

DEVELOPING THE BRAZILIAN ECONOMY

Micro study Summary

1. DEVELOPING THE BRAZILIAN ECONOMY

1.1 Introduction

The expansion of Sao Paulo Metro and the construction of the TAV Sao Paulo-Rio de Janeiro will boost inevitably the Brazilian economy. This preliminary report, elaborated before the onsite visit to Brazil, gives an overview about the mentioned effects on the economy keeping in mind the sustainability aspects after analyzing exhaustively different literature and official websites related to both projects.

1.2 Scope

The scope of this research is to analyze to what extent the Metro Expansion in Sao Paulo and the High Speed Train from Sao 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. The motivations for expanding the lines, the effects they will have on the different transport modals and the city are approached. Special importance has the environmental treatment and the accessibility of the metro for low income people.

The 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 expected modal split with demand will be approached in order to explain an cost-benefit analyses in order to make conclusions about the economic advantage and sustainability of the high speed train.

1.3 Research question

This research will be looking 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 extent 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, the Triple Bottom Line (Profit, Planet, People) will be studied. How the financial performance (Profit) take into account ecological (Planet) and social (People) performances.

1.4 Metro expansion São Paulo

The Sao Paulo Metropolitan Region (SPMR) has about 19 million inhabitants spread irregularly over 8,000 square kilometers. 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 centers) 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 322 km network to span 500 km by 2020 (Global Mass Transit Report, 2010). The planned extensions analyzed in the current report are:

- Line 2 connecting Green Vila Madalena and Cidade Tiradentes (expansion to the Southeast) → 38.8 km, 31 stations.
- Line 4 connecting Yellow Luz (central region) and Vila Sônia (western region) → 14.3 km, 11 stations, scheduled to be opened in 2012.
- Line 5 connecting Lilac Capão Redondo and Chácara Klabin → 25.5 km, 17 stations.



Figure 1 Sao Paulo Railway network after expansion Lines 2, 4 and 5 (Schwandl, 2009)

1.4.1 Strategic issues

The key development issues related to the expansion of the Sao Paulo Metro entail (Sustainable Development Department. World Bank , 2010):

- Improvement of quality-of-life of low-income users.
- Metropolitan coordination.
- Congestion, road accidents reduction and reduced emissions.
- Cost-recovery, financial management and funding issues.

Cost and financing plan of the Metro System

Line 2: The expansion of Line 2 was approved by means of a loan financing contract by the Bank for Development of Brazil. The project, expected to be completed by 2010, is part of the investments in the railway

system of Secretaria de Estado dos Transportes Metropolitanos de São Paulo (São Paulo Metropolitan Transport State Office – STM) with maturity up to 2015. (Brazilian Investment Bank, 2008)

The São Paulo Metro Line 5 extension project is executed as an investment loan from the Inter American Development Bank. The term of the loan will be 25 years with a 4.5 year disbursement period. The project will have an execution period of 4.5 years. (InterAmerican Development Bank, 2010)

Line 4: project stands as the first PPP project in Brazil to be financed in the international markets and the financial structure itself is built around an innovative two-phase loan framework from the Inter-American Development Bank. (InterAmerican Development Bank, 2010)

The most adequate type of concession for Line 4 is the sponsored concession mode (PPP), because of (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

A social-economic impact study developed by Companhia Metropolitanos de Sao Paulo (2010) shows the direct and indirect benefits from the implementation of Line 2-Green:

- The work will improve the traffic and reduce the traveling time;
- The region will attract investments from the private initiative and the value of the real estates 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.
- Construction accidents. Operational safety.

1.4.2 Construction topics

Technical issues

In this context, the architectural design is the catalytic element for the materialization of new concepts and the application of new construction technologies used for Line2, Line 4 and Line 5. 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.

Environmental treatment

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; and
- 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-km 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).

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 neighboring buildings. (Sustainable Development Department. World Bank , 2010)

In the State of Sao Paulo, the environmental licensing occurs in the SMA (Secretariat 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; and
- Maintenance of integrated tariffs such as the BUI, which benefits primarily the low-income segments of the population.

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.

Due to the high demand in public transportation in Sao 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.

1.4.3 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 centers 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)

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 Sao 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 qualitative measures are continuously taken in order to make the metro more attractive 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

After the implementation of phase I of line 4, the line 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)

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, close cooperation with the fire brigade and investments in training the staff.

Communication

Communication and marketing objectives include maintaining a good relationship with the population and stimulating the use of this safe and efficient mode of transport by reducing the time users spend in the system (COMPANHIA DO METROPOLITANO DE SÃO PAULO–METRÔ, 2004). 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.

1.4.4 Conclusions

The Metro Expansion will keep up the demand for a better infrastructure in the inner city of Sao Paulo. Hereby, a conclusion is elaborated in order to analyze to what extend the Metro Expansion will contribute in a sustainable way to the development of the Brazilian economy.

We will analyze the three main points regarding sustainability: People, Planet and Profit.

People

From the point of view of the people, the expansion of the Metro is supposed to make the Metro more accessible for poor people. 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. Further information about the effect of this project in the surroundings will be gathered on site.

Planet

The project will be very sustainable in the long term. The CO₂ emissions will be reduced. People will change from car/bus to metro, therefore it will increase sustainability. However, during the literature review we could not find much information about the waste of materials, systems to collect residues, recycling, etc. That would be interesting to gather information about this issue on site.

Profit

The project will create employment, not only during the construction but 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. However, there are not clear numbers about it in the literature review we made. It would be interesting to ask them on site.

1.5 High speed train TAV-Brasil

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 comfort 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).

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.



Figure 2: TAV alignment

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

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

HALCROW, a consultancy firm delivering planning, design and management services for developing infrastructure and buildings worldwide, made an elaborated feasibility study of the TAV project. HALCROW was commissioned by the Inter-American Development Bank. This study is the most recent (2009) and complete study available right now, using the latest information available. This study is used throughout this chapter.

1.5.1 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 extent 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 commissioned by the Inter-American Development 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. A small amount, less than 1%, is estimated for resettlement of 618 low income families. Prime Engenharia concludes that this is a very modest amount of a project of this magnitude, but explicable since a tunnel relieves the urban environment and minimizes the displacement of population. Road or rail projects much smaller than the TAV that pass through urban areas have population to resettle in the thousands of families (Prime Engenharia, 2009).

Another notable item is the environmental impact of TAV. Until yet, there is no study that calculates the effects on the environment in detail. Prime 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. Nevertheless, they do have some calculations 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. When the TAV starts operating the OPEX are around €150 million per year, increasing to € 350 million. 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 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). This doesn't seem much, but hence that Brazil is a country with 192 million people, compared to 16 million in The Netherlands consuming 110 billion kWh. If the Brazilians would live like the Dutch, they would use 1320 billion kWh. Of course, Brazil and The Netherlands are not comparable that way, but it indicates the relative high energy consumption of TAV. In the light of sustainability it is good to note that 85% of the energy production (437 billion kWh) in Brazil is provided by hydro-electric plants. This means that TAV theoretically could run on a renewable energy source and therefore by definition be more sustainable than a bus, car or plane (U.S. Energy Information Administration, 2010).

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 for car and bus travelers. Air travelers 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.
- *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 the operating cost of the TAV omits these benefits. It is not clear how these two stand opposite from each other.
- *Investment cost delayed/avoided*

The domestic airports of Rio de Janeiro and São Paulo are almost at maximum 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 opportunity 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.

- *Real estate development*

In line with the regional development, the real estate around the stations of TAV will develop as well. It is more attractive to settle down close to the stations due to the increased accessibility of the location.

Social

- *Improved quality of ride and ambience*

The TAV provides a safe and convenient way of traveling. 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*

A significant reduction in accidents will occur 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.

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 possibility 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 crowded urban areas. Due to shift from road and air traffic to TAV, less vehicles have to be 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. How will the airline companies react to these developments? They executed site surveys to examine the choice behavior 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 is present in this study. 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, would 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 the risks of the works and responsibility for the implementation of the service and its future operation.

The criteria to win the tender are quite simple: the one who requires least public funding and the one who charges the lowest fare to the end user 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.

1.5.2 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, Sao Paulo and Campinas is the most important economic region of the country. The states of Rio de Janeiro and Sao 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 Sao 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 and the GDP of the area of influence represents a significant proportion of the Brazilian economy. 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 Sao Paula region reflects the greater proportion of financial services here compared to that of Rio de Janeiro. The surrounding regions of Rio de Janeiro and Sao 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 Sao Paulo. (HALCROW, 2009)

Model split

Existing transport modes as the air, car and bus are well established in the market between the three cities, in particular the high frequency air shuttle connecting the cities of Rio de Janeiro and São Paulo. In 2008, the total estimated demand between Rio de Janeiro and São Paulo was 7.3 million trips with a market share for air of 60%, 17% for car and 23% for 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)

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 1: Model split (HALCROW, 2009)

The total estimated market between Rio de Janeiro and Sao Paulo without TAV is 10.7 million trips in 2014 of which air is forecast to have 68.34%. Introducing TAV increases this market to 12.1 million trips of which TAV has an estimated ridership of 6.4 million passengers and market share of 52.89% of the total market. TAV's market share of the air and rail market is 75% in the off-peak and 55% in the peak. In 2044 TAV ridership is forecast to increase to 24.9 million. (HALCROW, 2009)

A modal split study of the different sections show that the largest flow by volume is between Sao 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. The largest station by demand volume in 2014 is Sao 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 Sao Paulo-Campinas. (HALCROW, 2009)

Congonhas airport is presently close to runway capacity. At Santos Dumont there is only 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 Sao Paulo all suffer from congestion. The increasing car ownership will increase the number of 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 a 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 air fares 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.

Participation process

There is no information about the participation process of the TAV project. It is not clear how the affected stakeholders can participate in the decision making process. For example, are the 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 have a stake. To what extent 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.

Future plans

In the future there are no plans yet to expand the TAV route, despite the forecast that TAV tracks will reach its maximum capacity in 2038. There are some plans which may affect the TAV usage. There is a plan for high capacity transport systems between Barra Funda station in Sao Paulo and the city of Guarulhus, decreasing journey times between Guarulhos Airport and Sao Paulo making it more attractive. A plan for a light rail from airport Congonhas to the metrosystem of Sao Paulo. Plans to connect the highways of Rio de Janeiro outside the city, so that congestion will decrease. Same for Sao Paulo with a highway ring around the city. These plans make the other transport modes more attractive and so it's possible that it would impact the TAV.

1.5.3 Conclusions

The TAV project is an ambitious project of the Brazilian government to improve the connection between Rio de Janeiro, São Paulo and Campinas. The TAV project will relieve the pressure on the existing transport system and will prepare the most important cities of Brazil for the future. The high-speed train will boost the national and regional economy and attractiveness. The upcoming World Cup event and the Olympics are main drivers of this project. However, this research aimed at, in relation to the topic of this study to investigate to what extent 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.

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 extent 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?

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 by hydro-electric dams. Also the requirement of the government to produce 60% of the construction material at local scale, contributes to a sustainable development. A decreasing number of planes would make this project even more sustainable, but it's unsure if the number of planes would decrease by the introduction of TAV.

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 induce employment and contribute 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. Next to that, it is unclear how the project will be managed during construction. Some questions arise: Who takes the risks? Who cares about the direct construction environment? Do they communicate the building progress to the affected stakeholders? How do they deal with safety during construction? How will materials be delivered to the construction site?

As far as we know now, we can conclude that the TAV will contribute to the development of the Brazilian economy. But it is difficult to determine now whether this project contributes in a sustainable way to this development. More research, mainly on social (people) sustainability, is needed to draw up a more accurate conclusion.

1.6 On site research

Based on the literature review elaborated and the conclusions made regarding the project analysis, some questions have been elaborated to ask during the onsite visit in Brazil. This information will clarify all the unresolved aspects to complete the final report after the Study Tour.

1.6.1 Metro expansion - São Paulo

- Could they provide numbers about the benefits of the metro expansion? Which is the forecast?
- What is the influence on 'favelas'? How far are they located from the metro stations?
- What is the influence of the metro in the surroundings?
- What is the experience of the PPP in the Line 4?
- What were the motivations of the private party to participate? How do they face the risks?
- What were the motivations of the public party to launch a PPP and not for line 2 and 5?
- Did they use innovative and environmental friendly materials?
- Have future expansions been taken into account while developing the current metro expansions?
- Is the purpose of the expansion policy to control demand or just cover demand?
- How will travel times and car/bus usage change when the network expansions are in operation?

1.6.2 High Speed Train (TAV-Brasil) – São Paulo

- Who takes the risks during construction?
- How is safety dealt with during construction?
- 60% of the construction materials result from local production. How will materials be delivered to the construction site?
- How is the process of participation of stakeholders organized?
- What about political influence? Does prestige play a role in the decision making process?
- What if you don't meet the expected travel forecasts?
- What is the current state of the tendering process?
- Is there communication about the building progress to the affected stakeholders?
- Will the number of planes decrease because of TAV?
- What are the future plans considered maximum track capacity in 2038?
- Are there plans to expand the track to other regions?
- Are there other TAV plans in Brazil?

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