Suburban Commuter Rail System
S-Bahn
Chongqing - Tongliang Testline

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Aim of the Feasibility Study

- Introduce the concept of the German S-Bahn in China
- Verify the feasibility of the Chongqing-Tongliang Testline (S-Bahn)
- Advise CRT on the most suitable S-Bahn concept (technical, operational, financial) for the introduction of such an S-Bahn
- Apply the advantages of the German S-Bahn system to the Tongliang Testline, addressing the local particularities and requirements for the most efficient project implementation
- Lay the foundation of the Chongqing S-Bahn network system with the Tongliang Testline
- Facilitate the implementation of the project
- Prepare & support a nationwide promotion of the S-Bahn concept introduced by CRT
German S-Bahn Historical Background

- About 100 years ago, cities were looking for electrically powered railways with high capacity but more reasonable investment costs than the metro.
- S-Bahn stands for Schnell-Bahn (German for „fast-railway“), which is supposed to link suburban areas and city centers with a direct access.
- The trains should not necessarily comply with the mainline railway standard but be able to share tracks and stations with the railway when running outside of town.
- Most of urban public transport systems are DC-traction powered. Since energy efficiency of AC-Systems for traction is now a requirement, dual-traction power systems were introduced within the last 20 years. Particularly, the Hamburg S-Bahn system has the greatest similarity with the case of Chongqing today.
S-Bahn Key Features

- S-Bahn connects suburban areas with city center
- Run-through operation, sharing infrastructure with other mass transit and main railway lines
- Limited investment, limited operation cost, starts with moderate passenger demand in suburban areas with the potential to deal with increasing demands later on
- S-Bahn can cope with high demand in city center similar to mass rapid transit system (metro)
S-Bahn Systems in Germany

Sharing Tracks with metro and mainline railway

Germany's S-Bahn trains
- share tracks with mainline passenger trains, freight and private passenger trains
- use the same signalling and operation control system
S-Bahn Systems in Germany
Sharing Infrastructure with metro and mainline railway

1. S-Bahn and Metro arriving at same platform
2. S-Bahn and Metro at same platform
3. S-Bahn departing
4. Metro departing
Why Tongliang Testline (S-Bahn)?

- Chongqing is one of China's major cities
- Chongqing becomes the economic center of Yangtze River in 2020
- Chongqing's development focus is the "one hour economic circle"
  - Connecting the main urban center with development nodes of the suburban area
- Tongliang is the only county within the "one hour economic circle" without railway connection to Chongqing
- Extension of the existing Metro to Tongliang is not reasonable
  - Long distances, high investment costs, low speed, passenger demand
- S-Bahn is the right solution
  - Multifunctional use of rail infrastructure
  - Promoting the idea of high demand in city center but lower demand and lower investment costs in the suburban area
S-Bahn System

Low Investment, Low Operation Costs

- More energy efficiency due to change from DC to AC traction power
- Low investment due to signalling system extension (change from moving block to fixed block system)
- Alignment at grade
- Flexible operation mode due to dual power rolling stock (some trains terminate in Bishan, some trains continue to Tongliang)
- It is recommended to extend the existing Metro line 1 OCC to integrate the Tongliang Testline (S-Bahn) from Bishan to Tongliang
- The OCC shall integrate all features currently installed within the SCADA-system as well as within the environmental control system
The run-through operation starts with 17 train sets equipped with the DC/AC dual-power traction package. In far future 27 dual-powered train sets will be required.
Station Design Bishan

Station Design Track Layout (two levels)

- Track layout enables high operational flexibility:
  - Separate operation and reversing of 1,500 V DC and 25 kV AC trains
  - Run-through operation from the Metro Line 1 section to Tongliang
  - Reversing on platform in case of operational disturbances by using track connections in front of the platforms
  - Independent operation of trains in the depot area (depot access tracks separated from reverse and stabling tracks)
Rolling Stock

Modular concept for DC (Metro), AC, and AC/DC trains
Rolling Stock

Metro type „B“ car Chongqing Line 1

Status quo situation of Motor car with Pantograph (1.5kV DC)
**Vehicle Gauge vs. Tunnel Clearance**

Options for reduction of height excess:

- Application of pantograph with lower lifting height above parking position in working position (<230mm)
- Application of pantograph with lower height in parking position
- Reduction of construction height of roof/ceiling (e.g. ventilation ducts)
- Lowering of car-ceiling in area of roof slot for pantograph

4,140 mm – above top of rail
Top of Chinese pantograph (working position 230 mm above parking position for 25kVAC)

100 mm in excess of tunnel clearance

4,040 mm – Tunnel clearance (Overhead catenary)

3,810 mm – above top of rail
Top of pantograph (parking position)

0.00 mm – Top of rail

Top of floor
Traction Power Supply

Innovative 3AC -1AC inverter traction power substation (low interference to grid, no neutral sections)

Standard transformer traction power substation in V-connection (low cost)
Infrastructure Investment Costs (European Standard)

Comparison of investment costs (per km):

- S-Bahn infrastructure (double track line) vs. Metro infrastructure

![Bar chart comparing investment costs of different S-Bahn types](image-url)

**Investment Costs of Metro-Systems**
Parking Facilities

- The operator shall build & operate parking facilities at the stations
- Providing car parking facilities for Park and Ride (P+R) services
  - increases the catchment area of the S-Bahn system
  - will help to limit cars entering the CBD
- Land adjacent to stations shall be linked to CRT
- The distribution and pricing of the parking facilities should be integrated into the S-Bahn fare system
The total investment is 4.154 billion RMB (500 million Euro)

The benchmark figure for Tongliang Testline is around 129 million RMB per km

Even if one assumes a cost increase of 20%, the total cost are more reasonable than those of LRT (300 million RMB per km) or Metro (500 million RMB per km) systems

The estimation does not consider cost for civil structures and land acquisition:

- Bishan station accounted to Metro line 1.
- The government of Tongliang and Bishan county has declared to finance the civil structure cost for the stations of Tongliang, Polv, Dalu, Baojia and cost for the land
Tongliang Testline (S-Bahn) is financially viable

- Calculation of Net Present Value (NPV) and Internal Rate of Return (IRR) from the viewpoint of the operator CRT
- Using cost and revenue cash flow streams
  - Tongliang Testline (S-Bahn) investment costs (CAPEX)
  - Tongliang Testline (S-Bahn) operating and maintenance costs (OPEX)
  - Fare box revenues are derived from the travel demand forecast
- Discount rate: 4.6%
  - Represents terms and conditions of promotional loans granted by KfW Bank.
- The NPV is 353.9 mn RMB, the IRR is 5.37%.
  - CAPEX may increase up to 9.3% to achieve a positive NPV.
  - Even if the ridership is 8.6% less than the forecasted patronage, the financial viability remains ascertained.
- The major portion of the revenues must be used to repay the loans
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