Overview of Singapore Land Transport System and Engineering Procedures in Developing Rail Transit Networks

Outline

• History of Singapore’s Land Transport
• Overview of Land Transport System in Singapore
• Overview of Development Process

• Engineering Procedure for RTS network
• A Way to Forward
• Conclusion
## History of Singapore’s Land Transport

### Transport in Colonial

<table>
<thead>
<tr>
<th>1950s</th>
<th>• Public Works Department (PWD)</th>
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<tbody>
<tr>
<td>1960s</td>
<td>• building road transport infrastructures – roads, bridges, pedestrian walkways</td>
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<tr>
<td>1970s</td>
<td>• public facilities – schools, hospitals, libraries</td>
</tr>
<tr>
<td>1980s</td>
<td>• In-charge of only 340km of public road from 1819 to 1920</td>
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<tr>
<td>1990s</td>
<td>• Poor regulation &amp; lack of enforcement</td>
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<tr>
<td>1995s</td>
<td>• Hampered to bring order to the transport system</td>
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### Early Public Transport System

<table>
<thead>
<tr>
<th>Decade</th>
<th>Issues</th>
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<tbody>
<tr>
<td>1950s</td>
<td>• Rapid population</td>
</tr>
<tr>
<td>1960s</td>
<td>• Public Bus System</td>
</tr>
<tr>
<td>1970s</td>
<td>• Pirate Taxis</td>
</tr>
<tr>
<td>1980s</td>
<td>• Traffic congestion, Serious flooding, No longer suitable to use 1958 land use &amp; master plan by colonial government</td>
</tr>
<tr>
<td>1990s</td>
<td>• 5000 illegal taxis, Negotiate fares, Service quality and safety</td>
</tr>
<tr>
<td>1995s</td>
<td>• No systematic transport planning, Lack of integration, Frequent breakdowns</td>
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### Long-term Integrated Planning

<table>
<thead>
<tr>
<th>Decade</th>
<th>Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950s</td>
<td>• United Nations Development Program (UNDP)</td>
</tr>
<tr>
<td>1960s</td>
<td>• 4 years State &amp; City Planning Project</td>
</tr>
<tr>
<td>1970s</td>
<td>• 1st Concept Plan in 1971</td>
</tr>
<tr>
<td>1980s</td>
<td>20 yrs planning...</td>
</tr>
</tbody>
</table>
Long-term Integrated Planning

1950s
- 1st Concept Plan in 1971
  - New towns
  - Transport
  - Infrastructures
  - Recreation access

1960s

1970s
- Lack of policy
- Lack of continuity in vehicle registration
- Insufficient financial & manpower

1980s

1990s

1995s

20 yrs planning...

Strategic Transport Plan
- Island-wide expressway networks
- Arterial roads
- MRT system

Reorganization of Public Transport Industry

1950s
- Bus Reforms

1960s
- Taxis Reforms

1970s
- Implementation of world’s first Congestion Pricing Scheme

1980s

1990s

1995s

1950s
- Merge all bus companies → 3
- Formation of single private entry “SBS”
- Integration of all bus routes
- Standardization of bus fares

• Parking Policy
Reorganization of Public Transport Industry

- Bus Reforms
- Taxis Reforms
- Implementation of world’s first Congestion Pricing Scheme
- Parking Policy

- Eliminate illegal pirate taxi industry
- Formation of National Trade Union Congress “NTUC”

- Formation Road Transport Action Committee (RTAC)
- Implement Area Licensing Scheme
Reorganization of Public Transport Industry

1950s
• Bus Reforms

1960s
• Taxis Reforms

1970s
• Implementation of world’s first Congestion Pricing Scheme

1980s
• Parking Policy

1990s
• Rising parking charges (CBD vs Non CBD)
• Impose charge on each lot own by private car park operators

1995s

1950s

Reorganization of Public Transport Industry

1950s
• The Great MRT Debate

1960s
• Government decision to proceed MRT (1982)

1970s
• Development of Integrated Transport

1980s
• Bus-Rail Vs All-Bus System ???
• Long term investment ???
Reorganization of Public Transport Industry

1950s
- The Great MRT Debate

1960s
- Government decision to proceed MRT (1982)

1970s
- Development of Integrated Transport

1980s
- Formation of “Mass Rapid Transit Corporation” operate MRT System
- Formation of “Transit Link” (1989) to integrate bus and train service

1990s

2000s

2030s
Formation of Single Integrated Land Transport Agency

- Formation of “Land Transport Authority (LTA)” in 1995
- Implementation of “Electronic Road Pricing System (ERP)” in 1998, after 9 years of study, trials and re-tenders....

To integrate all aspect of land transport from planning to regulations

- Build Roads + Train Networks + Infrastructure
- Act as regulator for Performance Standard
- Spearhead Public Transport Related Needs

Implementing Electronic Road Pricing system

- Formation of “Land Transport Authority (LTA)” in 1995
- Implementation of “Electronic Road Pricing System (ERP)” in 1998, after 9 years of study, trials and re-tenders....

Automated version of Area Licensing Scheme (ALS)

- Improvements
  - Flexibility to vary charges (time, place, traffic condition)
  - Better manage road congestion
  - Minimize traffic volume
  - No more monthly / daily license
  - No human errors
Long-term Integrated Planning

1950s
1960s
1970s
1980s
1990s
2000s
2030s

Long range plan
Review every 10 years

Key Strategies?

- Plan for “Land Use + Transport Network” together
- Reduce need for people to travel
- Maximize accessibility to public transport services
- Emphasis on public transport
Integrated Land Use, Town & Transport Planning

• Balance between different demands for land usage
  ✓ Housing
  ✓ Business
  ✓ Transport
  ✓ Health
  ✓ Sustainability & Recreation

• Factor in changes (Local & Global trends)

• Ensure to address future possible challenges and needs

What “LTA” do?

• Macro Level (Concept Plan)
  ✓ Land-use planning
  ✓ Major transport infrastructures
  ✓ Safeguard transport corridors

• Micro Level
  ✓ High density commercial & residential development Vs Major transport modes
  ✓ Facilitate seamless travel by commuters
  ✓ Encourage public transport usage
The Quality Service Manager Office (QSMO) and Internal Audit Division report directly to CE.

Overview of Land Transport System in Singapore
Evolution of the Rail Network

- **1987**: Bishan Depot - NSL, EWL
- **1988**: Ulu Pandan Depot - NSL, EWL
- **1989**: Changi Depot - EWL
- **2003**: Senkang Depot - NEL
- **2009**: Kim Chuan Depot - CCL, DTL
- **2013**: Gali Batu Depot - DTL
- **2016**: Tuas Depot - EWL
Depot for MRT Lines

- **Services**
  - ✔ Stabling of the trains
  - ✔ Maintenance
  - ✔ Operational control

- **Components**
  - ✔ Stabling yard
  - ✔ Test track
  - ✔ Control room
  - ✔ Rail administration building
  - ✔ 66kV substation
  - ✔ Training centre
  - ✔ Maintenance facility

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**Depot for MRT Lines**

*World's first 4-in-1 depot*

A new 36ha depot will be built to house 220 trains for the Thomson-East Coast Line, East-West Line and Downtown Line. Said to be a world’s first, the depot will also house 550 buses. By integrating the depots, the Government expects to save 4ha of space, or about 60 football fields.
Developing a Comprehensive Road Network

Integrated Transit with Developments

- Integrated Transport Hubs
  - Train station
  - Bus interchange
  - Commercials (shopping malls)

Choices of public transport
Good connectivity
Convenience
Automobile Dependent Cities vs Cities with “Balanced” Transport

Adjust cities to cars
- Extensive construction of freeways → fast travel by car
- Transit services neglected → auto dependency: traffic congestion
- Pedestrians neglected
- Retail & many other activities relocated from central cities to suburban malls

Develop integrated transport systems:
- Improve public transport services parallel with highway/ street growth
- Develop coordinated modes
- Pedestrians encouraged
- Enhance cities’ livability → sustainability

Challenges in Land Use for Travel Needs

- Higher demand from economic growth
- Higher public expectation
- Growing population
- Scarcity of Land
Land Use Plan for Singapore’s Future Population

New Transport Strategy

- Land Transport Master Plan 2013
  - Make public transport as 1st choice
  - Reduce dependency on driving
  - Manage road usage
  - Meets diverse needs of people

“People-centred Land Transport System”

Source: Land Transport Master Plan 2013 Report, Land Transport Authority
Design & Construction

Development Process of Transport System

Long Term Plans (40 – 50 years)  |  Medium Term Plans (10 – 15 years)  |  Short Term Plans (5 – 10 years)

- Concept
- Planning & Master Plan
- Transport Project Feasibility Study
- Design & Construction

Multiple Agencies

- Road Development Programme
- Rail Lines Implementation Plan
- Bus Routes & Infrastructure Development

Land Transport Authority
Different Stages in Developing Rail Project

1. Developing RTS route options and scheme
2. Consultation with agencies and authorities
3. Consultation with internal LTA divisions
4. Engineering Investigation works
5. Obtain approval
6. Handover stage
Planning / Feasibility Study

1. Developing RTS route options and scheme

- **Identify & develop**
  - Railway corridor
  - Station locations
  - Station Interchanges
  - Conceptual mode of operation (Loop, spur, shuttle)
  - Depot location & size
  - Train stabling location & size
  - Integrated transport facilities & size

- **Considerations**
  - Future developments
  - Potential sites for integrated developments

- **Investigation Works**
  - Topographical Survey
  - Trial Trenches
  - Condition & Foundation Survey
  - Preliminary Soil Investigation Works
  - As built drawings

Planning / Feasibility Study

2. Consultation with agencies and authorities

- URA, DSTA, HDB, JTC
- PUB, EMA, IDA
- Nparks
- Land ownership issue, Integrated development in future & Redevelopment around RTS
- Consultation with External Agencies & Authorities
- Heritage Road, Heritage Trees & Tree conservations area within corridor
- Possible constraints by future & existing utilities & services
3. Consultation with internal LTA divisions

- Technical Support
  - Engineering
  - Safety & Contracts
  - Support from Internal Division

- Contractual, Costing & Scheduling Support

- Traffic Measures & Management of Traffic Matters

- Obtain Cabinet’s In-principal Approval & 1st DPC Approval

- Topographical survey & land matters
- Geotechnical & tunneling
- Architecture

- Rail

4. Consulting and advice on Transit Regulations & Operational Interface

5. Obtain approval

- Refine and select RTS route options
- Seek LTA senior management in-principle approval
- Conduct the viability study
  - Economic viability
  - Financial viability

- Obtain Provisional Planning Approval (PPA)
- Obtain Cabinet’s In-Principle Approval
- Submit Project Briefing Paper* to LTA Board of Directors
  *Proposed project budget, Contract value, Project programme, Justifications for the project
Planning / Feasibility Study

6. Handover Stage

- Complete set of Economic & Financial Viability Reports
- Alignment scheme and options reports & plans
- Station Locations
- Interchange Locations
- Conceptual plan on mode of operation
- Depot and Train Stabling Site/ Size
- Landuse consultations
- Target sites for integrated developments
- Information on future developments
- Information on major utilities affecting RTS line
- Building for underpinning/ acquisition
- 1st Development Planning Committee (DPC) approval

Different Stages in Developing Rail Project

1. Concept Design
2. Detailed Design
3. Consultation with external parties
4. Consultation with internal LTA divisions
5. Engineering Investigation works
6. Obtain approval
7. Handover for construction

<table>
<thead>
<tr>
<th>Approaches</th>
<th>Concept Design</th>
<th>Detailed Design</th>
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<tbody>
<tr>
<td>Design &amp; Build</td>
<td>LTA or its consultant</td>
<td>Main Contractor</td>
</tr>
<tr>
<td>Architect/ Engineer Design or Build Only</td>
<td>LTA or its consultant</td>
<td>Architect/ Engineer consultant</td>
</tr>
<tr>
<td>In-house Design</td>
<td>LTA or its consultant</td>
<td>LTA</td>
</tr>
</tbody>
</table>
## Engineering Design

### 1. Concept Design

<table>
<thead>
<tr>
<th>Develop</th>
<th>Finalize</th>
<th>Investigation Works</th>
</tr>
</thead>
</table>
| • Conceptual Architectural design  
• Conceptual C&S design  
• Conceptual E&M services design  
• Conceptual Railway system design  
• Preliminary staging plan  
• Conceptual Integrated Development Plan  
• Conceptual Railway Interfacing Plan  
• Conceptual Traffic & Utilities Diversion Plan  
• Preliminary Hazard Analysis  
| • Plan on mode of operation  
• Station size and footprint for FPA  
• Rolling stock and systems requirements  
• Cost estimate for project  
• Contract Document for A/E or D&B (if any)  
| • Additional Topographical Survey  
• Additional Trial Trenches  
• Detailed Soil Investigation Works  
• As built Drawings  |

### 2. Detailed Design

#### Design of Civil Works
- Design brief for Architectural, C&S and G&T Works
- Alignment Plans
- Trackworks Design
- Station and Tunnel/Viaduct Design
- Interchange/Depot Design
- Train Stabling Facilities Design
- Traffic / Utilities Diversion Plan
- Integrated Developments Plans & Design
- Staging Plans
- Construction Methodologies
- Cost Estimates
- Civil Contract Documents

#### Design of E&M and Systems Works
- Railway systems design
- E&M services design
- System Integration requirement
- System/safety Assurance requirement
- Plantrooms space allocation and optimisation
- Power intake location and Power Simulation
- Signalling simulation and Tunnel ventilation strategy
- EMC philosophy
- Hazard study
- Testing and Commissioning Plan
- Energy conservation measures
- Maintenance Philosophy
- ADRP, Development Control, Building & Structural Plan Submissions etc

#### Further Detailed Investigation Works (if necessary)
- Additional Topographical Survey
- Additional Trial Trenches
- Detailed Soil Investigation Works
3. Consultation with agencies and authorities

Consultation with External Agencies, Authorities & Technical Departments

- Development Control Approval
- URA
- Structural & Building Plan Approvals
- BCA
- Trees Planting, cutting & relocation
- Nparks
- Service & utility diversion
- Pollutin Control
- FSSD
- Matters on fire safety & Civil Defence shelters for underground RTS system
- PUB, EMA, IDA
- NEA

4. Consultation with internal LTA divisions

Consultation with External Agencies, Authorities & Technical Departments

- Planning support safeguarding & Development of RTS
- Contractual, Costing & Scheduling & Safety Support
- Constructability
- Advice on Transit Regulations & Operational Interface
- Planning
- Safety & Contracts
- Rail
- Corporate Development Research
- Traffic Management
- Traffic Measures & Management of Traffic Matters
- Vehicle & Transit Licensing
- Obtain 2nd DPC Approval & Approval from MOF
Engineering Design

6. Obtain approval

Consult with relevant external agencies & authorities on finalized design proposal & obtain their principal approvals

Obtain Final Planning Approval from Master Plan Committee

Cost Optimization by Strategic Project Governance Committee

Seek 2nd Development Planning Committee’s approval

Seek Internal Approving Authority for funding to commence the construction of RTS

Choice of Implementation Approach

Different Stages in Developing Rail Project

<table>
<thead>
<tr>
<th>Pre-Construction Work</th>
<th>Construction Works</th>
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<tbody>
<tr>
<td>Site Clearance and Setup</td>
<td>Foundation Works</td>
</tr>
<tr>
<td>Setting out</td>
<td>Temporary Works</td>
</tr>
<tr>
<td>Additional Soil Investigation Works</td>
<td>Station and Tunnel Construction</td>
</tr>
<tr>
<td>Additional Topographical Survey</td>
<td>E&amp;M and System Works</td>
</tr>
<tr>
<td>Additional Trial Trenches</td>
<td>Architectural Works</td>
</tr>
<tr>
<td>Services/ Utilities Diversion</td>
<td>Testing and Commissioning</td>
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<tr>
<td>Traffic Diversion</td>
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<tr>
<td>Drainage works</td>
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<tr>
<td>Demolition</td>
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<tr>
<td>Pre-Conditional Survey</td>
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</table>
Construction

Internal Support

- Obtain Approval for any variation in project budget from MOF/DPC
- Traffic Measures & Management of Traffic Matters
- Review approval of AIP submission
- Corporate Development
- Research
- Engineering
- Traffic Management
- Safety & Contracts
- Planning
- Contractual, costing, scheduling & safety support
- Planning support
- Safeguarding & Development of RTS
- Advice on Transit Regulations & Operational Interface

Construction

Obtain Approval

 Obtain MOF/DPC approval for variation in project budget → Seek IAA → Handover to Operator
A Way to Forward

**2013**
- Opening of Downtown Line 1
- 31 real-time bus arrival info panels

**2014**
- Opening of North-South Line Extension
- 13 more trains for NS-EW
- 13 more trains for Bukit Panjang LRT
- Completion of the bulk of BSEP improvements
- Introduce Quality Incentive Framework to Improve regularity of Bus Waiting Time
- Completion of more racks to secure 3000 bicycles at 32 MRT stations
- Install 30 CCTV cameras to deter illegal parking
- Revise the Carbon Emissions based Vehicle Scheme

**2015**
- 42 trains for NEL & CCL
- Pilot bicycle sharing scheme at Jurong Lake District
- Implement common bus fleet management system for all PT buses
- Extend Green Man Plus Scheme to another 500 crossings

**2016**
- Opening of Downtown Line 2
- Tuas West Extension
- North-South line re-signaling
- 28 trains for NS-EW
- 16 Train-cars for Sengkang & Puggol LRTs

**Short Term Initiative**

Source: Land Transport Master Plan 2013 Report, Land Transport Authority
A Way to Forward

Medium Term Initiative

2017
• Opening of Downtown Line 3

2018
• Completion of Walk2Ride programme
• Install lifts at 40 POBs
• Complete East-West Line re-signalling

2019
• Opening of Thomson Line 1

2020
• Opening of Thomson Line 2
• Add 90km of off-road cycling paths to more HDB towns to bring the total network to around 190km
• Complete North-South Expressway
• Install 20km of rail noise barriers

2025-2030
Opening of Cross Island Line
Opening of North East Line Extension
Complete an Island-wide cycling path network of over 700km

2021-2025
Opening of Eastern Region Line
Opening of Jurong Region Line
Opening of Circle Line Stage 6
Opening of Downtown Line Extension
Complete 7 more Integrated Transport Hubs

Long Term Initiative

Source: Land Transport Master Plan 2013 Report, Land Transport Authority

A Way to Forward

2030

8 in 10 households living within a 10-minute walk from a train station

85% of public transport journeys less than 20km completed within 60 mins

75% of all journeys in peak hours undertaken on public transport
Conclusion

50 Years of Transportation

Principles for urban governance

• Strong governance structure
• ‘Whole-of-Government’ approach
• Think Long-term for good urban governance
• Sound economic principles for sustainability

Key strategies for sustainable transport

• Integrated master planning for transit-oriented development
• Build a quality, efficient and sustainable public transport system
• Managing road usage
• Ensure environmental & social sustainability

Advanced planning …

Whole-of-government exercise …

People-centered Transport system …

City with balanced transport …

All of us use land transport, from the pavements on which we walk, to the trains, buses and other vehicles that carry us and the roads that these vehicles use. We’d like the land transport system to get us safely, efficiently, reliably and comfortably to our destination.
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References

• Cliff Lee. PPT. Land use planning: The Singapore Experience
• Overview of Singapore’s Land Transport Development 1965–2015