Transportation Market Study Yangtze Delta

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ABSTRACT: The Yangtze-Delta is one of the most developed economic areas in China. Its socio-demographic density and characteristics require further expansion and upgrading of its current transport infrastructure. The Transrapid technology could constitute an attractive transport alternative. The study focused on the possible ridership, its development over time and the cost and revenue projections of a Transrapid project in the region. Though there are a number of uncertainties it can be stated that the project needs a large share of public money before becoming interesting for private investors as a Public Private Partnership model.

1 INTRODUCTION

Along with China's fast and continuous economic development and its growing population mobility, fundamental changes in structure and means of transportation will take place. The medium and long-term railway plan of the State Council has given first positive indications for further development of maglev technology in China, induced by the successful completion and operation of the maglev project in Shanghai and its qualification as an attractive transport alternative also for medium to long distances.

To come to a better understanding of the current situation and the development perspectives in the Yangtze Delta,

- TRI - Transrapid International GmbH & Co. KG
- ICT - Institute of Comprehensive Transportation
- EAC - Euro Asia Consulting PartG

conducted a comprehensive study that focused on

- socio-economic environment and development in the Yangtze-Delta,
- transport infrastructure and passenger transport development,
- potential customer groups and maglev traffic forecast Shanghai – Hangzhou,
- respective operation concept and corresponding technical layout,
- consideration of Public Private Partnership (PPP) as alternative financing model.
- Target of this "Transportation Market Study Yangtze-Delta" is the provision of further planning parameters in socio-demographic and economic context to consider the maglev technology within future railway infrastructure projects, especially in the Yangtze-Delta and along the Shanghai – Hangzhou corridor.

2 SOCIO-ECONOMIC ENVIRONMENT

Supported by the government, the Yangtze-Delta region has constantly enforced the development of industry and investment climate, human resources and infrastructure to enhance the sustained and rapid economic growth. Nowadays the Yangtze-Delta is acknowledged as one of the largest metropolitan areas worldwide and is one of China's most developed regions and driving force in macro-economic terms.

With its established manufacturing base and favourable investment conditions, the Yangtze-Delta also takes a dominant position in international trade and Foreign Direct Investment.

In comparison with other economic centres as well as within a national context, the Yangtze-Delta is among the most densely populated areas in China with a ratio of 0.7 thsd people/ square-km (national ratio of 0.1).

Besides positive economic and demographic indications, travel and tourism intensity as another influencing factor on passenger traffic have also undergone a positive development in the Yangtze-Delta.

Despite short-term macro-economic control measures by the government, the Yangtze-Delta will experience positive economic and socio-demographic dynamics and remain an economic driving force within China. The World Expo 2010 will support Shanghai's efforts to build the city into a world centre for economy, finance, trade and transportation, which will tremendously help push forward Shanghai's modernization and internationalization.

3 PROJECT OVERVIEW

Based on previous considerations the study focused on the extension of the existing Maglev in Shanghai to the city of Hangzhou.

As the proposed project to Hangzhou is foreseen to connect with the existing Shanghai Airport Link at Longyang Road Station (LYR) a number of design parameters is already fixed , e.g. the maximum train length should not exceed eight cars to avoid costly modifications to the existing stations and maintenance facilities. And also the operation pattern is predetermined to a certain degree by the existing route.

Figure 1: Route Overview

Figure 1 shows an overview of the extension from Longyang Road station to Hangzhou. It foresees additional stations at the Shanghai Expo area, Shanghai South Railway Station, Jiaxing and Hangzhou East Railway Station. The intermediate stations at Songjiang and Haining were considered as optional in the initial route planning but the ridership forecast showed that they added only very little ridership and on the other hand increased over all trip times for the long distance relation so they were no longer considered in the detailed planning. The whole extension is about 162 km long and fully double track. This is the basis for the passenger forecast and the investment cost estimate.

4 CONTENT OF THE STUDY

The economic assessment of a transportation project requires five main inputs:

- ridership forecast
- investment volume
- operating costs
- revenue forecast
- distribution and development of these figures over time

Contractual and legal issues also have to be considered, but are of minor importance for the overall results.

Besides the alignment information, maglev passenger ridership forecasts are the most essential input requirement for the technical layout. The results of this forecast form the basis for the operation patterns that again determine the layout of the infrastructure and the operating system.

4.1 Ridership forecast

For the ridership forecast, a detailed analysis of existing alternatives and their qualities such as trip time and pricing was conducted. Together with the predicted socio-economic development in the region an origin/destination matrix was developed for the years 2010, 2015, 2020 and 2030.

Projections over a longer period of time are too risky and on the other hand not necessary because project times of more than twenty years are considered as rather uncertain by potential investors.

The main results of the ridership forecast are summarized in the diagrams below. Figure 2 shows the cross section load for all route sections for the year 2010 in one direction. The total height of the columns indicates the number of passengers that are travelling in the respective cross section of the route and the different patterns indicate the origin of the passengers.

Most of the passengers boarding at Pudong Airport stay on board until Shanghai South, where all of them leave the train, as well as the passengers coming from LYR and the Expo station.

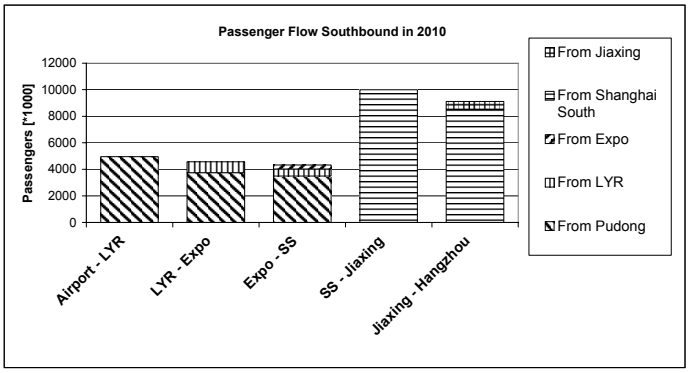

Figure 2: Passenger Flow Southbound

There is no significant ridership potential for trips from one of these sections to the other, or in other words the number of trips from the Airport, the Expo Station or Longyang Road Station that go beyond Shanghai South is so small that they do not appear in the forecast.

In the other direction all trips from Hangzhou and Jiaxing end in Shanghai South. So the project fulfils two very different purposes:

– the Airport to Shanghai South section is an airport feeder line
– the Shanghai South to Hangzhou section is an intercity line.

The importance of the individual stations is illustrated in Figure 3. Shanghai South is clearly the most important one as it is the end/starting point for both passenger streams.

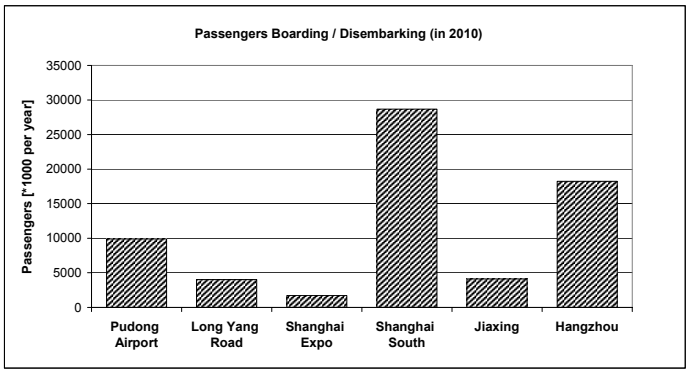

Figure 3: Station Importance

For the technical layout the annual ridership must be broken down to a demand per hour that represents a typical peak. For this purpose the average per day is used and 12 percent thereof as the peak hour to determine the maximum capacity of the system. This method ensures that an uneven distribution over the year and over the day is considered adequately.

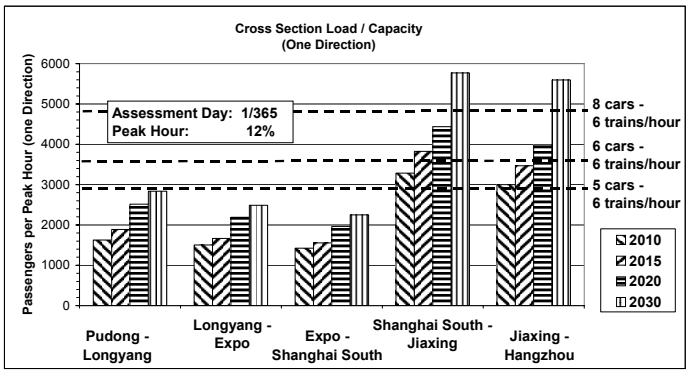

Figure 4: Cross Section Load

Figure 4 shows the passenger numbers between the stations during the peak hour for different timeframes of the prognosis for one direction. It also shows the capacity that is offered for various train sizes and headways.

4.2 The investment volume

Based on the ridership forecast the route will be double track and the minimum headway is 10 minutes. So the bill of quantities for the operating system can be defined rather precisely, but its price depends on a number of factors that are not yet defined in detail. The main uncertainty is the extent and the outcome of the intended localization.

In addition the guideway costs depend very much on the alignment and the required amount of special structures. One key issue for instance is the tunnel under the Huang Pu river between the Expo and Shanghai South.

The investment costs are estimated on the basis of two key assumptions:

– the investment expenditure per double km - including vehicles - is 200 million RMB (19 million EUR)
– the cost share between guideway and operating system is 50/50.

This is a simplified approach but former estimates in other studies have shown that this per km price is in a realistic range and it is also a figure that has been confirmed by Chinese officials as a target price for maglev. The share between operating system and guideway is only important for the calculation of the depreciation, so a shift from one to the other is of minor effect.

Based on the total route length of 163 km the total investment amounts to 32,600 million RMB (or 3,123 million EUR at an exchange rate of 1 EUR to 10.44 RMB).

4.3 Operating costs

The operating costs consist of three main blocks.

– train operation
– energy
– maintenance (personnel and material)

The calculation of the required personnel is based on the following operational key data:

– 18 operating hours per day (2.5 shifts)
– operation seven days a week
– one operation control centre for the entire route (three shifts)
– two maintenance facilities
– maintenance personnel as standby during the day
– main maintenance activities during the night shift
– three attendants per train
– six persons per station

Operational staff is required for the operation centre, train attendance, information desks at the stations and for cleaning. The total number of operational staff required is estimated to be about 350 in

2010. Since most of the personnel is fixed, the future headcount will only increase slightly and is basically limited to train attendance staff.

The total number of maintenance staff required is estimated at 265, 220 thereof being blue collar personnel. These figures will remain unchanged during the operation period of the maglev.

Figure 5 shows the split of the annual operating costs. The large share of energy is caused by the comparatively low costs for labour in China and the relatively high price for electric energy. The figure for spare parts is estimated without consideration of local content, so this figure is certainly at the upper limit and could be reduced in the future. Figure 5 also shows clearly that in China the reduction of personnel can not lead to a significant reduction in operating costs.

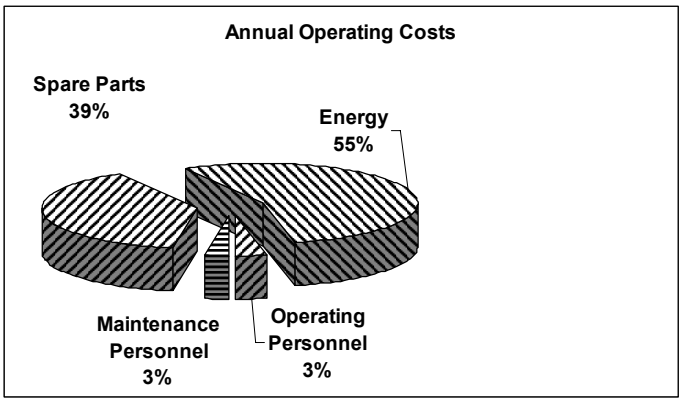

Figure 5: Operating Costs

4.4 Revenue forecast

ICT suggests a ticket fare which is in principle based on a price of 0.50 RMB per km (year 2010). This price assumption is based on market research undertaken by ICT in 2002.

In this research project a gross total of 2,560 potential customers were interviewed on their "degree of acceptance" suggesting a variety of prices for certain maglev connections.

In any case, pricing remains a major regulative factor for the operator to avoid both under utilization ("empty" trains) and over utilization (waiting and "chaos" at the stations) of transport capacity as transport capacities cannot be adapted "overnight" for technical and economic reasons. Pricing as a regulative factor also includes price differentiation, for example according to "time of the day" or "day of the week", in order to shift maglev usage to times of low utilization.

EAC has made some preliminary assumptions in relation to economy class and first class shares and prices as well as commuter shares and prices. The "single ticket first class" price is calculated on the basis of double the amount for the "single ticket economy".

For all connections from Pudong Airport to Shanghai 50 RMB is suggested as this is the current travel price on the demonstration line, hence no increase is assumed for the demonstration line between 2005 and 2010. All other connections are simply calculated "distance in km" x 0.50 RMB.

As most commuters obviously are economically not able to afford the single ticket fares for their daily trips to work special offers such as monthly or yearly tickets will be offered to them at a discount rate of up to 75 %.

4.5 Time Frame

4.5.1 Period of Planning and Construction (PPC)

It is the ambitious goal of all parties involved to have the Maglev connection in operation in time for the EXPO 2010 in Shanghai as the EXPO would gain significant attention, with Maglev trains stopping at the EXPO site. The completion year 2009 is not an economic requirement for the private investors but obviously a political requirement for the government side, especially the Shanghai and Zhejiang province governments.

This means that the construction phase must be completed by the end of the first six months of 2009 – taking the required thorough trial operation into account.

Should the construction phase start and/or end later than is assumed in this analysis, this alone will not significantly affect the major findings and suggestions of this pre-study work.

Figure 6 shows the investment schedule during the PPC.

Investment Schedule		
Year	**Amount**	**Share**
2005	156 Million EUR	5%
2006	781 Million EUR	25%
2007	937 Million EUR	30%
2008	781 Million EUR	25%
2009	468 Million EUR	15%
Total	**3123 Million EUR**	**100%**

Figure 6: Investment schedule

4.5.2 First Period of Operation (FPO)

The FPO is planned to start in 2010 and end in 2040.

The duration of the FPO is first deduced from a potential operator concession. The period of such concession is assumed to last at least 30 years. Secondly, passenger forecasts until the year 2040 are

available. Taking these aspects into account, both the concession duration and the passenger forecast tim frame, it is sound to assume a first period of operation from 2010 to 2040 (31 years).

Within this period, large re-investments are not considered.

4.5.3 Continuing Operation Period (COP)

Public transport facilities last longer than 31 years. The time frame of economic exploitation of the Maglev project goes far beyond the year 2040. Therefore an economic projection is carried out for the Continuing Operation Period (COP) beginning in 2041 following the FPO 2010-2040.

For the COP, a detailed business plan, as for the FPO, has not been made due to the limited availability of meaningful information for the respective years (i.e. passenger forecast, ticket prices, capacity limit, and competitive environment).

For this reason the last Cash Flow of the FPO is assumed to be constant and applied to the economic evaluation of the Continuing Operation Period.

5 RESULTS OF THE ECONOMIC ANALYSIS

5.1 Financing Concept

Regardless of the final setup of the legal structure of the investment project to be defined in the future, in principle three sources of capital are to be considered in a financing concept:

- Private Equity Capital
- State Equity Capital (Subsidy)
- Credit Capital

The partioning of capital in this way is meaningful, as the different capital providers associate different interest goals to their investment contribution. It is assumed that the state provides a state subsidy and not a state loan - this is a crucial aspect when it comes to the calculation of the Net Present Value (NPV).

The planning of the amount of shares of the three capital sources is guided by the following assumptions:

- Capital structure shall reflect a 1:1 ratio for private equity and debt capital.
- The amount of the state equity share is calculated in a way that the NPV of the investment equals 0 whereby the state capital is never to be paid back.
- All capitals will be paid in accordance to construction in progress during PPC.

Based on these assumptions and deliberations, the proposed financing structure is as illustrated in Figure 7.

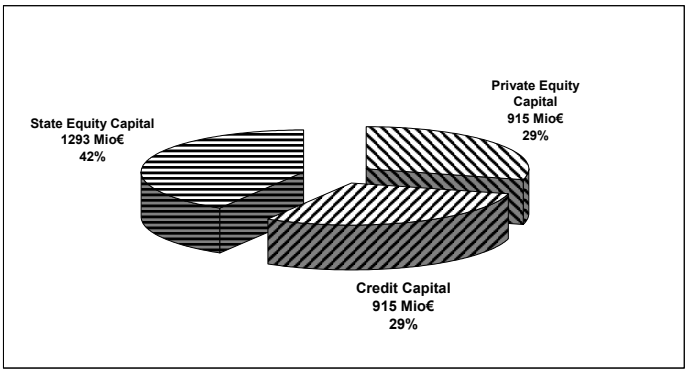

Figure 7: Project Capital Structure

Both, the private equity share and the credit capital share are 29.3% (914.5 million EUR), and the state equity share is 41.4% (1,293.6 million EUR) - altogether financing the investment of 3,123 million EUR.

5.2 Loans

Credit capital in the form of a bank loan (irrespective of how many banks are actually involved in a possible banking consortium) is planned to be drawn to partly finance the investment. This long term loan shall be fully paid back during FPO by constant amortisation.

During PPC and in the initial years of the FPO the revenues are not sufficient – after paying the operative expenses – to fully cover amortisation and interest of long term loan. To avoid a negative working capital another bank loan – referred to as working capital loan – must be drawn. The applied interest rate is 6.12 % for both loans.

In addition the following assumptions were made:

- The long term loan is drawn in accordance to construction in progress and constitutes a constant share of capital during PPC.
- Long term loan payment and interest of long term loan is to be paid at the end of each year.
- Long term loan shall be fully paid back by constant amortisation during the FPO (2010-2040)
- Avoidance of negative working capital determines the amount of working capital loan drawn.
- Working capital loan payment and interest of working capital loan is to be paid at the end of each year.
- Working capital loan shall be paid back each year as much as the annual cash flow allows for.

5.3 Loan and Interest Development

From 2005 to 2009 (PPC) the long term loan rises in accordance with construction in progress reaching

915.3 million EUR at the end of 2009 which is the credit capital of the investment.

The long term loan will be fully paid back by 2040 (FPO) by constant amortisation. The working capital loan reaches its peak of 259.1 million EUR in 2014. From then onwards the cash flow after taxes and after long term loan repayment is positive so that the repayment of working capital loan then starts. In 2021 the working capital loan is fully paid back.

The maximum total loan of 1,082.8 million EUR is in 2010.

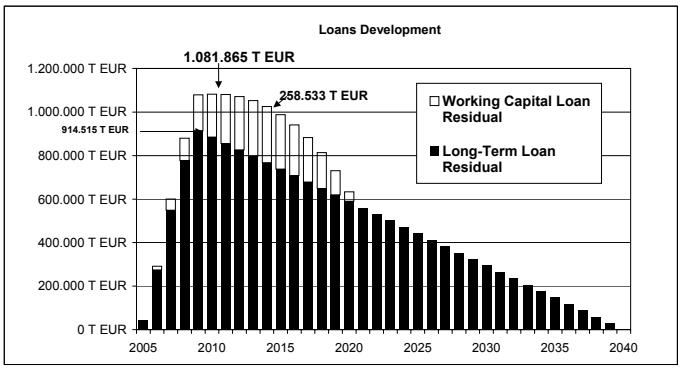

Figure 8: Loans Repayment

5.4 State Subsidy

It is assumed in this analysis that the state capital is brought into the investment in cash during the PPC. However, the way the state will actually contribute to the project in the future could look different from that. Alternatively the state could bring in assets, it can reduce taxes and fees, and so on.

For example it is common in China, that duties and taxes are reduced or even fully abandoned by the government authorities, in this case national, Zhejiang and Shanghai governments. After all, they themselves have a great motivation that the Maglev project Shanghai Hangzhou becomes reality.

Yet another form of state contribution could be an annual payment to the project company. This method would perhaps better fit into the long-term budget planning of national and regional governments.

Irrespective of the organization of the government involvement it will not principally change the "degree of necessary participation" as suggested by the state capital share as other forms of state contributions would have to be discounted to present values so that the required interest rate of the private equity is still met.

6 INVESTMENT ASSESSMENT

6.1 Base Case

In China, 10% interest rate for private equity is standard for long-term investments. That is why this interest rate is used in this analysis.

The interest rate for the credit capital can be drawn from the effective interest rate for long-term credits which is 6.12 % (source: Peoples Bank of China, date: 16 May 2005).

A government generally does not contribute into a public transportation investment to actually gain profit. However, usually the state does not want the capital it has invested to lose value over time, to avoid further investment contributions for extensions or follow-up projects in the distant future ("sustaining of assets"). This objective can be realized by associating the state capital with an interest rate to meet the inflation rate, which is assumed to be 1.5 % in this analysis.

The share of capital (29.3 % private, 29.3 % credit, 41.4 % state) results in a weighted average cost of capital of 5.34 % and leads to a net present value of zero in 2040. This is the capital share structure where the interest goals by all parties (private investors, banks, governments) are met by the cash flows of the investment.

6.2 Sensitivity Analysis

The sensitivity analysis shows what changes in the portion of state capital are necessary to keep all other parameters - especially the rate of return for private equity - unchanged.

The main figures that determine the necessary state capital are a change in the investment costs and a change in the revenues that can easily occur due to the uncertainties in the ridership projections

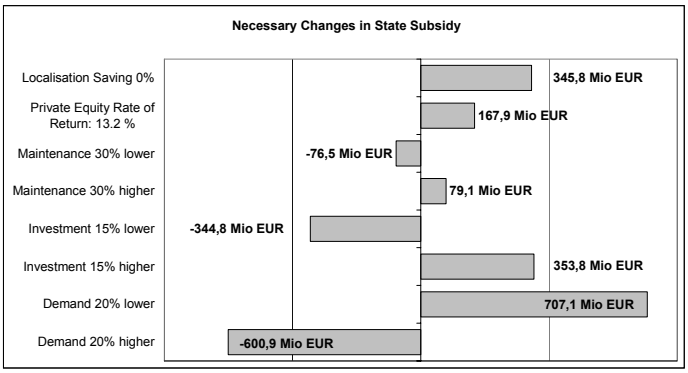

Figure 9: Sensitivity

7 CONCLUSION

The moderate Internal Rate of Return (IRR) of 10% for private equity capital is only possible if the state subsidy is already more than 40% of the whole investment in the base case. As soon as any delays or any changes in the not so pessimistic projections occur, a significantly higher engagement of the public sector is necessary to maintain the 10% IRR.

This IRR can be achieved at the earliest 36 years after the project starts up. This is a very long time for a private investor and during that time many unforeseen things may happen.

So even if in the long term the project bears the promise of a profit, there are a number of reasons why it can not be financed in a public private partnership:

- It is only interesting for the private party if a large portion of the investment is taken over by the state but why should the state finance the private IRR?
- The public partner has to cover the risks because it is responsible for the long term economic environment.
- The whole time frame is too long for project financing that normally considers a maximum period of about twenty years.

Apart from the sensitivity analysis another interesting scenario is: What would the IRR be, if no state capital were actually , i. e. if the investment were on a purely private business basis?

The IRR then would be 2.81%.

Such an IRR is definitely too small to attract any private investor.

8 ACKNOWLEDGEMENTS

Transrapid International (TRI) is a joint company of Siemens and ThyssenKrupp and responsible for the system engineering as well as marketing and promotion of Transrapid. As part of a consortium with Siemens and ThyssenKrupp, TRI was successfully involved in the construction of the Transrapid demonstration line in Shanghai. Major task of TRI has been the provision of technical system parameters and the planning of the operational and technical layout.

The **Institute of Comprehensive Transportation (ICT)** operates directly under the National Development and Reform Commission (NDRC) being responsible for the macro economic planning and monitoring in China. ICT itself is mainly involved in the planning of different transportation infrastructure projects in China such as railway and road transportation infrastructure. Major task of ICT within this study were the elaboration of the macro economic trends and transportation environment, the calculation of general transportation demand in the Yangtze-Delta as well as their impact on potential maglev passenger volumes.

EAC- Euro Asia Consulting PartG (EAC) is a strategic management consultancy supporting international multinationals and medium-sized enterprises along their entire scope of investment projects in China. Focus of consulting work is the planning and implementation of infrastructure projects in China with successful projects realized in the field of exhibition centres, airports, railway and power plants, investment goods industry, etc. Main task of EAC within the course of study elaboration was the conceptional support of ICT during the calculation of maglev passenger demand and its verification as well as the overall co-ordination of the study contents and its completion.