
- Inter-American Development Bank (IADB) – funding

Figure 4.15: Results of PROSAMIM: new housing, channels and infrastructure

- Coordination and implementation
- Ministry of Infrastructure (SEINF)
- Program Management Unit of the Streams (UGPI)

Partners

- Department of Labour
- Concessionária de abastecimento Águas do Amazonas (supply water of the Amazon)
- Concessionaire Manaus Energia (energy supplier)
- Committee of Representatives of the Communities
- Program Advisory Committee.

Besides these many partners, more parties were involved, mainly governmental parties.

Financing of PROSAMIM phase I

The financing of the first phase of the program required 200 million USD. The state of Amazonas invests 60 million and the remaining 140 million is invested by the Inter-American Development Bank (IADB). This loan has an amortization period of 25 years with a grace period of 6 years. The disbursement period is six years and the interest rate is according to LIBOR (London Interbank Offered Rate) (IADB, 2005). In their plans the IADB has e.g. taken into consideration that it is a necessity for a stable government to successfully implement plans. They recognized that with administrative changes, priorities could shift. Furthermore, a risk was identified in people losing belief in the government and with that, belief in the PROSAMIM program (IADB, 2005). See Table 3 for an overview of the program financing.

A cost benefit analysis was performed and this showed that the program was financially feasible. The following benefits were considered (IADB, 2005):

- Drainage and road improvements that lead to less travel time, prevention of damage, and therefore cost savings.
- The difference in rental value before and after resettlement.
- Benefits of sewer services, water services and public spaces. The value of these services and public goods are estimated on a willingness-to-pay basis.
- Benefits of healthcare.

When all these aspect are taken into account, the different projects (on a sub watershed level) are financially feasible. However, obviously, it is hard to estimate proper figures on some of the benefits mentioned above. In the loan document no exact figures or numbers were presented and it is therefore unclear whether and how fast this project will pay back its investments. During our visit in Manaus the state was very convinced that this programme has many benefits, and that they are able to service the debt in anyway. Therefore it is safe to say that PROSAMIM will not be stopped by lack of financial means.

Phase II

The second phase of PROSAMIM has also officially started. Although it does concern an other geographical area the same project and design principles will be applied. The IADB loan for the second phase was approved in August 2008. Further, due to the success of PROSAMIM I, a supplementary program is executed to resettle another 1672 families in the areas closely linked to the PROSAMIM I area. Table 4.3 below gives an idea of the size of the programs. This second phase is even bigger that PROSAMIM I. This time, the loan is approximately 154 million USD and another 66 million USD is contributed by the state of Amazonas (IADB, 2006).

Conclusions

Looking at the project organisation, we can

PROGRAM	IADB	FINANCED LOCAL	TOTAL	# FAMILIES
PROSAMIM I	140	60	200	6.349
PROSAMIM II	154	66	220	4.352
PROSAMIM SUPLEMENTARY	77	33	110	1.672
TOTAL	**371**	**159**	**530**	**12.373**

Table 4.3: Overview of PROSAMIM phases and financing in millions of USD (PROSAMIM, 2010)

summarize that different phases exist, improving different geographical areas. Funding clearly is supported by the IADB and the program contains different aspects, such as the development of sanitairy infrastructure. We think civil engineering solutions are found for several of the problems but more importantly: there seems to be a real focus on successful implementation of the program through community participation. This will be examined more closely in the chapter:

Implementation and problems during the project", see Figure 4.16 for an overview of our conclusions so far.

4.5.4. Implementation and problems during the project

In the previous sections, it has become clear that the project organisation was, in many ways, closely linked to the diversity of aspects and problems. For instance, not only technical aspects like construction channels and piping were considered, but social aspects were though of too. However, an earlier case study of the program (PROSAMIM, 2008) does mention several difficulties in implementing the program. Below, a description is given.

Political/Governmental

The preparation process of the program required extensive work. The management unit responsible for coordination of the program (UGPI) had to involve 17 (governmental) entities that were directly involved and 11 entities that were indirectly involved. Especially the agreement with the water company required much attention (PROSAMIM, 2008). In the initial setting, the water company would be responsible for construction of water services but this formed a problem. In a new bidding, the state would take control and transfer the system after completion back to the water company.

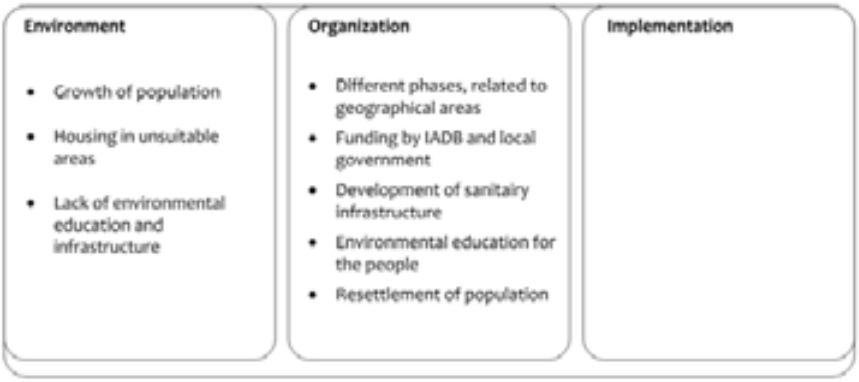

Figure 4.16: Environment and Organization of case study PROSAMIM

Furthermore, the IADB demanded that all preparation were finished in the sense that construction could start (e.g. ownership of land, right of way) along with the bank's approval (IADB, 2005).

Although the political and governmental arena can be real hurdle for implementing a project, it can also be a supporting factor. The latter is definitely the case with PROSAMIM. After phase 1 it became clear that PROSAMIM really made a real improvement to the people and the city, it was declared as a total success by the public. This also meant that political leaders will support in upcoming elections meaning even further support to the programme. The programme benefits for its own initial success.

Community participation

From a social point, this issue was very important to achieve success. As mentioned before, the community was involved from the early start of the program. The program organization also organized meetings, activities etc. to insure involvement. Another aspect which may have contributed in this respect was the choice to improve specific areas first, in a stepwise process. These areas would then become example and showcases of what could be expected.

It is really difficult to change old habits; people e.g. still have the tendency to throw garbage on the streets instead of in waste buckets. It will be important to keep educating the people to explain the necessity of sanitary life.

Technical

Although much information was available, there were still difficulties and problems with a lack of knowledge on soil/ground conditions. This has led to an expansion of the area that had to be improved. This was a significant increase in work according to the project organization (PROSAMIM, 2008), but the extent of this project is not known.

Next to this, there was also the difficulty in the supply of materials, especially soil for land filling. Several technical solutions had to be thought up to cope with these issues.

The report a case study recommended the use of good contractor, with multidisciplinary technical skills. This seems to be a good conclusion taken into account the many (technical) aspects that constantly have to be considered (PROSAMIM, 2008).

Urban/resettlement

The resettlement has proven to be difficult. It was difficult to meet the goals of those families, especially if they preferred to stay nearby the streams. But the resettlement process was carefully prepared 2-3 years in advance and the resettlement itself constituted in a 10-step programme. In the same way as in the political arena, the programme was able to sell itself after its initial success. During the site visit, the company indicated that from the over 10.000 families involved in the programme, only 30 objected.

Although there were several challenges in implementing the PROSAMIM program, no really strange problems occurred. Most of the technical challenges are related to a lack of knowledge or (ground condition related) information. This challenge could be expected; given the situation it will have been difficult to get accurate information. The difficulties in organizing the program are also explainable given the project environment. Many (governmental) parties are involved which makes coordination difficult. The participation of the local population was important and necessary, but of course also provided some challenges. In that sense, the problems in implementing the program can be explained by looking at the project envi-

ronment and project organization.

4.5.5. Conclusions from the PROSAMIM case study

When we consider the entire program lifecycle (of PROSAMIM I), we can see a close link between the project organisation and the environment in which this program exists. The challenges of improving quality of life in the Igarapés in Manaus are a multidisciplinary problem. Such a problem requires a multidisciplinary solution which seems to be the case with PROSAMIM. Especially social aspects were very important and community participation will have been a keyfactor in successfully implementing the program. Implementing the program seemed to have its challenges, mainly the need for good coordination of activities and parties was challenging.

When the 3C model is kept in mind, PROSAMIM has a strong connection between the three different sections showed in Figure 4.17. The whole Organization is to change the environment. So the project organization is largely based on project environment. Also there are challenges with implementation, like community participation and the resettlement of families. But we have seen that the implementation is decisive for the success of the program. Therefore the focus is on successful implementation of program through community participation.

Sustainability

We will address sustainability by looking at three aspects: People (social), Planet (environmental) and Profit/Prosperity (economic/financial aspects). In all aspects, we take into consideration how the future is taken into account (not only looking towards the next couple of years, but also beyond). We will pay special attention to the aspect of People, since this is the major focus in the projects studied in this micro-study.

People

The most important contribution of the PROSAMIM program is the improvement of living condition, safety and public health. Furthermore, the project also contributes to economic wellbeing for the population of Manaus in general. In this respect, we can state that investment in this program is investing in a social sustainable future.

However, on a smaller project scale; we also see that sustainability was taken into consideration. Studies e.g. assessed the ability of people, which will be using the new-build infrastructure, to be able to pay for the sanitary services provided. This, of course, is limi-

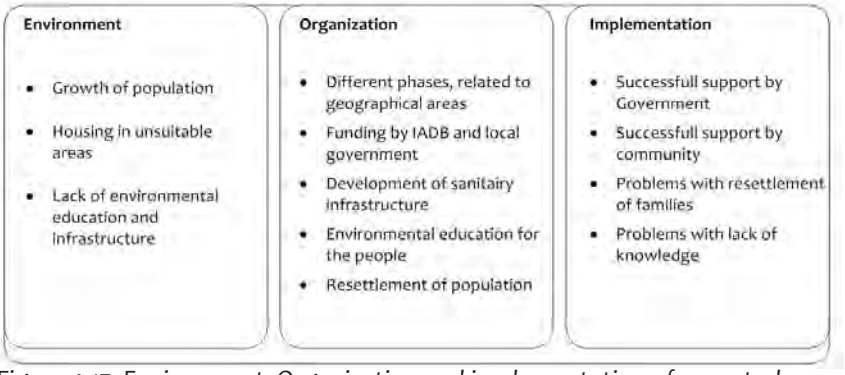

Figure 4.17: Environment, Organization and implementation of case study PROSAMIM

ted with the assumption that people will be willing to live in a way that is new for them. However, the participation of the local communities was given attention from the early start. This was done with the vision to really upgrade the living conditions for lower income people. The program doesn't just relocate people. It also takes some of the current functional aspects of the informal dwellings into account. The IADB for example, mentions the necessity to facilitate the re-establishment of affected businesses from the informal dwellings. Apparently many unregistered businesses were run from the - to be removed -dwellings. In this research we could not easily value the compensational measures towards former inhabitants in this research. We expect that public health will really be improved by the sanitary measures taken in the PROSAMIM program; this will contribute to the people.

We already mentioned that, after relocation, many people have improved their habits, although still points for concern exist to keep the new dwellings clean and prevent informal construction within the reconstructed areas.

Planet

The program also influences the aspect of planet. This mostly has to do with the improvement of water related systems like drainage systems and channels. This prevents pollution which was one of the major problems in the area. Sewage systems are emplaced to prevent (more) pollution of the Rio Negro. The aspect of planet, however, was not the main focus of the PROSAMIM program.

Profit

As far as the aspect of profit or prosperity, it seems that most attention is paid to the financing of the project itself. The IADB has conducted a cost/benefits-analysis which is also focused on whether the program is important and financially feasible. It is mentioned however, that the program will have a positive influence on, for instance, the city centre and free-trade-zone. However, in the loan documents we studied no real prediction on the long-term benefits were given. The division of benefits from this project is formally considered in the MCA, as mentioned in the loan proposal of the IADB (2005).

The report a case study also mentions that that population could participate in construction and maintenance activities to raise employment (PROSAMIM, 2008).

Conclusion

From a sustainability perspective, we also see that the program has taken the future years into account. Various measures are taken to insure success and to benefit from the PROSAMIM project in the years to come (for instance by preventing resettlement to be built near the streams). However, next to the clear improvements in safety, health and living conditions, it is less clear how the local population will benefit from PROSAMIM in an economic sense. This is also very important from a sustainability and social development perspective, so this should be investigated more. The people in the renewed areas get ownership over their new houses, the government of Brazil will benefit from the formalisation of the, currently informal, economy in the Igaurapés. Taking the people of the Igaurapés up into the formal economy and making them pay for the services they use will, possibly, enable Manaus and the state of Amazonas to provide the same services for future generations.

Role of civil engineering

What should be clear is that the role of civil engineering in the PROSAMIM program is extensive. Civil engineering is essential in improving living conditions, which in turn can contribute to social sustainable deve-

lopment. Although we think civil engineering (technical) solutions seem to have formed a foundation for social development, many other factors will certainly determine whether or not quality of life will actually be improved. Both hypotheses below will be discussed, in this regard, during the company visit of PROSAMIM.

4.6. Conclusions

In this final chapter we will present the conclusions drawn from the two cases, IBISS and PROSAMIM. First we will discuss both cases using the 3C-model and will therefore discuss the project environment, project organization and implementation of the two projects. After this, we will continue with discussing the aspect of sustainability in both projects (within the projects) and how they contribute to (sustainable) social development. Finally, we will conclude with a discussion about the role of civil engineering within these cases. We will then have gained in-depth knowledge about the two cases and will have answered our main research question.

4.6.1. IBISS & PROSAMIM

As the conclusions after the case study chapters also mentioned, the project environment, project organization and implementation are clearly related to one another. The project is organized in such a way that it deals with the specific aspects of the project environment. Likewise, the problems and successes that projects face are also explainable when we take the organization and the environment into account.

Because the project environment of both cases differ significantly (the problems, conditions and, most important, the actors in the specific cases), we also see different organizational forms and different plans being drafted and implemented. In the IBISS case, we see that several specific projects are undertaken. Each project deals with a certain problem. In the PROSAMIM case, we see a more integrated program being undertaken with a holistic approach per geographical phase. This also has to do with the fact that the different problems are more entwined with each other (dealing with them involves a big intervention). IBISS tries to reach their goals by developing and initiating multiple custom made projects, in an effort to tackle a multitude of - sometimes very different - problems. In Figure 4.18 we see both project summarized in the three aspects of the 3C-model, Environment, organization and Implementation.

Sustainability

When looking from a sustainability perspective. We see that both projects do take into account the long-term effects of the project. The IBISS project invests in several – mostly social – projects to enable people to develop themselves and make a living. In that sense, IBISS focuses on the core of the problem and not on compensating the results of this problem. This can be regarded as investing in sustainable social development.

The PROSAMIM project also takes sustainability into account in providing people with basic needs and solving environmental issues. But there also seems to be focus on guaranteeing the success of the program. Special attention is paid on making sure all the work done will keep being of benefit in the future and that the old problems do not re-emerge. The work of PROSAMIM is fundamental in development in the area but it is not yet entirely clear how the local population will benefit from PROSAMIM in the future.

Role of civil engineering

Maybe even more interesting is what role civil engineering has in these two cases,

Figure 4.18: Environment, Organization and implementation of case study IBISS (below) and PROSAMIM (top)

and how this role may change in the coming years.

The role of civil engineering within IBISS is minimal since most projects purely deal with social issues. In this sense, civil engineering does not contribute much to sustainable social development in the favelas in Rio de Janeiro. We think that the lack of transport possibilities might currently form an invisible barrier to improve living standards of many people living in the favelas. However, when the population in the favelas will develop, civil engineering may become more important. For instance, with development it is also common that the need for transport and infrastructure will increase. This will raise needs were civil engineering might be vital. Civil engineering could already play a role in boosting existing IBISS projects, but this has to be researched more in-depth.

Within PROSAMIM, civil engineering is a fundamental aspect to provide people with basic needs and to improve living standards. But (sustainable) social development in the coming years will probably mainly depend on aspects besides civil engineering, like the economy and employment possibilities for the local population.

Overall, we think that the role of civil engineering in sustainable social development in Brazilian cities is mostly an enabling role. Civil engineering builds a starting point for social development (PROSAMIM) or may solve problems that occur with development (possibly IBISS).

4.7. Epilogue

Looking back at our studies we can conclude that the study of these cases has had a large impact of how we think about the efforts undertaken to improve living conditions in Brazil. It really made an impact on us and other participants of the study tour. With the site visits we have seen the efforts in practise and gained a lot of understanding for the Brazilian situation. It was clearly that both projects, in their own, contributed to the improvement of living conditions.

It was interesting to see that the cases had a totally different approach on Civil Engineering, due to the difference between the two initiators; IBISS is a non governmental organisation and PROSAMIM was a project introduced by the government. Completely different, but they try both to improve the living conditions of the most fragile people in the society.

Sustainability is an issue that really differs between Brazil and the Netherlands. Totally different priorities exist in the way we would look at sustainability with a western perspective. In Brazil sustainability - in the cases we studied - focused on the basic needs for the people, giving people housing, sanitations and education and improving the future in this way. In Brazil sustainability really focuses at the current generation. In the Netherlands sustainability oftentimes is about reducing the usage of unsustainable energy and/or materials and therefore it looks at providing the future generation with the same possibilities as we already have.

We want to conclude by thanking the people from IBISS and PROSAMIM for taking the time and effort to explain and show their program or project to us. Without the, practical, insight they gave us we would not have be able to gain a good understanding of the role of sustainability and civil engineering in social projects in Brazil.

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5. SUSTAINABLE STADIUM CONSTRUCTION IN BRAZIL AND THE NETHERLANDS

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Bram Entrop
Jeroen van der Meer
Léon olde Scholtenhuis
Peter Schoonderbeek
Bart Wolbers

5.1. Introduction

Mega sports events like the FIFA World Championships (WC) can have a significant impact on the environment. The constructions of stadiums and venues, as well as during the actual operation of the stadiums require a lot of materials, energy and water. As host for the WC of 2014, a main goal for Brazil is to minimize the negative impact on the environment and maximizing financial and social benefits. Brazil won the bid for 2014 and convinced the FIFA that Brazil is able to meet the prescribed sustainability requirements. Meanwhile in Europe, The Netherlands and Belgium are competing with other countries like the United Kingdom to become host of the next WC. Albeit Brazil and Netherlands are two very different countries, they both should have sustainable stadiums in order to comply with the regulations of the FIFA. Therefore, the main goal of this study is to compare the Brazilian and Dutch perspective on sustainable stadium building. To do this, we investigated a stadium in Brazil and redevelopment plans for the stadiums in the Netherlands. The first is the Manaus Arena in the Amazonas State of Brazil. For the Netherlands we studied the Bidbook for the WC 2018 created by the Dutch Local Organizing Committee. Both stadiums have been built within the past fifteen years and are chosen as suitable stadium for the WC.

In this paper, we first present the theoretical aspects that are needed to define sustainability. Besides the theoretical aspects the view on sustainability of the FIFA is also discussed. Next, the method for comparison is given. The results are presented thereafter. Finally, we conclude with the discussion about the results and an overall conclusion.

5.2. Theoretical points of departure

There is a multitude of definitions on the concept of sustainability. A popular, but quite general definition on sustainability is the one of the Brundtland Commission (1987):"meeting the needs of the present generation without compromising the ability of future generations to meet their own needs". From this definition, we can also derive several attributes of sustainability. A good framework that includes these attributes divides sustainability into three pillars: people, planet and profit (Elkington, 1997). From the people perspective, sustainability occurs when the "formal and informal processes, systems, structures and relationships actively support the capacity of current and future generations to create healthy and liveable communities. Socially sustainable communities are equitable, diverse, connected and democratic and provide a good quality of life." (McKenzie, 2004). The planet attribute focuses on the environmental aspects of sustainability. For example, carbon emissions, energy and water consumption, and material use during construction and operation of a stadium are important aspects. Finally, a project is sustainable from profit perspective when the revenues or profit from a project are divided over all stakeholders equally.

This research it limited to the people and planet pillars of sustainability in a qualitative way. The following paragraphs will elaborate on two frameworks that enable us to assess the researched stadiums on people and planed aspects: the participation ladder (Arnstein, 1969) and the Triad approach (Entrop & Brouwers, 2010).

It is important that citizens are able to participate in decisions and processes where they are influenced by, in other words, in processes where they are a stakeholder. For the classification of the participation of stakeholders we will use the participation ladder of Arnstein (1969). He divides the degrees of participation in urban planning into eight different levels, ranging from manipulation till citizen control. Each step on this ladder describes the way in which citizens are able to influence the decision making process.

For the planet aspect, we chose to study water and material consumption, and waste minimization. There are several methods to assess these three topics for construction. One popular example that is used in construction to rank sustainability is LEED (Leadership in Energy and Environmental Design). A more suitable approach for this research is a qualitative one, the Triad Approach of Entrop and Brouwers (2010). The method ranks the water consumption, and material consumption and waste production on three steps. We will subsequently discuss the three ways to deal with water and materials/waste by describing the Trias Hydrica and Trias Hylica.

For the Trias Hydrica (Entrop & Brouwers, 2010) it is important to distinguish freshwater and grey water. Fresh water is potable and can be cascaded for grey purposes after disposal. Filtering fresh water is energy consuming and not always necessary. One can seriously reduce water consumption when re-using freshwater or using water of lower quality instead of freshwater instead. Water usage differs between continents. Having this in mind, we can describe the Trias Hydrica ranks water usage as follows:

1. First category consists of measures in buildings that prevent usage.
2. The next level consists of measures that use renewable water sources as much as possible (e.g. storm water for gardening and toilet flushing).
3. The last category uses fresh drinking water as efficient as possible (water saving toilets, showers, using water in a cascade form etc.).

When we look at the organization of events like the Olympic Games and WC, we can look at carbon emissions in several ways. First, there are carbon emissions during the events. These emissions result from (international) transportation, and commercial activities related to the event. On the other hand, there are emissions produced during the construction of facilities. The relevance of waste management is indicated in academic literature as well (e.g. Bossink and Brouwers, 1996). They cite Pinto and Agopayan (1994) who state that construction industry in Brazil generates 20-30% construction waste (by weight, percentage of total amount of purchased construction materials). For our research, we combined carbon emissions during construction and waste management under the heading construction materials.

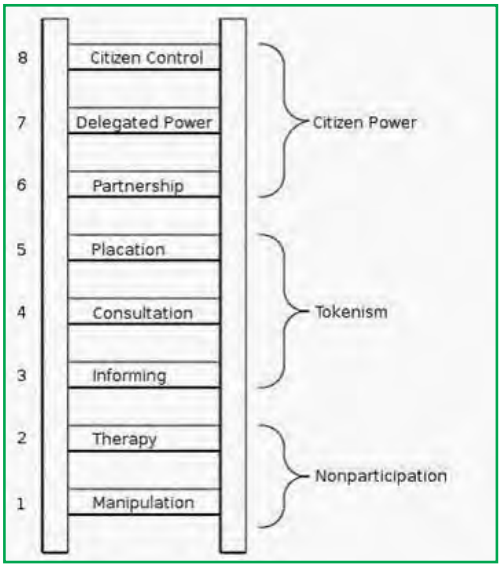

Figure 5.1: Participation ladder of Arnstein

Entrop and Brouwers (2010) propose the Triad Hylica to assess the quality of construction materials. They state that there are several important aspects when choosing materials. First, there the quantity of materials used should be minimized. Further, the quality and ability to recycle a component is equally important. Possible ways to measure the sustainable quality of materials is by Life Cycle Assessment (cradle to grave approach), the LEED-method, and ISO-certifications. A more suitable method for our research is the qualitative Trias Hylica:

1. The first categorized step is to prevent the unnecessary use of materials such as smart and efficient designs of components and of buildings, and combinations of functions (e.g. H-profiles and hollow floors on component level. An on facility level: flexible spatial planning (also see Lockwood, 2006 and Modular.org)
2. If the first step is used optimally, designers should integrate local renewable materials in building materials. (e.g. wood and cork)
3. The last category consists of designs that use non-sustainable materials. These should be used as little as possible (e.g. high strength concrete, cascaded use of materials).

For the Trias Hylica, it is important to realize that re-use and recycling of materials like wood also generate processing and transportation energy (also see Thormark, 2006). Re-use of materials in an unsustainable way is therefore part of the third category.

5.3. FIFA's perspective on sustainability

Next to the theoretical perspectives, the FIFA perspective on sustainability is a very important one for the construction of the two stadiums. The FIFA uses its competitions and events as platforms for running national and international awareness for raising funds for established social causes. Three recent campaigns are '20 Centers for 2010', 'my Game is Fair Play'' 'and 'Say No to Racism'. With football as a mean, FIFA tries to raise awareness for public health and education in disadvantaged communities. The second campaign address norms and values like respect, discipline and team work. Latter campaign tries to find and effective solution against racism.

The main sustainability focus of the FIFA is related to the people attribute. However, they also have an objective related to the planet. The FIFA wants the WC to be carbon neutral. For 2010, they therefore created The Green Goal 2010 program:

"The primary aim of Green Goal 2010 is to ensure the 2010 FIFA World CupTM is a carbon neutral event and that other negative environmental impacts of the event are minimized through implementing event greening principles such as sustainable procurement, energy efficiency, waste avoidance and water conservation." (Department of Environmental Affairs and Tourism, 2009)

5.4. Method

The strict FIFA regulations obliged WC hosts to build new stadiums or renovate existing stadiums to meet high standards (i.e. enough capacity). For this research two stadiums are visited: one stadium in Brazil and one in The Netherlands. Both stadiums prepare themselves for the FIFA WC. In Brazil the Arena Amazonia (Manaus Arena) is under construction. This stadium is located in Manaus, the capital of the state Amazonas. The new stadium is built on the same location as the old stadium (named Vivaldão). The Manaus Arena is the only stadium in the north of Brazil during WC 2014.

The Grolsch Veste is one of the stadiums that are presented in the 'HollandBelgium bid' for the WC 2018. In this study the Grolsch Veste is used as a reference stadium for the Dutch situation. The Grolsch Veste is an existing stadium in the city Enschede, close to the German border. At this moment it is not decided which country or countries may host the WC 2018. The FIFA will select the host(s) on 2 December 2010. Because of the uncertainty of hosting the WC, only rough plans of the Grolsch Veste are available. The current capacity of the stadium is 23.800, which will be extended to over 41.000 seats. Characteristics of both stadiums are listed in table 5.1.

As mentioned earlier, this report focuses on three main pillars: sustainable water usage, construction materials and social participation. In our preliminary research we also included the IOC's vision because Rio de Janeiro will host the Olympic Games of 2016. Their focus is also on the three pillars. To answer the research questions, information is gathered in multiple ways. First of all, information of both stadiums is obtained from documents on the internet. A presentation and interview with the main contractor of the Manaus Arena has given more in depth information. The Grolsch Veste is mainly researched by reading the HollandBelgium bidbook, which only provides general information at national level.

5.5. Results

The research findings are presented below. First, the findings on the water aspect are discussed, then the findings on material and waste minimization aspect, and finally on the social aspect. For each aspect, first the Brazilian situation is discussed, after that the Dutch situation is discussed. Finally, a general conclusion is presented.

5.5.1. Water

Water use is an important aspect within sustainable buildings. Most of the high quality water is used for non-potable purposes. A major part of the used potable water in buildings is used to flush the toilet. Nowadays storm water (grey water) is mostly treated as a waste product, while it could be used for non-potable purposes. For the FIFA WC 2010, there are some measures to decrease the water usage. The measures are related to the steps of the Triad Hydrica. These are (Black, 2008):

1. Use grey water to water the pitches (step 2)
2. Planting indigenous trees and plants (require less water) (step 1)
3. Harvesting rainwater (step 2)
4. Using water saving devices (e.g. flow regulators and dry urinals) (step 3)

	Manaus Arena	Grolsch Veste
City (inhabitants)	Manaus (1.738.000)	Enschede (157.000)
Local club (avg. spectators)	Multiple small clubs (unknown)	FC Twente (23.500)
Capacity during World Cup	46.000	41.200
Avg. Temperature[1]	27 °C	9 °C
Precipitation per year[2]	167 cm	77 cm
Public Transport	Monorail, bus	Train, bus, bike
Phase	Under Construction	Design

Table 5.1: Characteristics of stadiums

[1] (Weatherbase, n.d.)

Looking at these actions for the Trias Hydrica perspective, it seems that the whole range of categories is used. The actions to decrease water usage are mainly applicable in water use for the nature. How the FIFA decreases water use in stadiums and its facilities, are apart from flow regulators and dry urinals unknown.

Inspired by the fascinating diversity and forms of the Amazon Rainforest the Manaus Arena will be developed in a sustainable way. Manaus is one of the two green host cities of the FIFA WC 2014. To become a green host city of the FIFA WC 2014 water plays an important role. The measures prescribed by the FIFA are used in the Manaus Arena. Because Manaus has a high quantity of precipitation, storm water is the main aspect in the non-potable water usage. The stadium uses several innovative technologies regarding to sustainable water usage. The roof of the stadium collects the storm water. The roof consists of roof drainage with siphonic[3] system. The rain water tank in the control rooms collects the storm water from the roof. The water in the tanks in finally used for flushing toilets and irritation the grass.

The cold ground water is used to pre-cool the external air and will be collected in external containers. This means that flushing toilets, irrigating the pitch and pre-cooling the external air are provided with non-potable water. The air handling unit which pumps the ground water uses waste heat of the combined heat and power plant. This plant is fed with regenerative and CO2-neutral bio ethanol. (GMP pressebrochure, 2009).

A toolkit for stadiums is available to achieve sustainable stadiums. For usage of more sustainable water seven measures are included that correspond to the actions in table 5.2.

The water management strategy for the Dutch bid has four connected elements which can be grouped in two main areas: reduction of water used at venues, and use of rainwater instead of drinking water. A toolkit will be available to achieve sustainable stadiums based on these four connected elements:

1. Limit the use of energy-intensive drinking water
2. Limit the water flow to water treatment facilities
3. Use advanced water treatment technologies, which would make it possible to recycle and reuse treated water directly at the same location
4. Changing people's behavior regarding water

Rainwater will be collected on the roof of stadium or on the areas around it. Water-permeable ceilings and paving will have to be installed. To have sufficient water available, water is collected and stored during the period before the FIFA WC. The use of advanced water treatment technologies can be biofilm technologies, biofilm activated sludge and slow sludge production. Football stadiums mainly have greywater from irrigation and cleaning, thus contamination levels are low which makes stadium an ideal candidate to apply greywater systems.

5.5.2. Materials & Waste minimization

For the Trias Hylica, it is important to realize that reuse and recycling of materials like wood also generate processing and transportation energy (also see Thormark, 2006). Reuse of materials in an unsustainable way

[3] Siphonic roof drainage works very differently than normal downpipes. Rather than letting the water fall under gravity, which is what happens with traditional downpipes, it sucks the water off the roof at velocities up to seven meters per second. (University of South Australia, 2006)

Actions	Twente	Manaus
Rainwater collection and storage system in stadiums	√	siphonic
Water-saving toilets and urinals	√	√
Waterless toilets and urinals	√	?
Regulated washbasins, flow restrictors, flow sensor	√	√
Greywater-system	√ e.g. AquaCycle900	?
Blackwater-system	√ e.g. Envirosep SP 2000	?
Heating and cooling systems	√	√
...		

Table 5.2: Sustainable water measures

is therefore part of the third category.

Looking at the Manaus Arena, that is constructed by Andrade Gutierrez (AG), several sustainable measures are planned to be executed. On the project site, the old stadium is demolished to make room for the whole new Manaus Arena stadium. Regarding the waste aspect, waste separation is used. Furthermore, the concrete of the demolished stadium is crushed and used to cover ground on the project location (step 3 Trias Hylica). On the material aspect, they try to make optimum use of materials (step 1 Trias Hylica). The materials can be widely reused and recycled at the end of its life cycle. During the study visit AG showed that they make reuse of the seats of the demolished stadium (step 3 Trias Hylica). The seats are removed and transported to be used in another stadium. Furthermore, the old roof construction is also reused. In the design of the stadium, they considered the possibility that after the FIFA WC, the stadium might get another use. Therefore, they designed the spaces in the stadium flexible, so that they are capable for requalification (step 1 Trias Hylica). Generally, the Manaus Arena incorporates measures from step 1 and 3 of the Trias Hylica.

The FIFA sets certain targets for the new stadiums. For the Manaus Arena, AG must comply with the certification level of the LEED green building certification system. However, AG delivers special effort to try to get a higher level. The higher levels are silver, gold and platinum. AG is doing this effort, driven by the media and the pressure to deliver a high quality product.

The Dutch bid has an extensive sustainability approach. Concerning waste management the Dutch bid states that waste separation is going to be implemented. They state eight waste actions. Concerning material use, recycled materials (step 3 Trias Hylica) and prefabricated building elements are used. Also, low maintenance materials must be used. Flexible spacing (step 1 Trias Hylica) will also be implemented. Similar like in Manaus, the Dutch bid states that existing material must be reused wherever possible in renovation projects (step 3 Trias Hylica). At last, timber must come from sustainably managing forests (step 2 Trias Hylica). The Dutch bid

uses a sustainable stadium toolkit. There are three levels: A, B and C. C is the basic level that must be reached. So every higher level is bonus. All above stated measures are on the basic level. The use of timber in construction is stated in class A, the top class. Generally, the Dutch bid also incorporates measures from step 1 and 3 of the Trias Hylica. Whether step 2 (renewable materials) will be used, depends on the extent in which the Dutch will actually implement the sustainability measures.

The Dutch bid states that they have the intention to go for level A. But to what extent the sustainable approach really is going to be in practice, is unknown. The Dutch bid uses BREEAM (Building Research Establishment Environmental Assessment) as an Environmental Assessment Method. To goal is to get the outstanding certificate. But the FIFA doesn't demand this. This makes it hard to judge whether these beautiful promises will be realized in practice, affected by the hard practice of tight costs and time budgets.

5.5.3. Social

One of the aspects that have to be taken into account when organizing a mega sport event is the people perspective. When all the interests and stakes of the local community are taken into account during the construction process, the social sustainability of the project is ensured. Therefore our focus of social sustainability is on the participation of the local community in the design and construction process. However, this is not in line with view of the Bidbook and the contractor of the Manaus Arena. Their view on social sustainability is more focused on the general development of the local community, like education, sports and cultural activities. Therefore a comparison will be made between the participation for the Manaus Arena and participation in the Netherlands, as well as a comparison between the two views on social sustainability.

Before the demolishing of the old stadium in Manaus started, information about the project was provided to the local community and several Public Audiences were held. At these Public Audiences all stakeholders could present their opinion and objections about the project. When this phase passed an agreement about the demolishing of the

Actions	Twente	Manaus
Flexible spaces	√	√
Reuse of materials	?	√
Materials management	√	√
Use of renewable materials	√	-
LEED certificate	-	√
BREEAM certificate	√	-
Cradle-to-cradle reuse of materials	√	√
Reduction of emissions during construction	√	√
Separation of waste	√	√
Green goal waste management	√	?
Create public awareness	√	?

Table 5.3: Sustainable material measures

old stadium was made in consultation with local authorities, and the demolishing of the old stadium began. At that point however, some local politicians decided to still object to the demolishing of the stadium and went to the Court. The Court however ruled that the permits were granted and that objections no longer could be made. Nevertheless, the stakeholders had the possibility to participate in the process, although it is unclear what power they really had.

The possibilities in the Netherlands for the participation in construction projects are comparable to the situation in Brazil. In the Netherlands a stakeholder has several options to show their opinion about or object to construction projects. As a final option a stakeholder has the possibility to go to Court to settle their differences. A footnote that should be made is the cultural differences between the Netherlands and Brazil. The laws in the two countries might offer more or less the same possibilities, the attitude and the education of the citizens will finally determine the level of participation. That is where there is a difference between Brazil and the Netherlands, because poor people often lack the knowledge and the facilities to participate in these processes. (Kabeer, 2005) Since the level of development and welfare in the Netherlands is higher, it can be expected that the level of participation in the Netherlands also will be higher.

The level of social participation can be described by using the participation ladder of Arnstein (Arnstein, A ladder of citizen participation, 1969). Arnstein divides the degrees of participation in urban planning into eight different levels, ranging from manipulation till citizen control. It is however difficult to relate the social participation in a country to one of these degrees, it is only possible to give an indication of the level of social participation. For Brazil this would probably be somewhere between Therapy and the lower level of Tokenism, and for the Netherlands it would probably be in the range of Tokenism. Arnstein describes therapy as "not to enable people to participate in planning or conducting programs, but to enable powerholders to "educate" or "cure" the participants." Tokenism is described as "to allow the have-nots to hear and to have a voice. When participation is restricted to these levels, there is no follow through, no "muscle", hence no assurance of changing the status quo." Depending on several factors, like the level of education and the power of the stakeholder involved in the process, the level of participation ranges from Therapy to Consultation in Brazil and from Informing to Placation in the Netherlands.

The focus of the contractor of the Manaus Arena in relation to social sustainability was not on the participation, but more on the general development of the local community. The contractor supported projects that stimulated the involvement of disabled people in society, the prevention of child labour and the education of apprentices. The contractor also had a special program for cultural sustainability, that program was focused on the welfare of the workforce, and included the stimulation of respect for cultural differences, education of the workforce and a special day when personnel could show the construction site to their family. It can be concluded that the contractor had a wide range of programs to stimulate social sustainability on several aspects.

The focus of the Bidbook on social sustainability is however not on the participation in the development of the stadiums, but on more general goals of social welfare. The social goal as described in the Bidbook is to meet the demand and needs of people in a broad sense, both socially and economically. The Bidbook describes two Great Social

Goals. The first program, 2018 Open Football Clubs in The Low Countries, focuses on the social contributions to the host countries. The second program, World Coaching (football) program in developing countries, focuses on a social contribution to the rest of the world (Holland and Belgium, 2010). The stadiums in all host cities will adapt to the Open Stadium social approach. These Open Football Clubs have four important social goals:

- Integration of the ever increasing ethnic population.
- Values and principles, as well as mutual respect in society.
- Lifestyle changes among economically underprivileged children.
- Education and development for every child.

These social goals as described in the Bidbook are comparable to the scope of the social goals that the contractor of the Manaus Arena supports.

5.6. Discussion

During the research several changes are made in the research method. Main causes are cultural differences and communication difficulties with the Brazilian companies we have visited. This resulted in just one project: the Manaus Arena. For this reason we made a huge shift in the research outline. To measure the Manaus Arena on the sustainability aspect, the decision was made to choose a Dutch stadium (Grolsch Veste) to compare with. Because of the bid for the upcoming WC 2018, the Dutch made several plans for upgrading their stadiums and redeveloping the surroundings of these stadiums. Sustainability is an important factor in this WC bid. This gave us the possibility to compare both stadiums on the sustainable perspective.

One limitation of the research on the Manaus Arena and Grolsch Veste is mainly related to the collected data. For the Manaus Arena, the only available data were design sketches of the building retrieved from the internet and a presentation on site. Detailed information related to the actual execution plans and participation process was not available. For the Dutch situation, a main constraint was the fact that there were no concrete stadium renovations planned. Therefore, comparison with the Manaus Arena had to be made on basis of general plans in the Bidbook. Further investigation has to point out whether the sustainability measures in the plans are also the ones that become executed. The construction of the Manaus Arena is started, but the design is not fixed. For the Dutch situation, there are not real concrete refurbishment plans yet. This strengthens the internal validity of the conclusions.

Related to the external validity, this research assumes the Bidbook and Manaus Arena as representative for the Dutch respectively Brazilian situation. A bigger sample of stadiums, and more concrete plans or executed projects should be studied to support the findings from this research.

5.7. Conclusion

This paper discusses how the Brazilian and Dutch construction industry create their reconstruction plans for stadiums in a sustainable way. For this, the Manaus Arena and Grolsch Veste were investigated. The paper divides the concept of sustainability in three interrelated constructs, using the people, planet and profit approach (Brundtland Commission, 1987). To operationalize these constructs, this study focuses on three important topics that FIFA and International Olympic Committee highlight when discussing sustainability. First, sustainable use of water will be used to assess how both nations deal with the planet and profit part of sustainability. To increase the internal validity of the findings related to planet and

profit, also materials and waste treatment will be assessed. The assessment was conducted using the Triad Approach (Entrop & Brouwers, 2010); a qualitative method to rank distinguishable sustainability measures. We assessed the people perspective by looking at how stakeholders are involved in the plans. A supporting framework is the participation ladder (Arnstein, A ladder of citizen participation, 1969).

Referring to the sustainable use of water, the design for the Manaus Arena mostly includes measures from the second category of Trias Hydrica. This means that there are plans to implement measures that use renewable water sources as much as possible. Most of these measures were not implemented on voluntary basis, but were required by the FIFA. On the other side, the plans for Dutch stadiums include measures from all three Trias Hylica categories. Some of these measures are required by FIFA, others result from innovations.

As construction company of the Manaus Arena, AG, spends effort to make their working methods sustainable. For them, not only the FIFA but also public opinion and ambition support this vision. Also the Dutch Bid spends effort on the sustainability. The ambitions are high, and great promises are made to convince the FIFA. The Dutch bid include all the aspects of the Trias Hylica (where AG only include step 1 and 3), however the inclusion of step 2 depends on the extent in which the Dutch are going to implement their measures. Although these plans are quite ambitious, it has to be questioned whether these are all implemented in practice. In Manaus, some decisions on measures depend on costs and expected benefits and are still to be taken. For the Dutch, concrete construction plans for individual projects must still be made. This means that important driving factors for sustainable material usage and waste treatment are not restricted to formal requirements and regulation (e.g. FIFA requires LEED green building certificate) but still highly depend on the economical cost-benefit trade-off and the ambition of the project's stakeholders. Future will show if the promises of both nations on material use and waste management will be practicality achieved.

For participation and social sustainability, we can conclude that the construction of the Manaus Arena is comparable to the situation in the Netherlands. Both countries offer formal procedures to participate in the process, to object to plans or to lodge appeal. For the two studied projects, there was no information about the participation process in detail. This means that valid conclusions about participation besides formal processes can't be drawn. Participation doesn't seem to be openly discussed for these projects. For both projects, social sustainability is more focused on general development and welfare of stakeholders like residents and employees. These plans include stimulation education, social participation of for example disabled people and mutual

respect. The goals of both parties are therefore comparable. We can therefore conclude that the focus in both nations is more on social development rather than participation in the individual projects.

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6. IMPROVING LIFE

Bart Boeschen Hospers
Ferdinand van den Brink
Bert Lankheet
Stephan Meijers

6.1. Introduction

The Brazilian government is constantly working to improve life for the Brazilian people. Throughout our study tour, we have visited several – civil engineering related – projects that specifically aim to improve the local environment in some way. In this paper we examine the sustainability of a variety of civil-engineering related projects. Specifically, we look at projects that aim to improve the life of Brazilians.

The first project is Guanabara Bay Cleanup program (PDGB), which aims to achieve a better quality of life for both the city and the whole State of Rio de Janeiro. Launched in 1995, this project has already resulted in a 32% improvement of the sewage treatment system and, by 2010, more than 50% of all the sewage discharged in the Guanabara Bay will be treated. The projects aims at treating the discharged sewage in the Bay and this will improve the quality of the water.

The second project we visited is the São Paulo coastal sanitation project. In the rapidly growing coastal region of the state of São Paulo –Baixada Santista - wastewater is discharged untreated into the river and sea. Eighty percent of the water monitoring points in this region fails to meet water quality standards, affecting the living environment of the local population ever more seriously. The sanitation improvement project for the Baixada Santista aims to improve and expand the sewage system, develop an environmental monitoring system and upgrade the living environment of the local population.

The third and last project is the urban renewal in São Paulo. From 1991 up to 2009, 150 thousand residents have moved from the centre of São Paulo to other regions. In this urban renewal program, COHAB buys commercial-, and residential buildings and old hotels in the central district of the city, and replaces these buildings with new homes, for a total of 2500. These new homes will be aimed at families with monthly income of up to 10 minimum wages. The goal of the program is to bring back the population that moved to other regions, but who still work in the centre. Bringing people back to the center can have a significant impact on trip density in the area, reducing the intensity of transport use.

We defined five research questions to limit the scope of the research and to provide a structure for the study.

6.1.1. Research questions:

1. How does the development of water treatment facilities in Brazil compare to the development to the Netherlands?
2. What is the underlying motivation for starting water quality control projects such as the coast sanitation project and the Guanabara Bay Clean up program?
3. What are the projected effects of these projects are they truly sustainable?
4. How are water quality projects such as these financed, and what are the effects of this approach to financing? (Construction perspective)
5. Are projects like this controlled centrally from the government, and from what perspective are these projects started?

In order to answer these questions a combination of a literature study and site visits during the study tour is used. The findings of this research are given in this report. This report starts with an introduction of our understanding of the very word "Sustainabi-

lity". Then the report gives a brief overview of the development of water treatment in Brazil, and how it compares with the situation in the Netherlands. Following this we will answer the research questions for each of the projects described. The report concludes based on the summarized answers of the research questions. In this way the study attempts to give an indication of our view on the projects in Brazil.

6.2. Sustainability

Numerous definitions and interpretation arise when sustainability is considered. For this research an interpretation is used in which not only environmental issues are examined, but a more broad view taken on projects, business strategies and policy, namely the concept of People, Profit and Planet as shown in figure 6.1. This concept was introduced by John Elkington and defines sustainability as a situation in which these three central points are in balance. If one of these aspects is neglected, something can sustain on the short term, but will not at the long term, because people will protest, the company will go bankrupt or the environment will no longer support the harmful activities. Another reason to use this concept is that Dutch companies often include it in their vision and strategies (Boomen et al., 2009).

6.3. General policies

6.3.1.Current situation

Often Brazil is referred to as a well doing development country. The sewage sector can be seen in this line. It is doing quite well, but regionally there are large differences and the situation is still not equivalent to that in developed countries. Especially in rural areas the situation should be improved. This is shown in table 6.1 (JMP, 2010).

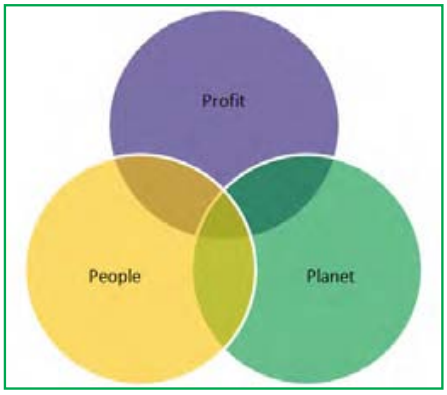


Figure 6.1: Three indicators of sustainability

Country	Year	population			Access improved sanitation (%)		Usage Open Defecation (%)	
		total (x1000)	Urban(%)	Rural (%)	Urban	Rural	Urban	Rural
Brazil	1990	149570	75	25	81	35	4	40
	1995	161692	78	22	82	35	4	37
	2000	174174	81	19	84	36	4	34
	2005	186075	84	16	86	37	3	31
	2008	191972	86	14	87	37	3	30
Netherlands	1990	14953	69	31	100	100	0	0
	1995	15448	73	27	100	100	0	0
	2000	15915	77	23	100	100	0	0
	2005	16316	80	20	100	100	0	0
	2008	16528	82	18	100	100	0	0

Table 6.1: Access improved sanitation

As is shown, the urban areas in Brazil are quite well developed, because almost 90% has access to improved sanitation. According to JMP (2010) improved sanitation means that people have access to a flush toilet, piped sewage system, septic tank, ventilated improved pit latrine, or a composting toilet. In The Netherlands flush toilets are installed almost everywhere. Waste water is transported via pipes to a waste water treatment plant and purged. For Dutch standards the mentioned types of toilets are therefore still less desirable.

Moreover, the table shows how often people make use of open defecation. Especially in rural areas this has to be improved, because it is extremely unhygienic and is consequently a source of diseases. Furthermore JMP (2010) states that nowadays more than 30% only has access to another type of unimproved sanitation, which could be even worse than open defecation.

However, the above standing numbers contain large uncertainties. It is unknown whether informal areas like the favelas are included, because official data may only be based on official data. Furthermore it is unclear whether the data is really measured or just estimated. Usually, this data does not contain this kind of information (Oliveira, 2006).

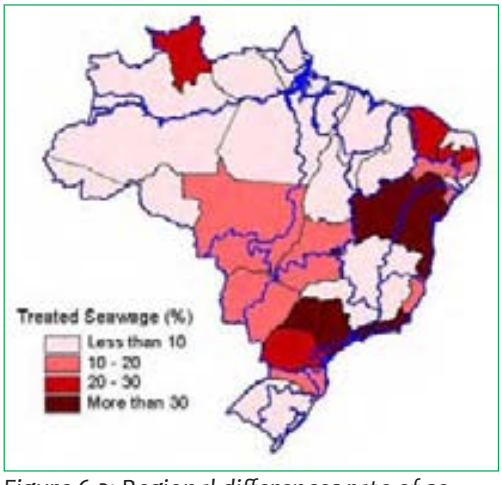


Figure 6.2: Regional differences rate of sewage treatment (Ponto, M. , 2010)

Furthermore, if people are connected to a sewage system, this water is not necessarily treated. Local sewage systems drain its water of into surface water. Especially in densely populated areas this leads to water quality problems. The amount of sewage water that is treated differs largely among different regions as can be seen from figure 6.2 (Ponto, 2010). From this figure it can be seen that the rate of treated sewage is higher in the south and southeast, probably because the problems are more urgent than in other regions and because more financial resources are available there (Porto, 2010).

In figure 6.2 the health risk due to poor quality of water is shown. This figure also makes clear that the problems are regionally different. The coastal regions seem to have more problems, but it cannot clearly be allocated

Figure 6.3: Health risk (from Heller, 2006)

to a certain region. Hence it is important to realise that in a densely populated area the health risk is larger than in rural areas. The figure in some way confirms the presumption that treatment rates are higher if the water quality problem is higher.

In the Netherlands the development of the sewage system is much more advanced. As already explained it has national coverage of improved sanitation and the quality of the sanitation service is very high. The country is known for its high quality and high standards on collecting and purification. Dutch equipment and expertise on water treatment has set world standards. Especially the treatment of municipal waste water has been improved by using bio filter technology (NWP, 2009).

The municipalities are historically responsible and held responsible for waste water collection. However, since the 1970s the provinces are responsible for sewerage treatment. Most of the provinces delegated this task to the waterboards or other specialised organisations (Kuks, 2006).

Almost all sewage water is collected together with rainwater and treated in a waste water treatment plant. Only during high rainfall events, the capacity of the treatment plants is insufficient and effluent may enter the environment, causing temporary, minor problems. Therefore, at some places separate sewerage systems are installed, to collect rainwater separated from waste water from households. Furthermore measures are taken to retain rainwater in the area it falls (RIONED, 2007).

6.3.2. Historical development

At the beginning of the 20th century expansion of the sector was driven by the social awareness of required hygiene to prevent epidemics. This led to a further development of the sector. Between the 1950s and 1969 the sanitary policies separated from the health policy and gained a higher degree of autonomy (Heller, 2007).

During the military dictatorship (from 1970s on), the sanitary policy was reorganised in order to improve the services by introducing the National Basic Sanitation Plan (PRANASA) in the 1970s, on which the policy is based nowadays. Due to this plan the responsibility was brought from the municipalities and the national government to the administration of the provincial states. This was necessary to satisfy the high demands due to the enormous urbanisation in this period (Motta and Moreira, 2006). States and municipalities and state governments established contractual relationships more or less in the same way as the concession model nowadays. The plan resulted in several new water supply and sewage companies. Unfortunately, during the necessary fiscal reforms and economical crisis in the 1980s and 1990s led to a drawback in the development.

With the transition to democracy after 1985 led to an enhancement of the role of municipalities. They got larger political administrative autonomy, larger budgets and increased access to financing for the municipalities. The municipalities became responsible to give concessions to a company. Because most companies were public provincial state owned, these companies remained in service (Motta and Moreira, 2006). This caused the current undefined responsibility between the states and municipalities (Heller, 2007).

The development of the Dutch sewerage systems began earlier than in Brazil, namely in the 1850s. The need for higher hygiene to prevent epidemics, made city councils experiment with possible sanitation methods. Flushing toilets became common good and

had to dispose of its waste water. Initially this water was drained of via the city canals, but in 1912 the first integrated sewage system was installed in Amsterdam. During the period 1900 – 1940 almost all Dutch cities where provided with sewage systems (Lintsen, 2005). From the 1930s on large scale sewage systems became implemented (ONRI-werkgroep riolering, 2009)

Before the 1970s most of the waste water returned untreated into the environment. This caused severe ecological problems. With pressure from the society, people realised that the waste water had to be treated. Almost all water is treated nowadays. More improvements can be made by improving the waste water treatment plants and the realisation of separated sewage systems.

6.3.3. Current governmental policy

In 1997 the National Policy on Water Resources has been introduced in order to get water and sanitation service more universally, proclaiming that that water is a common good of public domain. It aims at a sustainable water supply and sanitation, ensuring actual and future generations with water that meets both the quality and quantity required for the different uses. Though water supply is the focus of this policy, sanitation is intimately linked. To enforce this policy the national water agency, ANA, was set up in 2000. One of their tasks is to improve collaboration between states in solving water quantity and quality problems (ANA, 2010). Treatment of waste water is an important aspect as is emphasized by Oliveira (2005).

Furthermore, a program on water polution abetement (PROBES) has been set up in 2001 in order to reduce pollution and promote environmental recovery. This program funds sanitation projects on a regular basis during several years and is based on predetermined standards. The ANA makes assessments of compliance of these standards for each project.

Since the arrival of president Lula da Silva in the policy on basic sanitation changed significantly. The ministry of cities was endowed with a National Department of Environmental Sanitation (SNSA), which has as its task to "ensure the fundamental human right of acces to potable water and to life in a healthy environment in the cities and countryside, through universal water supply and sanitation, the collection and treatment of solid wastes, urban drainage and the control of vectors and reservoirs of transmittable diseases".

The current policy in Brazil is still based on the situation that existed during the dictatorial period. The main responsibility is for the provincial state authorities, but more responsibilities were introduced for municipalities. Sometimes this is causing an ambiguity of the responsibilities. Then the provincial states may have paucity in legislation, through which the state water supply and sanitation utilities does not need to take their onus. The municipal authorities however may give concessions to sanitation companies, which makes them responsible for monitoring. This responsibility is rarely taken. New legislation should overcome this discrepancy (Heller, 2007).

This has led to a discussion about the efficiency of the sewage companies of provincial state companies and municipal sewage companies. Sabbioni (2008) concluded from his research that the Brazilian shows significant economies of scale. Economies of scale gives a substantial saving of costs for investments, far outweighting the extra firm-related costs. This implies that companies at a provincal state level reach a higher efficiency. This is confirmed in Motta and Moreira (2006).

Furthermore discussion is going on about whether the sector should be based on more competitive standards. Motta and Moreira (2006) states that private companies will be able to get the required money earlier invested in the sector to get it more developed. However efficiency between public and privately owned companies does not show significant differences and looking to privatised companies in England, Wales and France, the opposite might be the case (Kuks, 2006). The water and sewerage sector shows a rather low potential for competition, due to the fact that high fixed costs and fixed assets with a long lifetime make competition unlikely to happen (Tupper and Resende, 2004).

Unfortunately, although it is clear that new national legislation is necessary, it is difficult to get this through the political decision-making process, because municipalities are afraid to lose power. Several initiatives were attempted to install a new legal and institutional framework, but were not successful. For instance, an initiative law was vetoed by president Cardosso in 1995 for "economical reasons" (Heller, 2007).

6.4. Guanabara bay clean up, programa de despoluição da baia de guanabara

Guanabara Bay (Baia da Guanabara) is a bay on the Atlantic Ocean located in the South-East of Brazil, between Rio de Janeiro and Niterói. The bay basin covers an area of 4000 km2 (Institute of the America's 2001), the bay itself covers 384m2 and about 11 million

Figure 6.4 Guanabara bay and its surrounding cities (Google Maps 2010)

Micro Study

people live in the Guanabara bay basin area (Lima and Legey 2010).The drainage basin of Guanabara Bay has an area of 4080 km2 and this consists of 32 separate sub-watersheds with 91 rivers and channels (Kjerfve, Ribeiro et al. 1997).

The bay's ecosystem was once diverse, but eutrophication, pollution and deforestation induced serious damage. The eutrophication is mainly caused by anthropogenic sewage waste (Guenther and Valentin 2008; Maranho, Abreu et al. 2009). This increases the risk for diseases like for instance dengue and yellow fever (Honório, Codeço et al. 2009).

Next to eutrophication, the bottom of the Guanabara Bay in Rio de Janeiro is also covered with a layer of highly toxic sludge, up to four metres deep. The sludge contains high levels of heavy metals such as zinc, mercury, and copper from industry. The metals enter the food chain and are very dangerous for the health of local people who depend on seafood from the bay for their sustenance.

Thereby the solid garbage is detrimental for the fish population. The bay's fisheries capacity has decreased by 90% because of the pollution, but there are still thousands of people who earn their living through fishing activities in this area. An estimated 5,000 to 18,000 fishermen are active in Guanabara bay, including both registered and unregistered (Jablonski, Azevedo et al. 2006).

The different causes for this level of pollu-

Figure 6.5 hydrographic region of Guanabara bay

tion range from the bay's industrial zone, home to much of Brazil's petrochemical industry, to the sewage from the city and to the intense deforestation in the bay's catchment area (Italian Ministry of Foreign Affairs, 2010). The major environmental problems in the bay are caused by the eutrophication of Guanabara Bay, as a result of the nutrients in wastewater discharged to the Bay, combined with the contamination of bathing waters with pathogens from the wastewater (Margulis, Hughes et al. 2002). Rivers flowing into the bay are highly polluted with wastewater and garbage. People throw almost everything into the rivers, for instance car tires, and even aborted fetuses (Osava 2007). Although several sewage treatment plants have been constructed in the past 20 years, increasing the total number to six, only 15% of the enormous amount of domestic and industrial waste discharged into the bay was subjected to any form of sewage treatment in 1991 (Kjerfve, Ribeiro et al. 1997). But in contrast to expectations, the city has a tolerable water supply, 84% of the population has access to fresh water and sanitary installations.

Next to a lot of minor oil spills from regular oil related activities such as oil transport and side effects such as leakage, the bay area suffered from some large oil spills. In January 2000, more than 1,3 million liters of heavy oil leaked from a refinery pipeline (Maciel-Souza, Macrae et al. 2006), and in 2001 Manguinhos refinery in Rio de Janeiro spilled 100,000 liters of oil from a pipeline into Guanabara Bay (International Network for Environmental Compliance and Enforcement 2002).

This pollution in the bay is mainly caused by the density of industrial activities in the bay area. In the bay there are 10,000 industries, 10 oil terminals, 12 shipyards and two oil refineries (De Sherbinin, Schiller et al. 2007). Urbanization and industrialization processes generate, respectively, diffuse and point sources of wastewaters and toxic effluents into the rivers to the bay. Thus, these materials are the principal reasons which cause changes in the level of water quality (eutrophication and contamination), and so impacting the economic activities dependent on water quality (fisheries and recreation—including tourism activities) (Bidone and Lacerda 2004).

6.4.1. Project goals

The Guanabara Bay cleanup program (PDBG) firstly aims to improve the life of the residents of the basin area. Besides this, it also aims to strengthen local government institutions whose activities can affect the Guanabara bay area positively (Ioris and Costa 2009). Literature indicates that the aim is to increase national health through this project.

The project consists of the improvement of basic sanitation and water supply systems, to revert current degradation process in Rio de Janeiro metropolitan region, reducing uncontrolled domestic sewage, garbage and industrial waste discharge into the bay (Ortiz 2004). To achieve this goal, the Rio de Janeiro state Water Company (CEDAE) planned to construct a sewerage collection network and water treatment plants. Thereby it aims to improve the water drainage of the area, and to manage waste successfully to prevent effluent from flowing into the bay. Treatment of wastewater around the Guanabara Bay, before the project was initiated was less than 10%. By the end of the first phase in 2003, approximately 55% of the wastewater should be treated and by the end of the second phase in 2010, this figure should rise to 80%(Institute of the America's 2001). By the end of the project, plants will treat 100% of the wastewater (Global water intelligence 2002).

The project is financed by the Inter-American development Bank (IDB), $350 million, the State of Rio, $206 million, and the Japanese International Cooperation Agency (JICA), $237 million (Institute of the America's 2001; Margulis, Hughes et al. 2002).

6.4.2. Progress

In this section we analyze the contributions that the project has made to the cleaning up of the Guanabara Bay.

The cause of the problem, being unfiltered and contaminated water being expelled into the bay from surrounding industry and residences calls for improved sanitation and water supply services in the area as part of the solution to the problem. The initial priority of the first phase of the program, therefore, was the construction of a sewerage collection network and primary treatment plants, so as to reduce the degradation of the waters of the bay. The studies involved indicated that the pollution generated in the bay itself, originating from primary activities, makes up a significant portion – around 60%, of the global organic pollution. This provided evidence for the need to remove nutrient discharges from effluents flowing into the bay, in order to reduce the problem of eutrophication and to recuperate the ecosystem. (World Bank, 2002)

A visit to CEDAE's new Alegria plant supports this notion. CEDAE is working on the Sarapui wastewater collection System. The main focus of this project is to install main sewer lines throughout large parts of Rio de Janeiro. Their focus, however, is on the main lines and it ignores the connecting trunk sewers leading to questions about the responsibilities of these works. Unfortunately, they were unable to indicate which party is responsible for these connections.

When looking at the main difficulties with the project in its current form, is that conflicting interests are undermining the overall effectiveness of the process. The main implementing agency (CEDAE) omitted to internalize the main objectives of the project and only concentrates on its own interests in the project. The clean-up of Guanabara Bay itself is of little direct relevance to CEDAE, beyond the support it provided for construction wastewater treatment plants. (World Bank, 2002)

In the case of the PDGB, CEDEA as a state water and sanitation company was left with the responsibility of dealing with matters which fell outside its remit, although there were no incentives for the company to do so. Unlike SABESP, which directly benefits from the maintenance of good water quality in the Guarapiranga reservoir, CEDAE is not overly concerned about improvements to the water quality of the bay. This is true at least in terms of its fundamental responsibilities of water supply and for revenue generation. As for pollution control, the environmental agency FEEMA had been mandated to control industries and was allocated specific funds to improve enforcement. Meanwhile, urban discharges remained the responsibility of CEDAE, which paid scant attention to FEEMA regulations and standards, in the absence of the likelihood of rigorous sanctions. CEDAE was therefore in a position to decide its strategy for dealing with urban discharges without interacting with other agencies, except insofar as it was obliged to respect the agreements covered by the IDB financed project. Despite evidence that some of the proposed wastewater treatment measures foreseen in the project were technically weak, CEDAE has been reluctant to reconsider its strategy.

Several high profile consequences of the poor structuring and planning of the project that occurred during the project are as fol-

lows:

- The solid waste treatment plants have effectively been abandoned;
- the CEPT (Chemically enhanced primary treatment) plant is operating at half of its nominal capacity owing to problems in making domestic connections. CEDAE has no agreement with the municipalities of Baixada Fluminense to collect and treat sewage discharges which means that investments are being made with no guarantee on returns;
- the secondary treatment plant in São Goncalo (on the East side of the Bay) with a nominal capacity of 780 l/s has been operating with 280 l/s, due to construction difficulties encountered in carrying out domestic connections and to the unwillingness of the local population (amongst the poorest in the metropolitan region) to pay for wastewater collection; and
- the most successful components of the program has been the construction of a submarine outfall linked to the Icarai WWTP to transport effluent out into the Bay, thus protecting nearby bathing beaches.

6.4.3. Control

When we look at the responsibilities in the project, we see that the original budget of the program in 1994 was 793 million USD of which 350 million was financed by the Inter-America Development Bank (IDB), 237 million by the Japan Bank for International Cooperation (JBIC) and 206 million from the state of Rio de Janeiro.

CEDAE (Companhia Estadual de Aguas e Esgotos, Rio de Janeiro State Water and Sewerage Company) will control the connection of 139 000 households to the sewage system. The treatment plant of CEDAE in Rio is the biggest of its kinds of Brazil. Furthermore, it is unique because usually the secondary treatment is not executed in Brazil if waste water is treated. Since the plant has been brought into use, the water quality of the bay slightly improved. However, it is unknown whether this is due to the plant or due to other actions. The project mainly aims at the long term and is part of the arrangements for the Olympic Games.

Furthermore, CEDAE will develop an effective system to control production and supply of fresh water to the slums in the south of Rio de Janeiro. Also the deployment of 387 km of pipelines, 34 000 residential connections and 525 000 water meters is controlled by CEDAE. CEDAE considers itself as a company that cares about society, because it participates in various programs. First of al, they use the residue of both the primary and secondary treatment is to obtain biofuel. Biogas is used for the electricity supply of the plant itself, while biodiesel can be used for other purposes. A small part is used as compost. Furthermore they participate in projects on the planting of trees and on resocializing of prisoners.

6.4.4. Sustainability

People

When looking at the project from a people oriented perspective, we can conclude that the project has not been able to achieve all the targets, although its targets are partly focused on improving the quality of life of the inhabitants in the Guanabara Bay region.

The expected impacts of the program's first phase included direct benefits to the population located in the areas of project influence, the vast majority consisting of low-income people, diminishing the incidence of infant mortality and of waterborne diseases. Other benefits included the non-interruption of socio-economic activities following floods

and improvement in water quality of the beaches in the interior of the bay.

When we look at the statistics displaying people's access to a sewerage collection network, we see that in the Rio de Janeiro state that, after the first phase of the project was completed, 10% of the urban, and 35.7% of the rural inhabitants had no access to the sanitation network (World Bank, 2001). This is a total of approximately 457.000 households in the Guanabara Bay Region without adequate sanitation. We question the accuracy and applicability of these statistics in the sense that we wonder whether unofficial households are included, as there are numerous favela's in the region. Additionally, the question remains whether these homes have access to rudimentary sanitation facilities such as septic tanks, which remove the largest health risks. This could undermine the goal of the project to improve the quality of life, in part by reducing the health risks prevalent in the area resulting from poor sanitation.

Throughout the project, one of the main issues with the execution of the project has been the cooperation of the local populace. People in the area are frequently unwilling or unable to pay for sanitation services that the project involves. This has resulted in significant overcapacity in the WWTP's. For example, the secondary treatment plant in São Goncalo with a nominal capacity of 780 l/s has been operating with 280 l/s. In addition, the placement of trunk sewers has proved more difficult than expected, due in part to a lack of involvement of the local population in the process.

Planet

When looking at the effects the project has had on the quality of the environment from a planet perspective, we can conclude that due to issues arising during the execution of the project, the project had not achieved its goals by the end of the first phase of the project in 2001. The project, however, has clearly had a positive effect on the water quality of the bay, and in the long term it will have an even more significant impact. From this we can conclude that the project certainly has a positive effect from a planet perspective.

Profit

When we look at the project from a profit perspective, we see that profit has suffered throughout the project in the interest of the other two factors of sustainability.

The project goals of the PDGB do not directly include an economic side. The project is financed by three parties, including the state government of Rio, the Japanese International Cooperation Agency (JICA), and the Inter-American development Bank (IDB). The division of financing and the multitude of organizations that are involved in the project, have led to difficulties in the execution phase of the project. Responsibilities are often unclear between the various parties and we see that these organizations frequently feel a lack of project responsibility. This leads them to work independently of each other, with different goals in mind. In some cases we see that this can lead to a worsening of the pollution situation in the bay.

Local inhabitants are largely dependent on the fisheries in the area for sustenance and income. In the literature, it becomes apparent that some options such as dredging the toxic sludge can provide a quicker, more permanent solution to the pollution problem in the Guanabara Bay. This, however, will release the toxic materials into the water, to the detriment of the fisherman and local health. The choice not to dredge is clearly made on basis of economic and health concerns. Additionally, this choice is beneficial

for the thriving tourism industry in the area.

6.5. Baixada Santista Coastal Sanitation, Onda Limpa Baixada Santista

The Baixada Santista is a coastal metropolitan region (BSMR) in the state of São Paulo, it covers nine municipalities: Santos, São Vicente, Praia Grande, Mongaguá, Cubatão, Guarujá, Itanhaém, Bertioga, and Peruíbe. Baixada Santista covers about 2.372 km² (Deutsch Wikipedia 2010). The Baixada Santista region is a tourism, industrial and port center. Santos is the administrative centre of the area it also has the biggest seaport of South-America. The Santos Estuarine is part

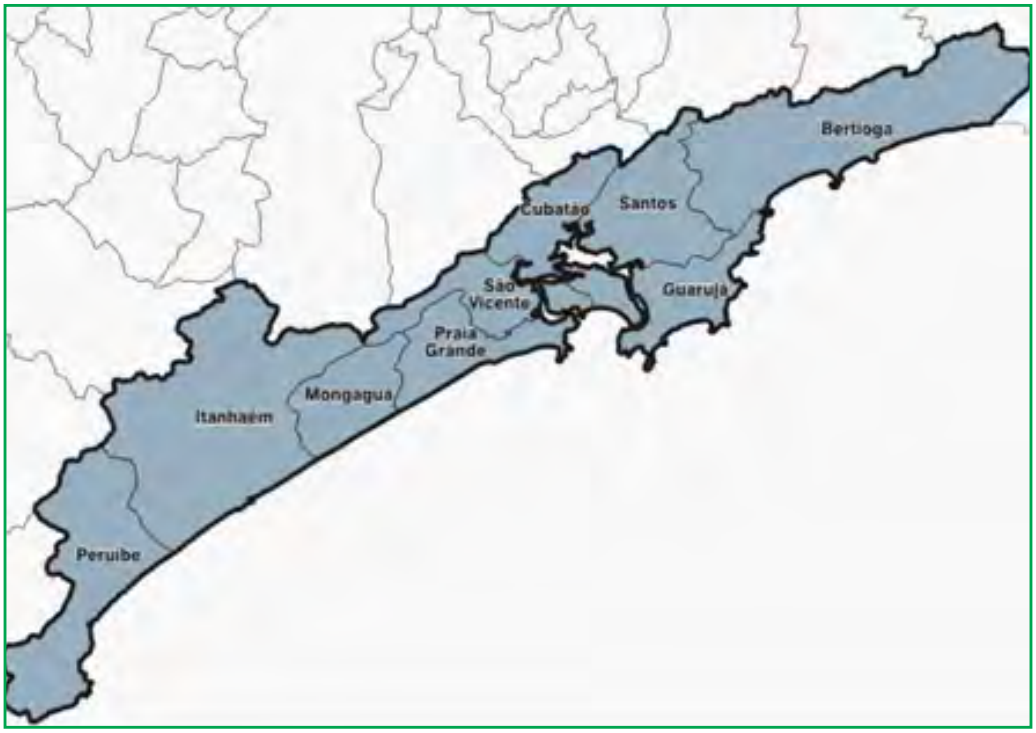


Figure 6.6: Detailed map of the BS metropolitan region (Governo do Estado de São Paulo 2010)

Figure 6.7: Baixada Santista (Explore Brasil 2009)

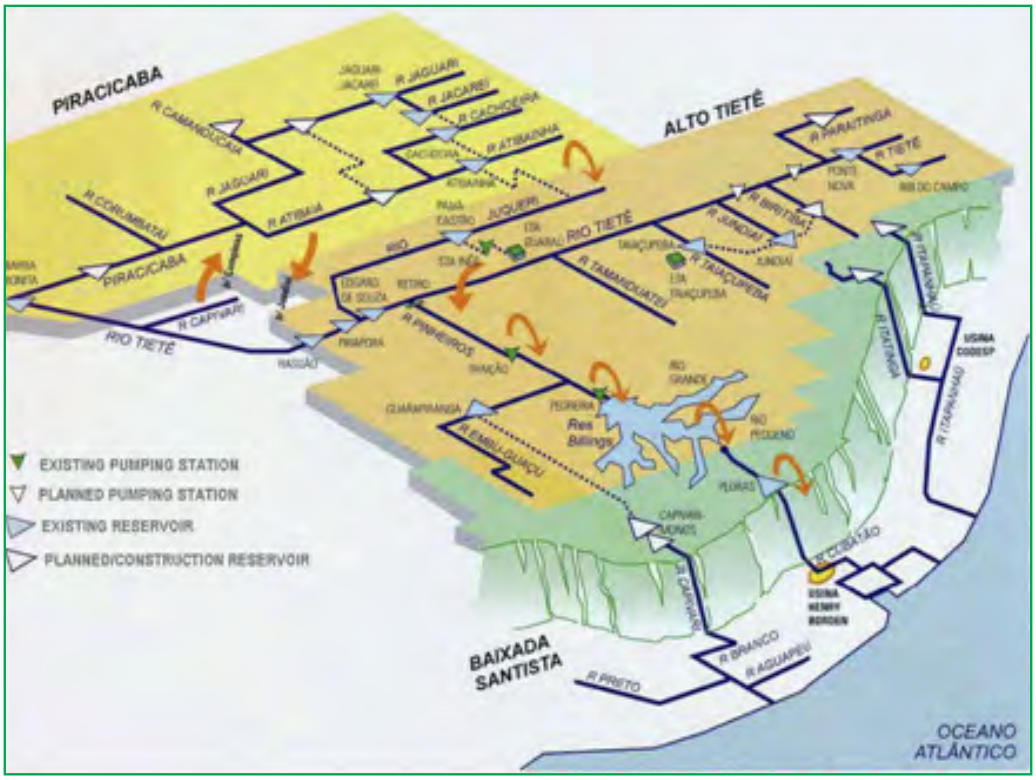


Figure 6.8: São Paulo Basins (Braga 2000)

of the Baixada Santista, the estuarine consists of three main channels: São Vicente, Santos and Bertioga (Ecomanage 2010).

6.5.1.Problem

Baixada Santista is notorious for its high levels of pollution, which are related to industrial, port and urban activities. Around the industrial pole of Cubatão city, high nutrient concentrations are found (Braga, Bonetti et al. 2000). It is one of the most important industrial areas in Brazil due to the large number of industries operating in Cubatão such as steel, petrochemical and

fertilizer industries (Rodrigues, Lamparelli et al. 1999; Ramos, da Silva et al. 2009). High levels of oxygen-demanding substances, phenols, metals (e. g., copper and zinc), and pesticides have been detected in the water in Baixada Santista, and metals and pesticides have been found in sediments. The pollution of the Baixada Santista area has multiple causes, analyzing the most important ones is a starting point in explaining the goals of the particular project we describe in this report.

First, Oil spills induced serious damage to the quality of the water in the Baixada Santista area. It is in Baixada Santista that most of the accidents in São Paulo state happen. Santos and Cubatão are the most affected by this kind of pollutant In 1984 a pipeline burst leading to the spill of about 700,000 liters of crude oil. This also caused a fire in Cubatão (Rodrigues, Lamparelli et al. 1999).

Second and perhaps more important is the lack of proper sanitation in Brazil and in

Bertioga	28%
Guarujá	57%
Mongaguá	21%
Praia Grande	46%
São Vicente	61%
Cubatão	31%
Itanhaém	11%
Peruíbe	17%
Santos	98%
BSMR	53%

Table 6.2: Level of sewage collection of municipalities in the BSMR (Logos Engenharia 2010)

Figure 6.9: Infant Mortality Rate in Sao Paulo State (Logos Engenharia 2010)

the Baixada Santista Metropolitan Region (BSMR) in particular. Less than 13% of the municipal wastewater is treated before disposal in the surface water system (Sampaio, Mateus et al. 2008). As a result faecal pollution leads to health problems in the area, for instance yellow fever, dengue, malaria, and cholera (Garreta and Alves 2003). The infant mortality rate in the area is significantly higher than the average of São Paulo state, see figure 6.9. The BSMR is densely populated, but it lacks a sewage drainage network or sewage treatment facility, a significant part of the domestic effluent drains directly into the Santos Estuary (Abessa, Carr et al. 2005; Sampaio, Mateus et al. 2008) see also Table 6.2. As a result of this lack of sanitation there is scarce freshwater in the area, so there is not much freshwater for drinking, and agriculture (Peters and Meybeck 2000).

The third source of pollution, the water in Baixada Santista contains high concentrations of metals. This can be attributed to weathering of naturally occurring ore deposits and waste resulting from occupation and industrialization (Rodrigues, Lamparelli et al. 1999; Peters and Meybeck 2000). The heavy metals accumulate in organisms such as fish and shrimps. In the eighties the water quality in the region improved, as a consequence the number of organisms containing toxic material increased, which was dangerous because people tend to eat them (Nauen 2003) and accumulated harming materials can be harmful.

6.5.2. Project goals

São Paulo's state water company SABESP initiated a project to recover the environment in Baixada Santista (SABESP 2010). SABESP is Brazil's largest water utility in terms of users, serving 323 of São Paulo state's 645 municipalities. SABESP provides water to 25 million residents through a 54,000km network and sewerage service to 16.8 million residents through a 34,000km collection network (Business News Americas 2003). The project is scheduled to completion in 2011.

About three million people will benefit from the environmental recovery project, which at least, is the intention. This benefits consist of: reducing the number of admissions for waterborne diseases, reducing the mortality, especially infant mortality, remediation of the rivers and canals, recovery of

bathing beaches, increase tourism, increase population Income, job generation.

The project is a collection of measures including: construction and expansion of sewage treatment and pre-processing, construction and expansion of pumping stations, construction and expansion of underground and underwater sewage systems, and construction and expansion of waste-water collection networks. This should increase the index of sewage collection and treatment coverage from 53% to 95% in the nine cities in the Santos Basin Metropolitan Region. People living in favelas are included in the data, although it is difficult to estimate the number of households and people living in these areas. But still in Santos, the sewage connections in the favelas are included in the GIS maps. People living in informal areas are obliged to connect to the sewage system, but the project team tries to persuade the people through extensive communication, where they explain the necessity and benefits of a connection to the sewage system. The government and SABESP use several promotional methods as television and radio commercials to convince these people. But when people still don't want to connect they are forced through law. They have to pay a monthly fee for the connection.

Investments into the Project are expected to total R$ 1.9 billion (about €0.8 billion), this is financed by the Brazilian development bank (BNDES) and the JBIC (BNDES Brazilian development bank 2010). JBIC is the Japan Bank for International Cooperation, the bank wants to contribute to the development of the economy in general, and to the preservation of the global environment in particular. Therefore the bank finances environmental projects all over the world, especially in developing countries.

This project, therefore, should result in better public health, a higher attractiveness for tourism and a recovery of the ecosystem. The improvement of public health is twofold: better sanitation results in less diseases, and the food does not contain as much toxic substances as before (Mateus, Giordano et al. 2008). Thereby the project results in 4000 temporary Jobs and 140 permanent jobs in order to keep the system in operation (BNDES Brazilian development bank 2010).

6.5.3. Control

SABESP (Companhia de Saneamento Básico do Estado de São Paulo S.A, State of São Paulo Basic Sanitation Company) is the company that organizes the controls the actions taken in the São Paulo region. SABESP controls the Onda Limpa project together with São Paulo state government. Logos Engenharia is responsible for the project management. Logos uses various management plans to control the project:

- Quality management plan

Sewage Network	1.175 km
House connections	120.000 units
Pumping Stations	101 units
STP	7 units
Preconditioning Treatment Plants	2 units
Submarin Outfall (Praia Grande)	4 km
Submarince Outfall (Santos/São Vicente)	Improvement

Table 6.3: Onda Limpa Program numbers (Logos Engenharia, 2010)

- Environmental management plan
- Communications management plan
- Highway systems management plan
- Marketing (connection of consumers to the sewer network) plan
- Management of the occupational safety, health, hygiene & environment plan

Logos uses GIS to keep an overview of the sewage connections that are already realized to avoid rework and to support planning. This is necessary because the project area is 150 km wide and therefore it is difficult to have technicians and maintenance engineers everywhere in this area.

The project manager of Logos Engenharia assumed to reach 80% of sewage collection under the current circumstances, though that new investments were needed to reach 95%. He thought it would take another 30 to 40 years to connect everyone in the area to sewage. The goal is reach 100% sewage collection, as if this is reached São Paulo will be the only Brazilian state to have 100% sewage collection.

6.5.4. Sustainability

The project is still at the start and therefore there are no clear numbers of the results of the progress so far. As a result we succinctly describe the expectations for the three P's of sustainability, people, planet, and profit.

People

Taking a people's point of view, the project is intended to be beneficial. The program is focused on recovery of the Baixada Santista water quality because this is a prerequisite for a public health. By increasing the sewage collection public health should improve.

Planet

As for the Guanabara bay project, the project should benefit to the environment, be-

Figure 6.10: Planned progress of the Onda Limpa Program (Logos Engenharia 2010)

Micro Study

cause it is intended to reduce the pollution of the water system in the area. Revitalizing the flora and fauna is actually of major importance for both Onda Limpa and PDBG. The Santos coast is a tourist attraction, in particular for all people coming from the city of São Paulo. Ten thousands of people descend the road to Baixada Santista to have a nice weekend. This is quite similar for the Guanabara Bay, especially Praia Flamengo is popular for recreation. This popularity heavily depends on the quality of the water but also on the presence of a diverse flora and fauna. Thereby in case of Baixada Santista, it is the goal to protect and redevelop the Mata Atlantica (Atlantic Rainforest).

Profit

The project is financed by the Brazilian Development Bank (BNDES) and Japanese International Cooperation Agency. The total financing is about €0.6 billion. As in the Guanabara Bay project this may lead to problems, because responsibilities of the various parties are unclear.

The economic side of the project lies in the fact that the region becomes more attractive for tourists when there is less pollution. But on the other hand one can also say that the Baixada Santista is not a specific tourist region. When one thinks of beaches, he doesn't think about São Paulo but of Rio. But instead, the region might just get attractive because of the project.

The sanitation projects in itself have a sustainable goal, improving the life of millions of residents, but the tools used in order to reach this goal are not always sustainable. As an example Sabesp first uses a submarine outfall to discharge partially treated effluent into the Atlantic Ocean, but this is a major improvement compared to the old situation. Thereby the projects generates thousands of jobs in the BSMR.

6.6. Renova centro, são paulo city revitalization

6.6.1. Problem

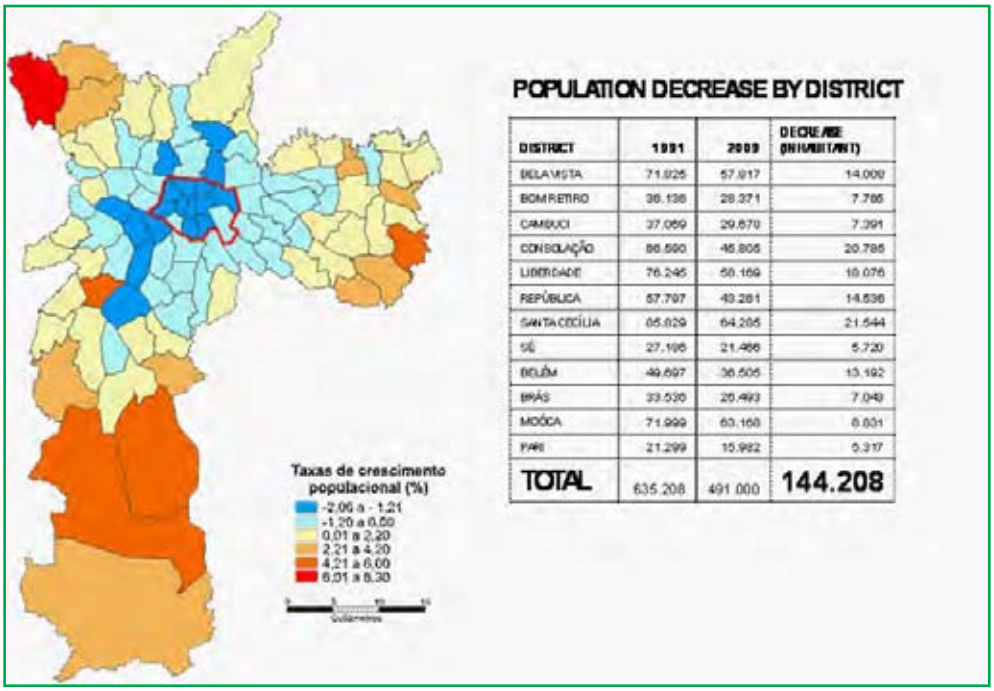
The city center of São Paulo deals with a decline of its population the last decade. Over the last 20 years, around 144 inhabitants have left the center, in exchange for the other areas of the metropolitan region of São Paulo. This makes the city expand into regions not intended for habitation, like nature areas. Another major problem is the fact that in these regions, were the people have moved to, there are only a limited amount of jobs available, sometimes even as few as 0,004 jobs per inhabitant. This lack of jobs makes that people have to travel daily from the overpopulated areas without work, to the (relatively) under populated areas with work. These commuters put a high strain on the traffic system of São Paulo. (COHAB, 2010)

Also many of these commuters live in precarious settlements (unsafe, hazardous dwellings). In São Paulo alone, around 3.3 million people live in these unsafe conditions. Given the fact that the city of São Paulo has around 11 million inhabitants, 3.3 million is around 30% of the total population. Furthermore, 67% of these people live in a state of poverty.

The increase of the population of the city of São Paulo also increases the housing need, next to the already existing precarious settlements. The expected demand for dwellings in the year 2024 will be around 700.000 dwellings. Most of these are needed for families up to 6 minimum wages. The projected deficit of dwellings is around 130,000. (COHAB, 2010)

6.6.2. Project goals

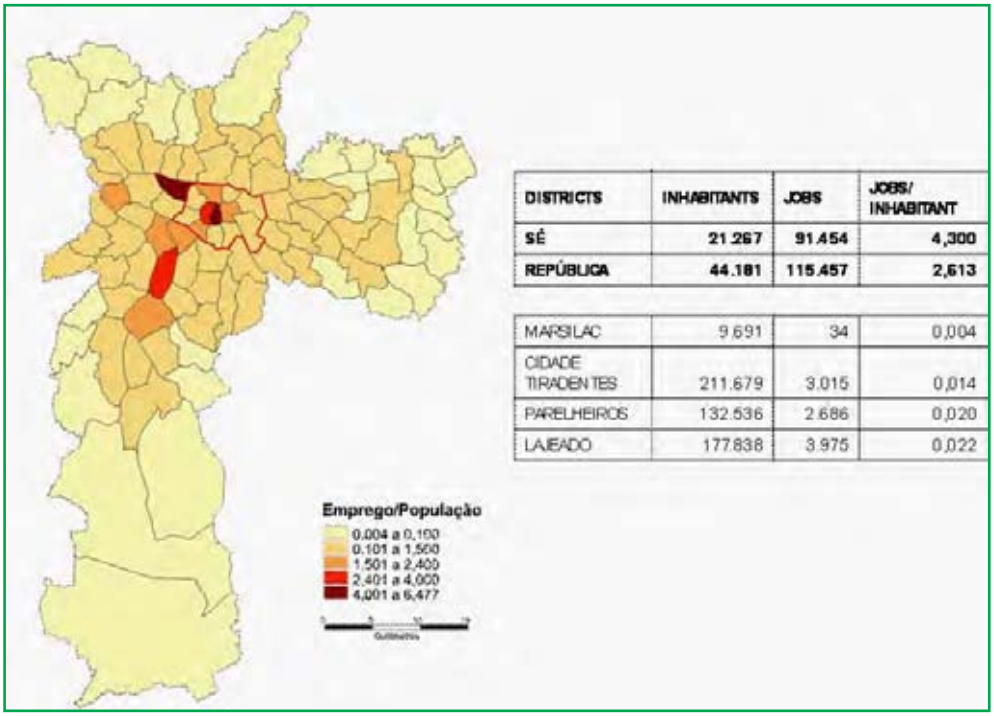
The goal of this project is to bring back people to the center of São Paulo. This should save around 7 thousand bus, subway and



POPULATION DECREASE BY DISTRICT

DISTRICT	1991	2009	DECREASE (INHABITANT)
BELA VISTA	71.925	57.917	14.009
BOM RETIRO	36.138	28.371	7.766
CAMBUCI	37.069	29.670	7.391
CONSOLAÇÃO	66.590	46.805	20.785
LIBERDADE	76.245	58.169	18.076
REPÚBLICA	57.797	43.261	14.536
SANTA CECÍLIA	65.629	64.205	21.544
SÉ	27.166	21.466	5.720
BELÉM	49.697	36.505	13.192
BRÁS	33.530	26.493	7.049
MOÓCA	71.999	63.168	8.831
PARI	21.299	15.992	5.317
TOTAL	635.208	491.000	**144.208**

Figure 6.11: population growth (1991 – 2009) (COHAB, 2010)



DISTRICTS	INHABITANTS	JOBS	JOBS/ INHABITANT
SÉ	**21.267**	**91.454**	**4,300**
REPÚBLICA	**44.181**	**115.457**	**2,613**
MARSILAC	9.691	34	0,004
CIDADE TIRADENTES	211.679	3.015	0,014
PARELHEIROS	132.536	2.686	0,020
LAJEADO	177.838	3.975	0,022

Figure 6.12: jobs per inhabitant (COHAB, 2010)

train trips a day. To lure these people back to the center of São Paulo, a selection has been made of 53 abandoned buildings, mostly located in the districts Sé and Republica. These buildings will be transformed into 2500 apartments, aimed at families with a monthly income up 10 minimum wages.

Most of these selected buildings were built in the 1940's and 1950's and differ in previous usage. Around 61% are previous commercial buildings, 16% are former hotels and 23% are abandoned residential buildings. (COHAB, 2010) The selected buildings are currently being acquired by COHAB (Companhia Metropolitana de Habitação de São Paulo, Metropolitan Housing Company of São Paulo). The acquirement is mostly reached by negotiations with the owners of the buildings. This as many of the buildings are owned or inhered by people who do not have the money to renovate the building and are therefore happy to sell the building to COHAB for a good price. If the negotiations with the owners of the buildings fail, COHAB also has the power to use expropriation to acquire the ownership of the selected buildings.

Furthermore, this project creates cheap and decent living conditions. This increases the living standard for the people previously living in precarious settlements and also foresees in (some of the) shortcoming of 130,000 dwellings, needed in 2024. In the Renova Centro project the fast majority of the new developed dwellings are studio flats or 1-bedroom apartments. Only 5% of the units are designed for larger families, these are 2-bedroom apartments. (COHAB, 2010)

The goal is to finish the renovation of the buildings within three years, starting from 2010. There will be no problem allocating people to these apartments, as COHAB already has a database with almost one million families that want to live in the renovated city center. Therefore "gaining an apartment is almost like winning the lottery". (COHAB, 2010)

6.6.3. Control

A partnership between COHAB and the Faculty of architecture and urban development, University of São Paulo (FAU-USP) has made up criteria for the selection of buildings which will be acquired for the program. The criteria used for these buildings are:

- occupation degree
- databank information
- juridical evaluation (ownership and background)
- construction (safety, conservation state)
- architecture (built area, adequation to residential use, number of housing units)
- economical feasibility studies

As shown in figure 6.13 the buildings are located mostly in the districts Sé and República. The total investments for this first step of the program are estimated at around R$ 400 million, which will be financed together by the Municipality of São Paulo en the Caixa Econômica Federal (the second biggest Brazilian bank) (Música para o centro de São Paulo, 2010). The coordination of this part of the program will be done solely by COHAB. COHAB is a state company providing the lower income population the access to proper housing, following regulations established by Municipal and Federal authorities. (História, 2010)

The project Renova Centro is based on experience with previous successful examples like the Riachuelo building (completed in March 2008), the Asdrúbal do Nascimento building (figure 6.14, completed in July 2009) and the Senador Feijó building (July

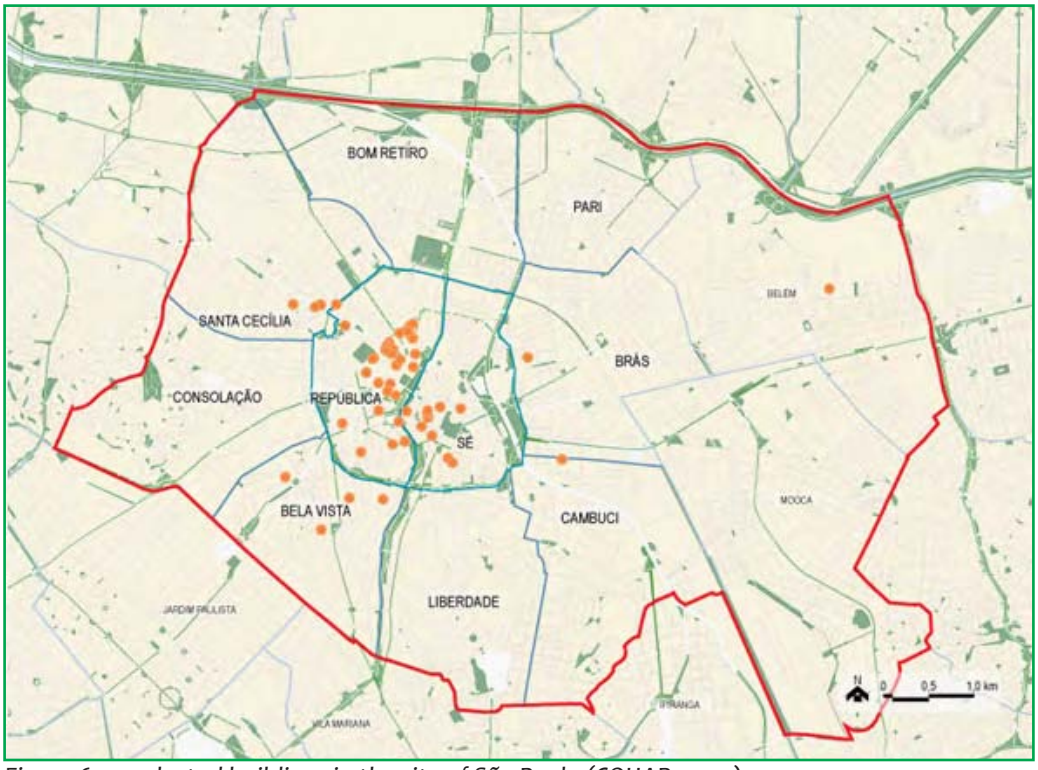


Figure 6.13: selected buildings in the city of São Paulo (COHAB, 2010)

2009). (COHAB, 2010)

6.6.4. Sustainability

People

When looking at the Renova Centro project from a people's perspective, the project has great benefits for the population of São Paulo. The project delivers new and decent housing for the lower income class of São Paulo.

Furthermore, by bringing people back to the city center, the transportation system of the city is a little bit relieved as less people have to travel daily from and to work. This means less crowded metros and buses, which is a benefit for the people who still have to use these systems.

So from a people's perspective, the Renova Centro project can be considered as a sustainable project.

Planet

The project also has benefits for the environment of the city of São Paulo, as fewer people have to travel, the total trips saved reduce the strain on the environment. The total effect on the environment is unknown, as there are many other factors that have an influence on the environmental quality. But it can be safely stated that the fact that the less amount of daily trips has a positive effect on environmental quality.

Also the fact that existing buildings are used to develop the housing units, instead of demolishing old and building new ones, can be considered as a sustainable aspect of the

Renova Centro project.

Profit

On the profit part, the Renova Centro project is somehow unsustainable. A lot of money is needed to redevelop the old buildings into new housings units, suitable for the lower income classes of the people of São Paulo. But it is unclear if all of the costs for the project, will be fully covered by the rent paid by the families living in the new dwellings. As with many social housing projects, a lot of the costs are covered with subsidies and other taxpayers money.

6.7. Discussion

As we stated in the introduction, this report is based on both a literature study and site visits to each of the three projects. In some respects, the regarded projects are not comparable with each other. Therefore, we draw more general conclusions in this report and specifically, we focus on the sanitation projects because this topic is closely related to the meso study (Brink et al., 2010). This is the main reason why our policy framework only involves the policy on sanitation.

Figure 6.14: Asdrúbal do Nascimento, before and after (COHAB, 2010)

This approach limits our research in various ways. The literature study relies on written documents in English, which means that the availability of information was limited for the COHAB project in particular as the project mainly involves Brazilian companies, government agencies and other stakeholders. Furthermore this project has a rather small scale compared to the range of projects COHAB is taking charge of.

Another constraint is due to the large differences in presentations. It's important to note that impressions during these presentations and site visits rely on our perception of only a few people and one organization. The project Renova Centro is mainly the responsibility of COHAB, so they should be informed on most processes involved in this project. However, the presentation about the Guanabara Bay clean-up programme was held by CEDAE, which is an executing party only involved with the construction of main pipelines and the operation of it. This is only a part of the whole program. Because CEDAE does not have an overview on the whole program it makes it difficult to make an assessment on the whole project based on the site visit. Consequently, the presenters were only acquainted with the technical aspects of their work.

Both limitations make this research vulnerable to drawing incomplete conclusions on limited information. To illustrate this problem, we presumed that government agencies often talk at cross-purposes as we concluded from the literature in the chapter about general policies. This supposition was confirmed during the presentation of

CEDAE. They refer to the municipality and state governments as the responsible party with regard to societal and environmental issues, and consequently they don't take this into account in their project. This led to their inability to answer some of our research questions regarding these aspects. However, because this mostly depends on the site visit, the basis to draw a conclusion on this is too exiguous.

This is also indicated by the number of questions which remained unanswered or even unasked, because it was clear that this was not the right institute to ask. Important questions, for example about the uncertainty with regard to favelas, are further elaborated in the recommendations for further research.

In this report sustainability is an important part of the description of the projects. As the title of the report indicates, all projects have as a central purpose the improvement of living conditions of people. Although the projects have not been set up with sustainability as a project requirement, they actually are as is stated in the project descriptions and conclusions. However, assessing sustainability of a project it is complicated, because sustainability is a very broad concept. Although the definition is used of John Elkington (Boomen et al., 2009), this still leaves plenty of margin for different interpretations. A project may be sustainable in some way, but one might think of a solution that would be an even more sustainable one.

The Renova Centro project for example has three intended results, namely to create more housing for people from the low and middleclass, to decrease traffic between the city centre and the suburbs and to improve the attractiveness of the city centre as a sojourn area. It has disputable in what extent the project will contribute to a sustainable solution to these results. Most probably it may improve the attractiveness of the city centre, but in terms of households it serves in accommodation or trips it safes between the centre and suburbs, it may be negligible.

Furthermore the money for realization of a project will be earned back in the future, so loans will be paid back. The timescales are typically very long for the considered projects. Therefore social development fund is required like loans from the Inter-American Development Bank to start up these kind of projects.

6.8. Recommendations for further research

Following from our research, we have a list of suggestions for future research which are not answered during the study tour. Some of these may be suggestions for future research into Brazilian projects.

- Are there already some results known (numbers and figures), from the Baixada Santista project?

Although we have numbers about planned investments and people already connected to the system, the project is still developing, and new numbers are to be expected.

- How do CEDAE deal with the ever growing favelas and other informal, unregistered districts?

This question was partly answered in the Baixada Santista project, but the problem in Santos and the Baixada Santista area are considered to be not that big as the problems in Rio de Janeiro. People of CEDAE could not answer this question because they only had information about the water treatment plant, and quality of the water.

- Does the Renova Centro project or the city of São Paulo encourage the use of renewable energy sources such as solar or wind power?

It seemed that for the Renova Centro project, and also for other projects in Brazil, people first wanted the job to be done. After the primary infrastructure is there, people may start to think about sustainability. This has to do with needs, people are only concerned with environment if their primary needs are fulfilled. So it is interesting to see how the story in Brazil develops, is sustainability becoming more important in the coming years?

6.9. Conclusion

When we look at the three projects we studied, we can conclude the following with regards to our research questions:

1. How does the development of water treatment facilities in Brazil compare to the development to the Netherlands?

Like often concluded on other sectors in general, we can conclude that Brazil is doing quite well compared with developing countries. Regionally there are large differences and the quality of sanitation is below par. The actual situation is based on the developments during the dictatorial times. Then the responsibilities were given to the provincial state. Later municipalities got responsibility to give concessions to sewage companies. This has led to ambiguous situation where the provincial state and municipalities are both reluctant to solve problems. This phenomenon occurred at the sanitation projects, especially at the Gunanabara Bay Cleanup programme. The executing party restricts itself to its strictly indispensible tasks. Additional legislation should improve this situation.

In The Netherlands however, sanitation developed much earlier. In the 1970's almost all people had access to improved sanitation, but the wastewater was not treated. Since that time waste water improved significantly, through which the water is rather clean nowadays.

2. What is the underlying motivation for starting water quality control projects such as the coast sanitation project and the Guanabara Bay Cleanup program?

When observing the projects from an outsider's point of view, we see that projects such as the Baixada Santista and the Guanabara Bay cleanup programs are carried out mainly in the interest of public health. The high levels of pollution in the bay varying from toxic metals to the biological contamination caused by eutrophication is a severe threat to the health and well being of the surrounding populace. This has spurred the government into starting projects with the main goal of decreasing the pollution in these areas to directly influence public health.

With most of the effluent from the surrounding areas entering these bays untreated, the projects are integrated with projects to increase sewage accessibility in the area. However, we notice that this part of the projects often runs into resistance from the locals due to the lack of willingness to pay for sanitation services, especially from the poorest layer of the populace living in favelas. At SABESP these areas are covered by investing a lot of patience and money, while at the Guanabara Bay Clean up project these areas seems to be avoided.

Additionally, we see that there are financial factors that play a role in the approach taken to the cleanup of the bays. In order to retain the capability for fishing and tourism, approaches such as dredging are prohibited for they reintroduce toxic materials from the sludge into the water and this poses significant health risks.

3. What are the projected effects of these projects are they truly sustainable?

When we look at the projected effects of the projects we notice that the main influence of the projects have impacts on all three facets of sustainability. These effects are projected as follows:

- People: All three projects have been started to improve the living standard of the Brazilian people. With the first two project this is done by improving sanitation and the water quality consequently. Because especially the poor people suffer from public health problems, the most improvement is made for those people. While the project of CEDAE end with the construction of the main sewage lines, SABESP goes to step further by realising all household connections also in the poor areas. The COHAB project tries to improve living standards for people by improving the houses in the center. These houses are meant for middle class and lower class households. Due to the renovation of the buildings, the whole neighborhood benefits, because vacant houses are filled op and cease attracting visual pollution and criminality.
- Planet: Due to the sanitation projects the water quality in both areas already improved. This improvement can not directly be imputed to the measurements taken in the project, because the relation is not verifiable by measurements. Consequently this will have positive effects on wildlife as well as human activities in the area. In the future this effect will even increase, because of further improvements. The measures are really aiming at the long term. The environmental effects of the project of COHAB are rather small. Small improvements should occur, because the daily trips that people make to their work become smaller. Furthermore, renovation in stead of rebuilding of the houses safes material.
- Profit: The regarded projects typically have in common that no profit targets have been defined. The projects are started from another perspective and are financed with development funding with low interest rates. The effects on the local economy however may be profound. Side effects of the sanitation projects will include increases in utilization of the water, especially in the tourism and fishing industries. These effects also appear in the COHAB project. Furthermore, many trips can be saved between the major work districts in the city center and the suburbs, approximately 7000 trips will be saved with the current project results.

Overall, when we look at these projects from a sustainability perspective, we regard them as sustainable. All three aspects, people, planet, and profit, are influenced in a positive manner by the projects. In some respects, the projects are open to improvement, especially in the field of project control and divisions of responsibilities.

4. How are water quality projects such as these financed and controlled, and what are the effects of this approach?

Financing for these projects all have similar structures in the sense that both private and public parties are involved. Main contributors to these projects are: The Inter-America Development Bank (IDB), the Japan Bank for International Cooperation (JBIC), the respective states and private parties such as housing corporations and water companies.

This form of financing has a clear influence on the various parties with control over the project in the sense that responsibilities are often ambiguously divided. This in turn can have serious effects on the execution of the project, and in some examples we see that it can lead to a worsening of the situation. For example: In the Guanabara Bay project, for example, local citizens were not consul-

ted and they are now unwilling to pay for the sanitation systems produced by private parties. However, due to the responsibilities lying elsewhere, the sanitation facilities are being run at very low capacities leading to an inefficient system.

In general we can say, that the Netherlands are optimizing their sanitation and water treatment systems, and that Brazil tries to catch up with countries like the Netherlands. Doing so requires a lot of efforts but, according to the information of the excursions, Brazil has made a good start.

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7. FINAL WORDS: BOOMING BRAZIL

In this report, we have presented the results collected throughout the entire trajectory of the study tour. Starting at the beginning of February participants of the study tour have researched a variety of aspects of Brazil. As explained in the section "about the tour" they have conducted a macro level analysis of Brazil focusing on aspects of the country such as its geography, history, politics, economy, culture and technology. Following this research, students conducted a more in depth analysis of the civil engineering sector specifically focusing on Brazil's construction, transportation, and water management sectors. These preliminary researches have been published in our preliminary report in advance of the study tour. In addition, all participants have conducted an in depth analysis of specific projects we visited during our study tour. To achieve this, we prepared a literary research in advance of the tour, discussed with companies during our visit, and wrote a final research report which we present in this report.

In general, we saw many differences between the Brazilian and Dutch approaches in the way that each country regards sustainability in the civil engineering sector. We can conclude that the countries are incomparable in many areas, and therefore they approach problems in a different manner. We get the strong impression that while the Netherlands is mostly focused on the optimization of existing conditions, the Brazilians are creating their country. By this we mean that Brazil is facing problems which no longer exist in the Netherlands, and that they are creating solutions for these problems. In the Netherlands, these solutions are already in place, but are constantly being improved, updated and optimized to reach a sustainable permanent solution.

That said, we clearly see the influence of sustainability policy in the projects we visited in Brazil. Aspects including all three fundaments of sustainability are being assessed in their projects including social issues, environmental impacts, and the effects on the countries' economy. This has led to many projects being approached in a very sustainable way, which was not the case in the Netherlands when solutions were first created.

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The organization of the 'Booming Brazil' Study Tour, although still ongoing, would never be possible without the support and contribution of the following organizations and individuals. They contributed to the tour by investing time, money, or sharing specific knowledge about Brazil or the organization of a study tour. We would like to thank them for all their efforts!

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We are glad that the following people support the Booming Brazil study tour by taking position in our Board of Recommendations:

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1.6. Other

- Guides Carla and Rolf
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