Systems Thinking in Public Transportation

Ngien Hoon Ping | Chief Executive, Land Transport Authority
We keep your world moving
Our work begins... the moment you step out of your home

- **143,966** goods vehicles
- **102,800** street lights
- **143,052** Motorcycles
- **603,763** cars
- **17,554** buses
- **9,232** Kilometres of roads
- **119** MRT stations
- **43** LRT stations
- **4,961** Bus stops & Taxi stands
Land Area is a constraint.
Singapore

Land Area:
721.5 km²

Road Use:
12% of Land Area

Population:
5.64mil

Nominal Gross Domestic Product: S$447.3 billion

Annual Tourist Arrivals:
17.4mil
The land constraint presents many challenges.
Driving Forces

Shrinking Workforce
0.7 citizens entering to one exiting workforce

More Populous
Overall population will grow by 1 to 1.4M; higher travel demand

Ageing Population
Elderly accounts for 60% of population growth

Greater aspirations
Commuters are more vocal but also more willing to contribute

Ageing Assets
Ageing of key roads/rail assets and transport & operational technical systems

Disruptive Technologies
Rapid advancement of faster and smarter transportation technology is reshaping journeys
The Land Transport Ecosystem

- Public Transport Operators
- Union
- MOF
- Government Agencies
- LTA
- Ministry of Transport
- Commuters
- Vendors
- Political Office Holders
- Overseas Players
- Overseas Players
Public transport... is an **engineering problem**, where the network has to be mapped out to have the right connections and coverage, and designed for easy and effective maintenance. It is also an **economic problem**, where the various players like operators, asset owners, Government and commuters will have the right incentives to do the right things. And at an even more difficult level, public transport is a **sociopolitical problem** — an economic mobiliser and social equalizer.

-PM Lee's views on public transport
  — abstract from SUTD ministerial Forum, 5 April 2018
Systems Thinking

“Systems Thinking enables you to grasp and manage situations of complexity and uncertainty in which there are no simple answers. It’s a way of learning your way to effective action by looking at connected wholes rather than separate parts.”

“Systems Thinking is a framework for seeing interrelationships rather than things, for seeing patterns rather than static snapshots. It is a set of general principles spanning fields as diverse as physical and social sciences, engineering and management.”

- International Council on Systems Engineering (INCOSE)
Large Scale Transport System

Need

Limitations

Stakeholders

Sustainability

Optimisation

Critical Systems Design Considerations

Feedback
Walk Cycle Ride SG as our strategy

WCRSG envisions a land transport system that meets the needs of commuters and businesses through a host of quality options.
Rail Reliability
We are working with operators to improve rail reliability, with targeted Mean KM Between Failure (MKBF) for MRT lines at 1 mil by 2020.

As of Nov 2018 MKBF – MRT 661,000km

New Rail Financing Framework
LTA is taking over assets from operations as a move to achieve:

- More responsive to increased ridership
- Focus on providing reliable services
- More competitive rail industry

Rail Renewal
Including sleeper replacement, signaling system, new trains, power supply works, and so on.
A reliable public transport network
Renewal works for North-South and East-West Lines

6 Core Systems – 3 Done, 3 to Go!

Sleeper Replacement **Completed**
- 188,000 wooden sleepers replaced with concrete sleepers

Power Rail Replacement **Completed**
- 12,000 pieces of power rail replaced

Resignalling **Completed**
- NSEWL

Upgrading and renewal of power supply system
**Ongoing**
- Reduce power-related faults
- Real-time monitoring
- Better fault prediction, detection and identification

Track circuit replacement
**Ongoing**
- Detect location of trains on the track
- Speedier recovery from a signalling system failure

66 first-generation trains
**To be replaced**
- New trains will have:
  - Sensors to monitor performance
  - Imaging sensors and laser scanners to detect early signs of anomalies
Early Closure Late Opening
Improvements to enhance maintenance

Condition Monitoring Vehicle
Real-time monitoring of rail network to predict and fix faults before they occur

‘Smarter’ Trains are equipped with condition monitoring tools; tapping on data analytics
Design for O&M

Embedded inputs from PTOs early when designing and building new railway systems.

Example flowchart for depot design

1. PTO workshop engagements
2. PTO involvement in design acceptance review
3. PTO participation in project delivery
4. PTO jointly conduct handover/takeover inspection & acceptance
5. Assessment & feedback by PTO
6. PTO jointly review enhancement proposal

Conceptualisation of RTS
Depot Design Development
Depot Design Acceptance
System Interfacing Works
Completion of Depot
Depot Enhancement
O&M
Design for O&M

Incorporated DFOM considerations with PTOs early when designing and building railway systems.

Tuas West Depot
Workshop inspection pit to adopt 1.55m clear height from the rail to the grating provision, compared to varying height in the past.

Mandai Depot
Mechanised Overhead Cranes that are able to lift up to 10ton and improve workflow in depot, compared to 8ton in previous depots.
Beyond good engineering design, it is important to bring fore the needs of the O&M Phase to achieve and deliver the full life cycle performance of the rail network.
Network Effectiveness
We are building more rail lines to improve connectivity.

- Rail Lines Opening

- **2019**
  - Thomson-East Coast Line Stage 1
  - North South Line Canberra Station

- **2020**
  - Thomson-East Coast Line Stage 2

- **2021**
  - Thomson-East Coast Line Stage 3

- **2022**
  - Thomson-East Coast Line Stage 5
  - Downtown Line 3 Extension

- **2023**
  - Thomson-East Coast Line Stage 4

- **2024**
  - Circle Line 6

- **2026-2028**
  - Jurong Region Line Stages 1-3

- **2030**
  - North East Line Extension
  - Cross Island Line

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**360km**
Rail network by 2030

**8 in 10**
Households will live within 10 minutes walking distance of a train station
Road Network
Dynamically routed bus services can optimize transport resources and improve demand-response.

**Normal Bus Services**
- Buses ply fixed routes
- Demand aggregated at designated bus stops

**Demand Responsive Bus Service**
- No fixed schedules
- On-demand, dynamic routes
Satellite technology to enhance road usage with smart and comprehensive road traffic management.
Localised control of traffic with smart traffic lights, giving priority to emergency vehicles and public buses.
Simulation of traffic schemes and infrastructure to aid planning and design (e.g., KPE & MCE design)

- Highly detailed road geometry & lane markings
- Simulation of drivers’ granular behaviours (e.g., lane changing, acceleration, deceleration)
- Capabilities for impact analysis such as delay in travel time, queue length at junction
We are developing AV technologies for public transport and point-to-point mobility services, with pilot deployment in Punggol, Tengah, and Jurong Innovation District.

(Year 2022 and after)
Cycling Network
We are enhancing first-and-last-mile connectivity and experience.

Build more **covered walkways** to allow pedestrians to walk more comfortably

Collaborate with **bicycle sharing** companies to encourage responsible shared bicycle use amongst the public

Implement **licensing** to ensure safety while allowing private hire cars as an alternative to taxis
Enhancing commuters’ experience with digital services

MyTransport.SG 2.0

Personalization
Set daily journeys on the home screen and subscribe to real-time transport alerts.

Multimodal Journey Planner
Informs commuters of nearby bus services and MRT stations will help commuters plan journeys across different transport modes.

One.Motoring Site
Vehicle Owners can use SingPass or CorpPass two-factor authentication (2FA) for new digital services:

- Transfer of vehicle ownership
- Transfer of PARF and COE rebate
- Transfer of temporary COE
- Vehicle Deregistration

Enhances productivity and reduces the transaction time required
Enhancing commuters’ experience with smart technologies

Hands-free Fare Gates will enable people with disabilities to enter and exit train stations with ease by eliminating the need to tap their fare cards at the gates.

Account Based Ticketing (ABT) enables commuters to use their credit or debit cards with contactless function for fare payments. There will be no need for upfront top-ups and your train and bus fares will be processed and charged to your credit card.
Working With Our Partners
Land Transport Industry Transformation Map (ITM) to prepare the industry for the next lap

Officially launched in Feb 2018, together with tripartite partners

 Targets by 2030:
- 75% of peak hour trips by public transport
- 1,000,000 train-km travelled between delays >5 min by 2020
- 85% of public transport trips (<20km) completed within 60 min
- Up to 8,000 new bus and rail jobs
Working closely with tripartite partners

Vision: An innovative land transport industry enabled by technology and a highly competent workforce

Leverage Technology
Leverage emerging technologies to improve productivity and deliver safe, efficient and reliable transport system for commuters

Workforce Planning and Development
Upskill/reskill public transport workers to keep pace with technological advancement and encourage continual learning

Enterprise Development
Build local capabilities especially in mission-critical areas to enhance value capture and internationalisation

LTA, industry companies and the union working together to implement the ITM
1. Make WCR your preferred way to travel, as the future of land transport must be car-lite to be sustainable;

2. Make WCR travel options to be easier and more inclusive to meet the needs of all Singaporeans as our society ages and matures; and

3. Enhance land transport system for liveability, through safer roads and paths, cleaner and quieter environments, or freeing up land for more community spaces.
Thank You