China, PR: Metro Shanghai, Phases I and II

Ex-post evaluation

OECD sector	Railway sector / 201030
BMZ project ID **Metro Shanghai I** **Metro Shanghai II**	 1989 65 444 1995 65 219
Project-executing agency	Shanghai Metro Corporation (SMOC)
Consultants	DeLeuwCather, ETC and DE-Consult
Year of ex-post evaluation	**2004**

Metro Shanghai (Phase I)	**Project appraisal (planned)**	**Ex-post evaluation (actual)**
Start of implementation	Q 3 1988	Q 1 1988
Period of implementation	5 years	7 years
Investment costs	EUR 0.9 billion	EUR 1.1 billion
Counterpart contribution	EUR 0.6 billion	EUR 0.8 billion
Financing, of which Financial Cooperation (FC) funds	EUR 0.2 billion	EUR 0.3 billion of which: FC EUR 0.2 billion
Other institutions/donors involved	<>	<>

Metro Shanghai Phase II	**Project appraisal (planned)**	**Ex-post evaluation (actual)**
Start of implementation	3. Q 1 1995	1. Q 1 1996
Period of implementation	5 years	4 years
Investment costs	EUR 1.0 billion	EUR 1.0 billion
Counterpart contribution	EUR 0.7 billion	EUR 0.7 billion
Financing, of which Financial Cooperation (FC) funds	EUR 0.3 billion of which: FC EUR 0.2 billion	EUR 0.3 billion Of which: FC EUR 0.2 billion
Other institutions/donors involved	<>	<>

Performance rating (both phases)	2
• Significance / relevance	2
• Effectiveness	3
• Efficiency	3

Brief Description, Overall Objective and Project Objectives with Indicators

The two projects “Metro Shanghai I” and “Metro Shanghai II” comprise the construction of the first two underground lines (Line 1 and Line 2) in the city of Shanghai.

The overall objective of Line 1 is the sustainable and noticeable reduction of the time spent on daily travel between home and place of work. The overall objective of Line 2 was to contribute to a more fluent traffic. No indicators were defined to measure the achievement of the overall objectives.

The project objectives of the two phases were combined and specified as an improved passenger transport in Shanghai. Indicators to measure the achievement of the objectives were the average annual passenger volume and the passenger volume at peak hours (only on Line 1).

Project Design / Major Deviations from the original Project Planning and their main Causes

The project marked the introduction of a modern and promising system of mass transport, which is currently being expanded rapidly.

According to the project design the city centre of Shanghai was to be connected more strongly with the outer districts of the city by installing a north-south axis (Line 1) and an east-west axis (Line 2). The aim was to create a longer-term alternative and supplement to road traffic, which - due to the rapid increase in motorised traffic and the limited possibilities to expand the road infrastructure - is increasingly meeting its limits, thus hampering the further development of Shanghai into a regional growth centre.

At the time of the project appraisal for Line 2 in 1995 there were more than 230,000 motorised vehicles, 7 million bicycles and 7,000 busses and mini-busses on Shanghai’s roads. According to estimates the current traffic volume in Shanghai comprises 1.8 million passenger cars, 18,600 busses, 48,600 taxis and 185,000 trucks. Despite the considerable extension of the road network, among others through the construction of four-lane and partly multi-floor ring roads, which temporarily eased the situation in some districts of Shanghai, traffic jams have recently increased again. The maximum speed in the city centre of Shanghai is estimated to have remained unchanged at not more than 15 km/h.

The FC project comprised for Line 1:

- the construction of a rail section of approximately 21.3 km, about 18 km of which are underground, and of 13 metro stations, and the supply of 29 metro trains with 6 cars per train.

and for Line 2:

- the construction of a rail section of approximately 16.3 km and of 12 metro stations, and the supply of 24 metro trains with 6 cars per train.

One depot and one central workshop were built and equipped to supply both lines. Moreover, the two projects comprised the technical equipment of the line, consulting services to coordinate the systems and support the implementation as well training measures for the operation and

maintenance including advice for the supply and use of a train simulator to train the drivers. While the implementation of Line 1 was delayed due to the start-up difficulties that are quite common to projects of such volume, the implementation of Line 2 went according to plan and schedule. The FC funds were primarily used to finance the rolling stock, accompanying consulting services and the training of the operating and maintenance staff.

Key Results of the Impact Analysis and Performance Rating

According to information provided by the project-executing agency the share of Metro Shanghai in the total annual passenger volume in local public transport in the city of Shanghai is estimated at around 12%. This high share is the result of the existing underground network, which currently comprises the Lines 1, 2 and 3 as well as Line 5, and the coordination with aboveground bus traffic (which still requires improvement) and the connection with other means of transport (long-distance trains and the Transrapid). This market share will increase further once the expansion of the underground network is continued. Currently the following underground sections are under construction: The extensions of the existing Lines 1, 2 and 3 by 27 km, the new construction of Lines 4, 6, 8 and 9, which cover a total rail network of altogether 108 km. As a result the total rail network, including Line 5, will in the future comprise around 190 km.

The overall objective of Line 1 is the sustainable reduction of the time spent on daily travel between home and place of work. Originally, the indicators specified for the achievement of the objective were 0.7 million trips per day and 23,000 passengers per direction at the peak hour (as soon as the project had fully started operation). Originally, 16 metro trains were available to reach this objective. As soon as another 11 trains had been delivered the indicators for the achievement of the project objective were 1.0 million trips per day and 40,000 passengers per direction and peak hour (time horizon: 2005).

The passenger figures for Line 1 show that the project objective has not been achieved so far. In 2003 0.5 million trips were counted per day. The expected peak values were exceeded only in 2004, when 51,000 trips were counted during the peak hour in the northern direction on Line 1. Thus, the theoretic capacity limit was exceeded after a short period of time (138% of normal capacity and 104% of the maximum capacity).

The project objective pursued with Line 2 was the improvement of passenger transport. The indicator was the average passenger volume of 0.7 million passengers one year after commissioning. This objective was not achieved in June 2001(official start of operation was on June 11, 2000). With around 0.3 million passengers per day only 40% of the expected passenger volume was reached. However, recent figures from the last few months of the year 2004 (0.5 million passengers per day) show a positive trend. According to the project-executing agency the reasons of the low passenger figures on Line 2 are due to the lack of coordination between the metro and aboveground bus traffic. During the morning peak hour the normal capacity utilisation was 140% and maximum capacity utilisation was 106%.

Due to the passenger figures, the high market share of the Metro in Shanghai's total local passenger transport volume and the high average speed of the Metro of around 35 km/h as compared with the aboveground traffic of a maximum of 15 km/h (improvement of the traffic

situation/more fluent traffic) the overall objective of the two Metro projects can be considered as achieved.

The coverage of operating costs from the ticket revenue was over 100% in the years 2000 to 2003. In order to ensure the proper operation the project-executing agency, the Shanghai Metro Corporation (SMOC), does currently not require any capital contributions from its shareholders or any state subsidies – on the contrary, in the years 2001 and 2002 the corporation could even generate a substantial surplus, which was distributed to the shareholders.

Based on the cash-flow statement, which was drawn up on the basis of the existing financial data, we made a rough calculation of the real internal rate of return for Lines 1 and 2 in order to assess the advantageousness of the investment. The result of the calculations is a negative internal rate of return of -5.16% for Line 1 and of -4.3% for Line 2.

In view of the high importance of the underground system for the future development of local public transport we consider the risk of insufficient subsidies to be minimal with regard to the debt service, which accounts for less than 1% of the revenues of the City of Shanghai.

Also compared to the situation of the local public transport systems in Germany, the result of the microeconomic analysis is positive. On the basis of the information available to us, it has to be assumed that local public transport systems in Germany cannot cover operating costs from tariff revenues. In Germany as well the deficits are compensated by the regional authorities or through cross-subsidisation among supply companies of the municipal utility.

The overall assessment of developmental effectiveness of the two programmes can be summarised as follows:

- The objectives originally defined for Lines 1 and 2 in terms of passenger numbers were only partly achieved at the different points of time. Some of the project objectives formulated had been very ambitious. Due to the technical design of the project the capacity limit of Line 1 has already been reached during the peak hour. The same applies to Line 2. If longer trains are used and additional investments are made in the signal system of Line 1 the capacity can be considerably increased at a limited expense. The current market share of Lines 1 and 2 in the overall volume of public local passenger transport is quite substantial at 12% (sub-rating for the effectiveness of both projects: rating 3).
- In view of the high complexity of evaluating the macroeconomic effects, we decided against making any macroeconomic calculations. However, we do assume positive effects overall (increase in economic efficiency, time savings, creation of jobs, aggregate learning cost savings through technology imports and adaptation) that justify public subsidisation. We have taken into consideration that the long-term availability of public subsidies to cover the operation, debt service and reinvestment by Shanghai Metro Corporation is given (sub-rating of the efficiency of both projects: 3).
- The projects laid the basis for the development of a modern mass transport system. In retrospect, the point in time of project implementation was well-chosen since the project made a useful contribution to the long-term resolution of the serious traffic problems in the

City of Shanghai. The use of the FC funds paved the way for additional efforts to eliminate typical infrastructure bottlenecks in metropolitan areas. The further expansion of the metro network and the overall positive technology transfer illustrate the project's substantial capacity-building impacts for the sector as a whole. Thus, we classify the project's developmental relevance and significance as satisfactory (sub-rating of the relevance and significance of both projects: 2).

After weighing the sub-results and taking the required subsidisation of Metro Shanghai and the highly positive structural effects into consideration, due to its long-term impacts we assign the project altogether satisfactory development effectiveness (rating 2).

General Conclusion applicable to other Projects

- The present projects show that the introduction of a new inner-city, rail-based means of mass transport (metro or light rail system) does not necessarily reduce road traffic to any significant degree. In the case of the City of Shanghai the massive parallel expansion of the road network even led to a temporary increase in the average velocity on the roads, which quickly fell back to its former level due to induced traffic (yet at a higher traffic flow rate). The value-added of rail-based transport stems primarily from the fact that it enables the transport capacities to be expanded quickly, safely and on a broad scale without further increasing air pollution in the cities, which is usually very high already. In the case at hand, this capacity was utilized to only a small extent by people who abandoned the roads for the tracks (surely due in part to the tariff policy, especially the price difference compared to other alternatives such as busses or taxis); instead, the metro mainly catered to the increase in traffic that the roads were no longer able to handle (induced traffic). A direct consequence of this experience is that capacity utilisation frequently does not jump up rapidly. Rather, demand is slowly rising to match existing capacities. Therefore, (due to the mostly invariable design of central system components) underutilization of capacity will have to be accepted for a certain period of time. Accordingly, such solutions – as in this case – are only recommended for cities in which demand for transport will increase in the long term as a result of the dynamics of urban development (possibly supported by restrictions on individual traffic).
- Another experience to be applied in other, similar projects is that for inner-city, track-based means of mass transport the full costs and frequently also the operating costs cannot be covered from tariff revenues – even in cities where the conditions are as favourable as in many large Chinese cities. Even if the economic impacts (time savings for users, road safety, lower land requirements, environmental impacts) are clearly positive and justify the investments, a solution like this one is only recommended if the project-executing agency - as was the case here – has sufficient, reliable sources of revenue and if there is broad political consensus about the longer-term subsidisation of such systems.

Legend

Developmentally successful: Ratings 1 to 3	
Rating 1	Very high or high degree of developmental effectiveness
Rating 2	Satisfactory developmental effectiveness
Rating 3	Overall sufficient degree of developmental effectiveness
Developmental failures: Ratings 4 to 6	
Rating 4	Overall slightly insufficient degree of developmental effectiveness
Rating 5	Clearly insufficient degree of developmental effectiveness
Rating 6	The project is a total failure

Criteria for the Evaluation of Project Success

The evaluation of the "developmental effectiveness" of a project and its classification during the ex-post evaluation into one of the various levels of success described in more detail below concentrate on the following fundamental questions:

- **Are the** project objectives **reached to a sufficient degree (aspect of project** effectiveness**)?**
- **Does the project generate sufficient significant** developmental effects **(project** relevance **and** significance **measured by the achievement of the overall development-policy objective defined beforehand and its effects in political, institutional, socio-economic and socio-cultural as well as ecological terms)?**
- **Are the** funds/expenses **that were and are being employed/incurred to reach the objectives** appropriate **and how can the project's microeconomic and macroeconomic impact be measured (aspect of** efficiency **of the project conception)?**
- **To the extent that undesired** (side) effects **occur, are these tolerable?**

We do not treat **sustainability**, a key aspect to consider for project evaluation, as a separate category of evaluation but instead as a cross-cutting element of all four fundamental questions on project success. A project is sustainable if the project-executing agency and/or the target group are able to continue to use the project facilities that have been built for a period of time that is, overall, adequate in economic terms, or to carry on with the project activities on their own and generate positive results after the financial, organizational and/or technical support has come to an end.