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Comprehensive Planning of the Rail Transportation System(2/2)- The Study of the National Policies for Rail System Development

Summary Report

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Summary Report

Institute of Transportation, MOTC

Institute of Transportation
Ministry of Transportation and Communications

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ABSTRACT

One of the principal policies for Taiwan's transportation agencies to mitigate intercity and urban traffic congestion and increase usage of public transit is the growth of the railway system. Due to common problems such as long planning and construction periods, restrictive budgets, and unsustainable operations, local railway development has been slow.

By reviewing the literature of rail transportation policies in various countries and analyzing domestic land use and rail development trends, this study makes the following recommendations for Taiwan's railway system: (1) facilitate a trans-island loop and intercity transportation, (2) connect the nation's major cities, and (3) provide flawless trunk line services in metropolitan areas.

These visions reflect the core values necessary to satisfy travelers' expectations, guide transit-oriented land use and development and efficiently manage transportation resources. With said visions and core values completely implemented, the railway system in Taiwan may be able to achieve the following goals: (1) becoming travelers' first choice in transportation by providing superior services, (2) providing the foundation for flawless transportation through an integrated transit network, (3) developing primarily along rail corridors through a tight connection with urban and rural activities, and (4) developing a sustainable system by inheriting and innovating rail culture.

For these purposes, this study performs a comprehensive assessment of the current rail practices and the most recent plans for future development, as well as an analysis of general constraints in Taiwan. This study also blueprints a complete rail framework and establishes key policies with 20 initiatives that guide rail transportation to do the following: (1) provide safe, reliable and efficient rail services, (2) develop organized and flawless rail transportation systems, (3) enhance intercity rail services, (4) improve urban rail framework, (5) embrace green transport, and (6) complete institutional infrastructure.

ABBREVIATIONS

BOHSR: Bureau of High Speed Rail
CEPD: Council for Economic Planning and Development
CK: Chu-Kuang Express
DORH: Department of Railways and Highways
DORTS: Department of Rapid Transit Systems
DOT: Department of Transportation
EMU: Electric Multiple Units
HSR: High Speed Rail
KCG: Kaohsiung City Government
KMRT: Kaohsiung Mass Rapid Transit
LRT: Light Rail Transit
MOTC: Ministry of Transportation and Communications
MRT: Mass Rapid Transit
MRTB: Mass Rapid Transit Bureau
TB: Transportation Bureau
TC: Tze-Chiang Limited Express
TCG: Taipei City Government
TMRT: Taipei Mass Rapid Transit
TOD: Transit Oriented Development
TRA: Taiwan Railways Administration (may be referred to as the TRA rail)
TSC: Taiwan Sugar Corporation
RRB: Railway Reconstruction Bureau

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PREVIEW

1. Background

To reduce intercity and urban traffic congestion and encourage citizens to use public transit, many of Taiwan's transportation agencies have focused on continuous railway development as their principal policy. Local rail transportation has developed slowly due to such obstacles as long planning and construction periods, restrictive budgets, and unsustainable operations. By reviewing the literature of rail transportation policies in various countries and analyzing Taiwan's own rail development issues, this study proposes visions, spatial network plans, and policy initiatives for future domestic rail development.

2. Objectives

- 2.1 Learn about domestic and foreign rail development policies and trends.
- 2.2 Identify current practices, potential topics, and policy guidelines for Taiwan's rail system (including such aspects as infrastructure, plans, organizations, and so on).
- 2.3 Propose rail development visions and programs for government authorities' reference.
- 2.4 Reexamine and then direct rail policies to timely meet the needs of national development and properly allocate rail resources.

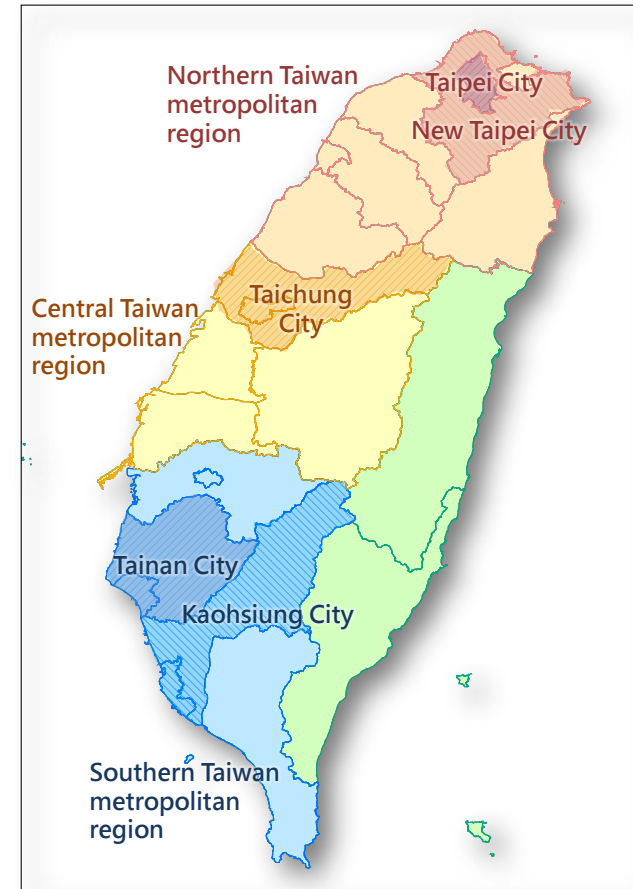
3. Study Scope and Period

3.1 Study scope

- (1) Intercity transportation covers the entire area of Taiwan.
- (2) Regional transportation primarily focuses on the northern, central, and southern metropolitan regions in western Taiwan.
- (3) Urban transportation primarily focuses on the five municipal cities, which are Kaohsiung, New Taipei, Taichung, Tainan and Taipei (directly under the jurisdiction of the Central Government), as well as Taoyuan.

3.2 Planning period

Due to the rail's long construction and operation spans, as well as extensive effects, the planning period for this study is 30 years with a demand forecast year of 2040.



Study areas

4. Contents

- 4.1 Define Taiwan's current rail development policies and future planning directions.
- 4.2 Analyze Taiwan's rail development, passenger and freight growth trends, the rail transportation market, and related topics.
- 4.3 Propose programs for Taiwan's rail development.
- 4.4 Specify principles and quantitative criteria for key issues.
- 4.5 Form visions, goals, objectives, and policy initiatives regarding different (intercity and urban) rail systems.
- 4.6 Coordinate between the industry, government, academic, and research sectors for more feasible and accurate execution plans.

5. Brief Findings

- 5.1 The domestic policy documents have revealed that the development of rail transportation needs to be integrated cross-disciplinarily. Domestic prompts include:
 - (1) Safety enhancement is the top priority for rail development.
 - (2) The high speed rail (HSR), Taiwan Railways Administration (TRA) rail, and urban mass rapid transit (MRT) systems should have their own development policies based upon the market segmentation.
 - (3) Cross-mode integration is essential for improving the rails' operational environment.
 - (4) Improving administrative and organizational programs and introducing private investment are essential.

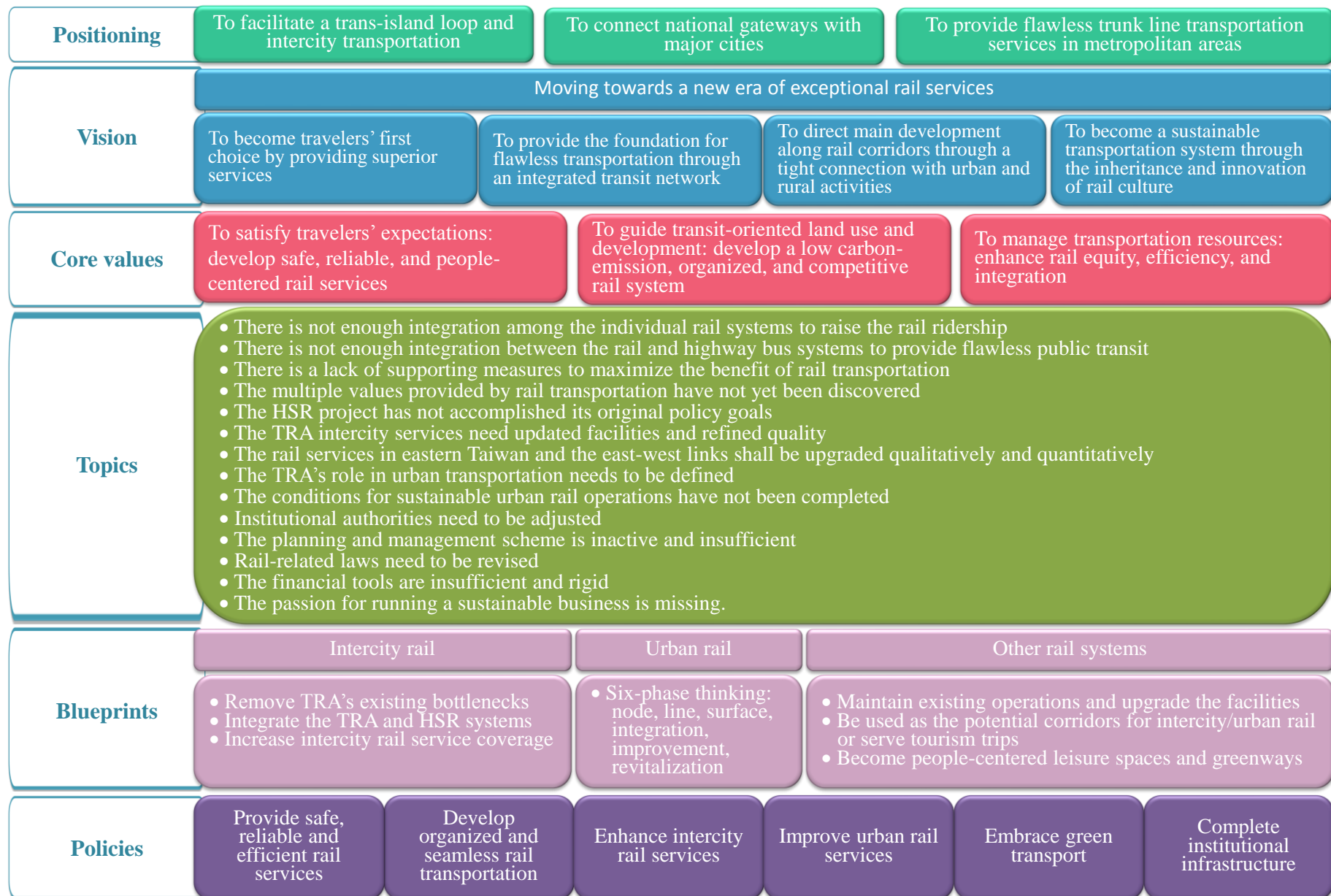
5.2 Prompts of foreign rail development policies include:

- (1) Dedicated organizations.
- (2) Specific policy goals and definitions for rail safety, capacity, and reliability.
- (3) Consideration of the social and cultural functions of rail transportation.
- (4) Rail freight incentives.
- (5) Service-oriented rail passenger transport policies.
- (6) Recognition and adoption of rail transportation as environmentally friendly.
- (7) Creation of the pay-as-you-go concept to fund rail projects and the internalization of private modes' social costs.

5.3 Private vehicles have traditionally dominated Taiwan's transportation market, but as the HSR and urban MRT systems continue to operate, rail ridership increases.

- (1) Before the operation of National Highway No. 1, the annual rail growth of passengers was 3.25% and that of passenger-km was 6.76%.
- (2) After the operation of National Highway No.1 began, the annual rail growth of passengers dropped to 1.21% and that of passenger-km dropped to 0.9%.
- (3) After the launch of Taipei MRT, the annual rail growth of passengers jumped to 11.59% and that of passenger-km jumped to 6%. This shows how simply supplying the rail option can effectively shift the transportation market.

5.4 Strategic framework for rail development in Taiwan



Strategic framework for rail development in Taiwan

6. Six Recommendations

6.1 Coordinate for the benefit of rail development and accordingly harmonize construction and operations.

- (1) Central competent authorities should start the process for coordination among agencies and establish guidelines for rail development.
- (2) Local governments should verify the viability of each individual rail project through comprehensive transportation planning.
- (3) The general public should participate and share their opinions in the policy making process in order to support and direct public transit policies.

6.2 Establish and refer to rail development indicators to distribute resources.

- (1) Said rail indicators should be periodically investigated and examined.
- (2) Passenger satisfaction surveys can help complement the rail indicators.
- (3) These rail indicators can be used for allocating funds in the transportation budget.

6.3 Reinforce rail transportation programs for better qualitative and quantitative services.

Rail authorities should coordinate both horizontally and vertically and build teamwork relationships during respective rail projects. Improved rail services rely on a rolling review of the operational status, as well as of subjective and objective circumstances.

6.4 Utilize transportation environmental management measures to increase rail transportation's competitiveness.

Push-and-pull strategies can encourage public transit ridership and create better rail development.

6.5 Accelerate cross-disciplinary integration to fund rail construction through various sources.

Both central and local authorities should accelerate cross-disciplinary integration and focus on establishing cooperative mechanisms and legal deregulation that would enable the introduction of various rail funding sources, thus allowing for a better transportation

system.

6.6 Accelerate fundamental database construction, technical research, and professional cultivation and succession.

High-quality planning, evaluation, and decision making relies on having complete databases. Technical research and development, as well as professional cultivation and succession, are essential to fulfilling the visions of rail transportation.

INTRODUCTION

7. Existing Rail Networks

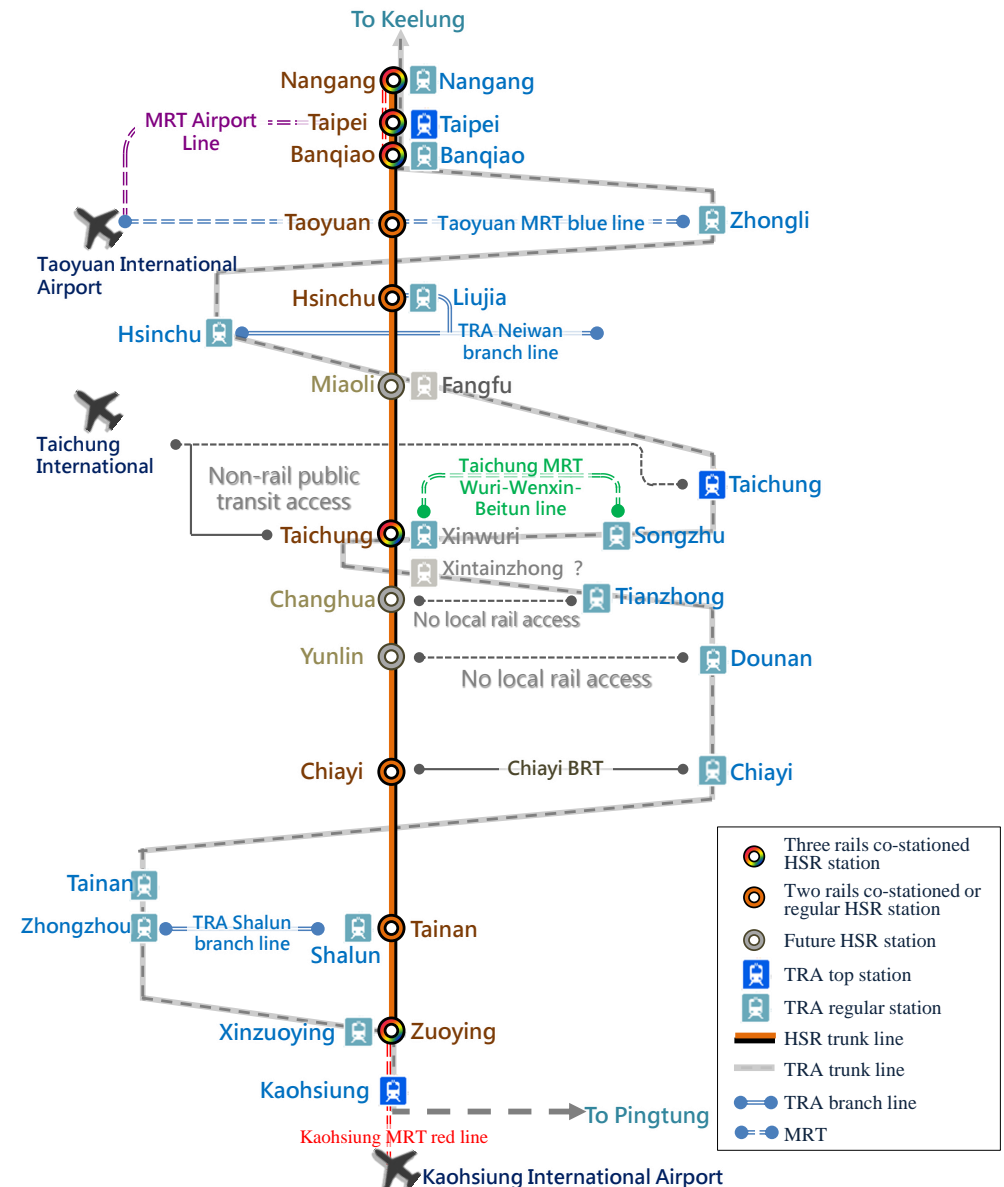
7.1 Current railway framework

Current rail systems and terminals in Taiwan

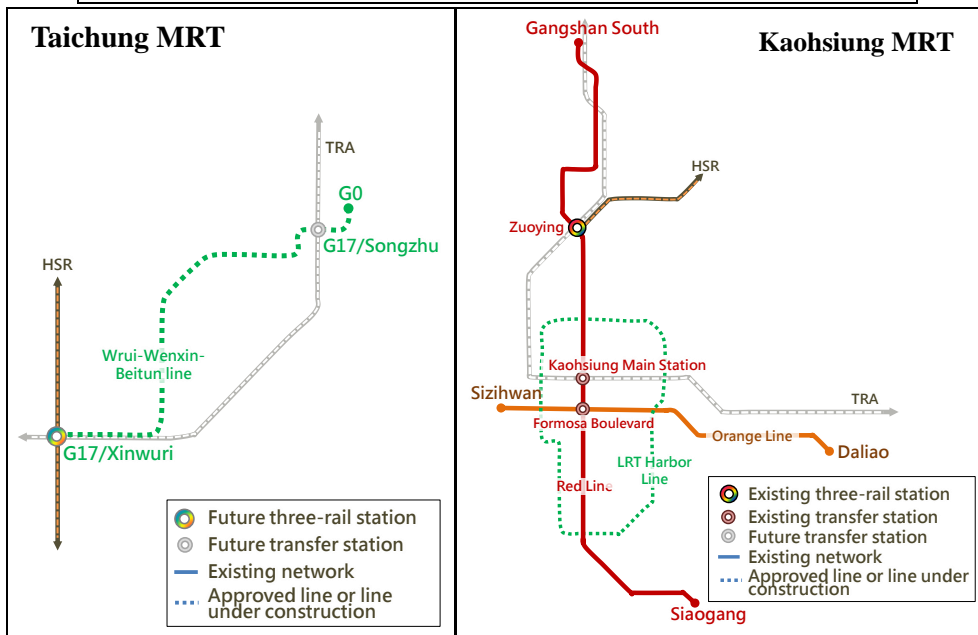
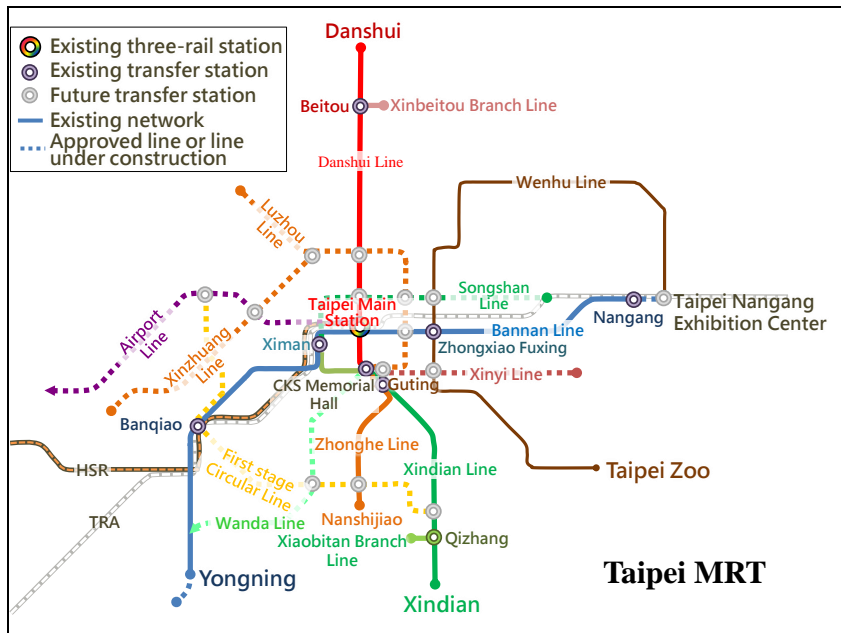
System \ Item	Services	Length	Number of stations
HSR	Long-distance passenger express services in western Taiwan	345 km	8 (with 4 additional future stations in Miaoli, Changhua, Yunlin, and Nangang)
TRA	Long-, mid-, and short-distance full passenger services and partial freight services in western Taiwan. Intercity express and regional rail services in eastern Taiwan.	1085.3 km	126 passenger stations, 89 passenger/freight stations, and 1 freight station
Taipei MRT	--	90.5 km	82
Kaohsiung MRT	--	42.7 km	38

7.2 Although the current railway network is generally complete, it still needs service improvements and could benefit from possible extensions. For example, the TRA railway has no access to Hengchun peninsula, which has the potential to be a world-class scenic spot; transfers between the TRA Coast and Mountain Lines can only be made at the north and south ends (Zhunan and Changhua Stations), which are 90 km apart; the efficiency and level of service at the sections connecting the West and East Trunk Lines are inferior because of geographic constraints in Yilan and the non-electrified single track of the South Link Line.

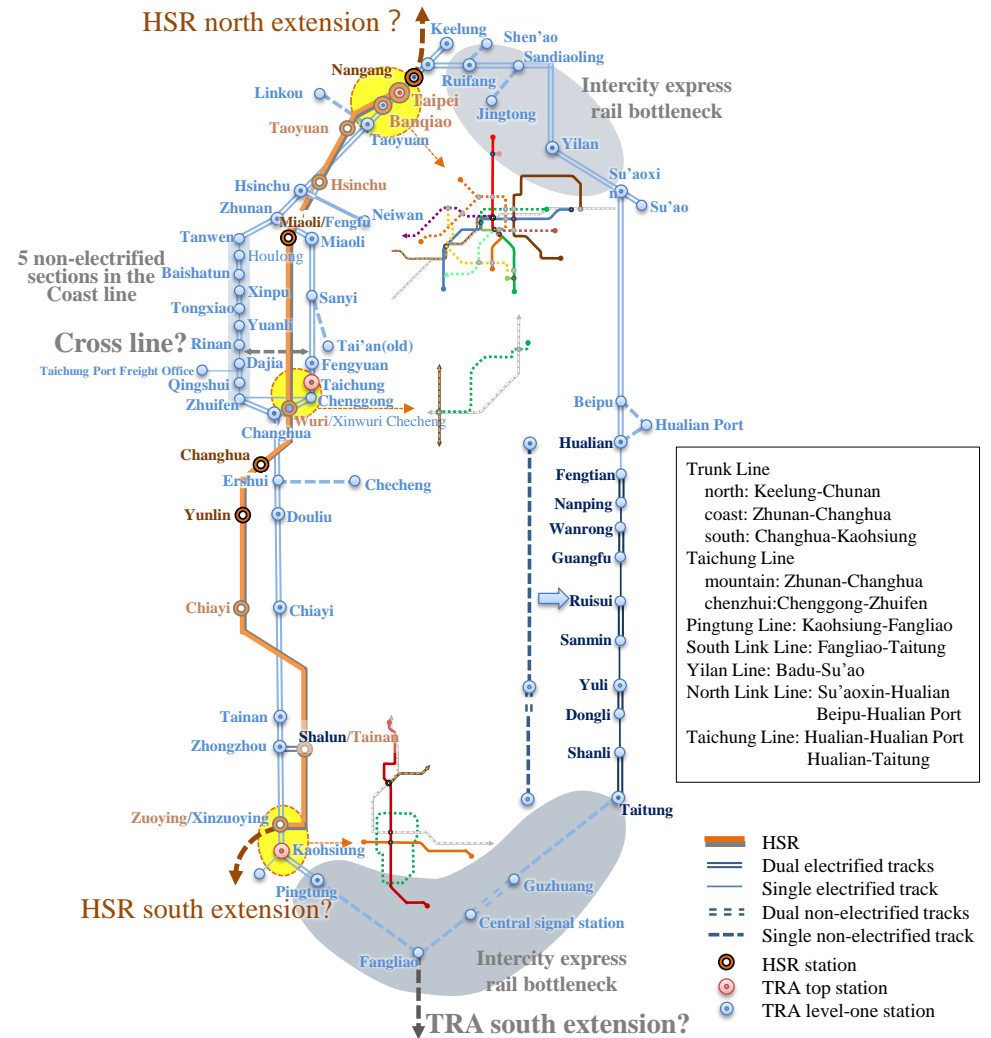
7.3 The current co-stationed or co-constructed HSR terminals are generally integrated with the TRA stations and major airports. Emphasis in the future will be placed on further refining this integration.



Schematic diagram of the integration of HSR, TRA, MRT, and the international airports



Schematic diagram of the urban MRT backbone network

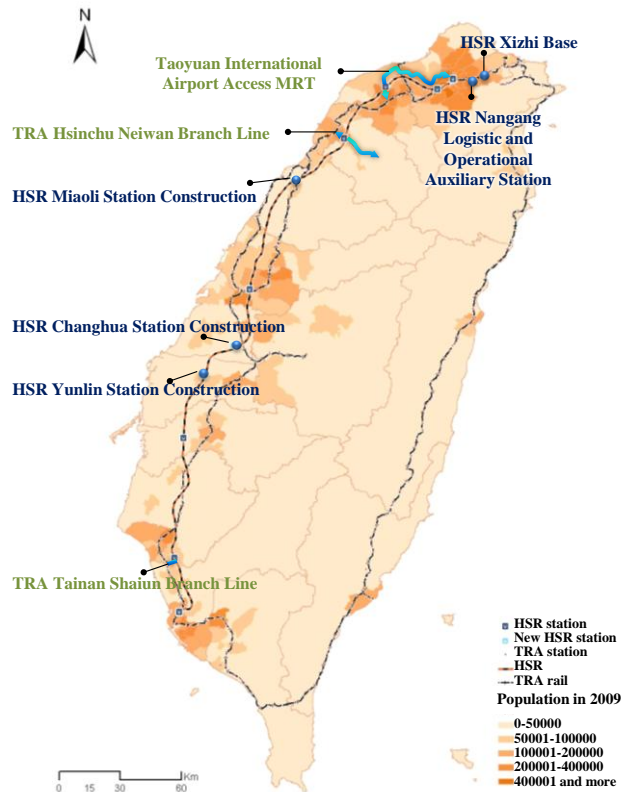


Schematic diagram of the future HSR and TRA backbone network

8. Major Rail-related Construction Plans

8.1 The HSR system

The HSR main line has been operating since 2007, but its feeder railways are the upcoming focus for improving accessibility to HSR stations. The already approved projects include “HSR Nangang Logistic Station Serving as the Operational Auxiliary Station”, “HSR Xizhi Base”, “Miaoli, Changhua, and Yunlin Stations Construction”, “TRA Hsinchu Neiwan Branch Line”, “TRA Tainan Shalun Branch Line”, and “Taoyuan International Airport Access to MRT System”. Projects currently in the preliminary planning stages include “HSR Future Construction Plan” and “TRA Neiwan Branch Line Electrification”.

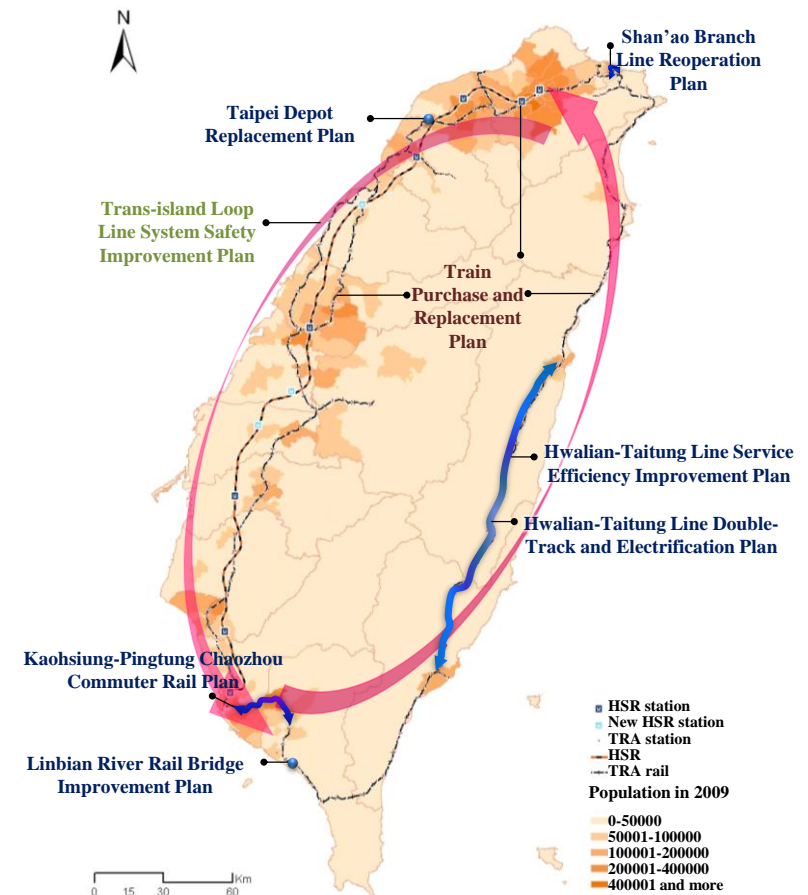


Schematic locations of the approved HSR and its access transportation system projects

8.2 The TRA system

(1) Trans-island loop network

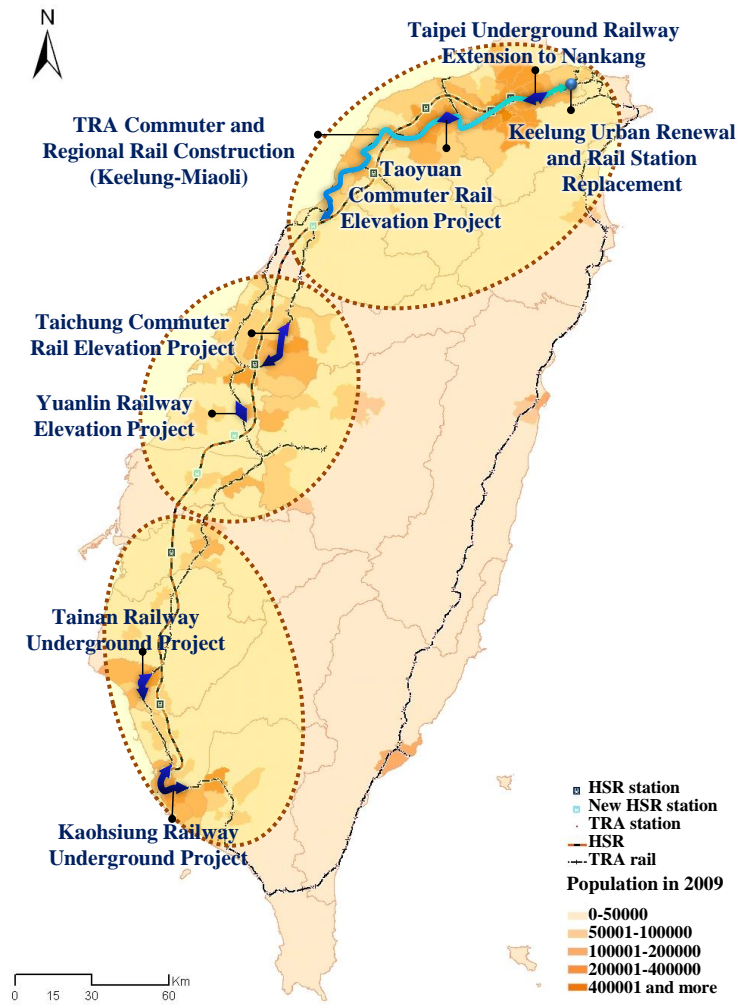
The approved projects, as shown below, cover the following four aspects: reshaping and improving the western Trunk Line’s commuting service, strengthening the eastern Trunk Line’s tourist services, completing the trans-island loop, and enhancing redevelopment of local spaces.



Schematic locations of the approved TRA trans-island loop network projects

(2) Urban commuter rail and grade separation

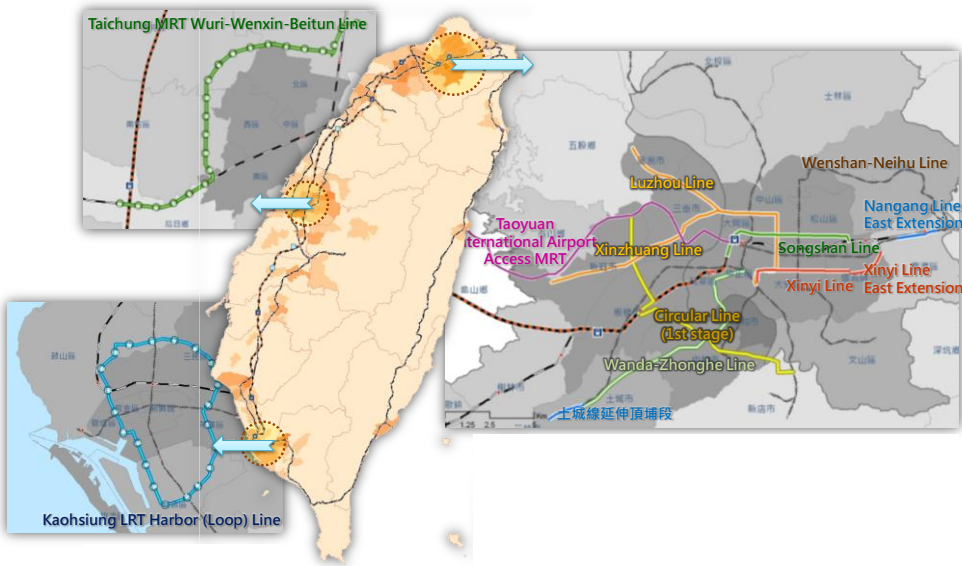
The approved TRA urban commuter rail and grade separation projects, as shown below, are primarily in the northern, central, and southern metropolitan regions.



Schematic locations of the approved TRA commuter rail, grade separation, and related projects

8.3 The MRT and light rail transit (LRT) systems

The approved projects shown below include the Taipei MRT Nangang Line East Extension, Xinzhuang-Luzhou Line, Xinyi Line, Songshan Line, and Tucheng Line Extension to Dingpu, as well as the first stage of 5.4 km of the Circular Line, Taichung MRT Wuri-Wenxin-Beitun Line, and Kaohsiung LRT Harbor Line.



Schematic locations of the approved urban MRT and LRT projects

9. Operation, Administration, and Budget Allocation

9.1 Characteristics of rail operating organizations and their administration framework

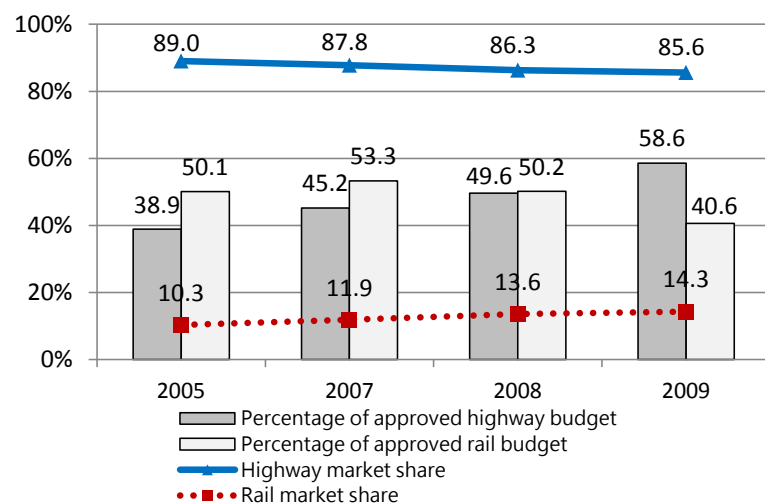
Overview of the rail construction, administration, and operation departments

Item	HSR	TRA rail	Taipei MRT	Kaohsiung MRT
Construction	Franchise company	RRB and TRA (MOTC)	DORTS (TCG)	Franchise company
Operation	Franchise company	TRA (MOTC)	Sustainable company	Franchise company
Superintendent	BOHSR (MOTC)	Administrative: DORH (MOTC) Technical: TRA (MOTC)	Administrative: DOT (TCG) Technical: DORTS (TCG)	Administrative: TB (KCG) Technical: MRTB (KCG)
Administrative issues	BOHSR will be dissolved after acceptability testing and asset transferring to the operating organization, at which point there will be no superintendent of HSR operations.		--	MRTB will be dissolved after acceptability testing and asset transferring to the operating organization, at which point there will be no superintendent of MRT operations.
Ticketing system	Independent	Independent	Independent (Easy Card)	Independent (TaiwanMoney Card)
Fare	Distance-based	Distance-based	Distance- and section-based	Distance- and section-based
Item	HSR	TRA rail	Taipei MRT	Kaohsiung MRT
Rate issues	The TRA and HSR systems have the following three issues: (1) The unit rates do not progressive decrease with distance. (2) A lack of differential pricing based on service and/or time hinders some marketing strategies. (3) There is no fare coordination mechanism coordinated between both systems.		--	--
	Having an HSR fare without a minimum rate potentially competes with other intercity public transit systems, thus causing issues like inequity and inefficiency.	(1) Fare rates do not effectively respond to market demands. (2) Ticketing is complicated.		

9.2 Budget allocation

(1) Overall budget allocation

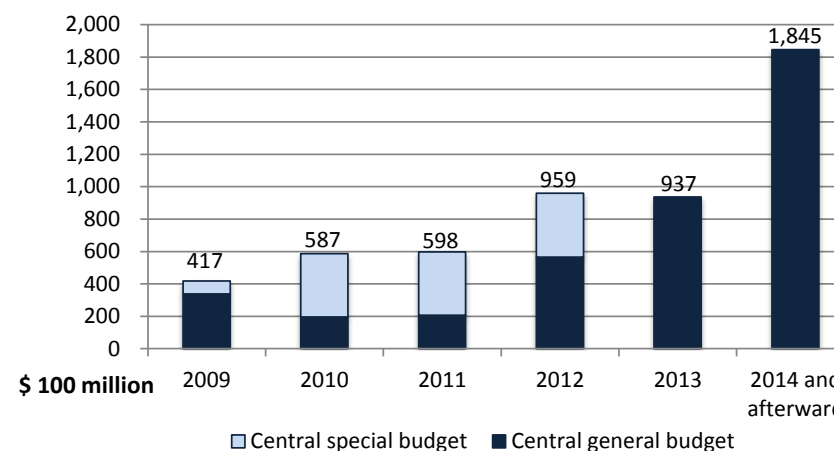
The rail construction budget in the past 10 years increased from NT\$27.9 billion to 66 billion. Ridership (TRA + HSR) also rose when certain rail construction work was completed and/or service was improved. The ridership gap between highways and railways has shrunk in recent years. In 2009, highway ridership was six times more than rail ridership.



Percentage of the approved budget and market share regarding highways and railways

(2) Budget forecast analysis

The rail budget is expected to continue to rise, from NT\$41.7 billion in 2009 to NT\$184.5 billion in 2014 and beyond. However, the total budget requirement after 2011 is about NT\$433.9 billion. It should be pointed out for the Ministry of Finance and MOTC that the special budget is for projects from the 2009 to 2012 fiscal years. Any projects not yet completed by 2013 will need to return to the central general budget for further funding.



Annual railway budget requirement predictions

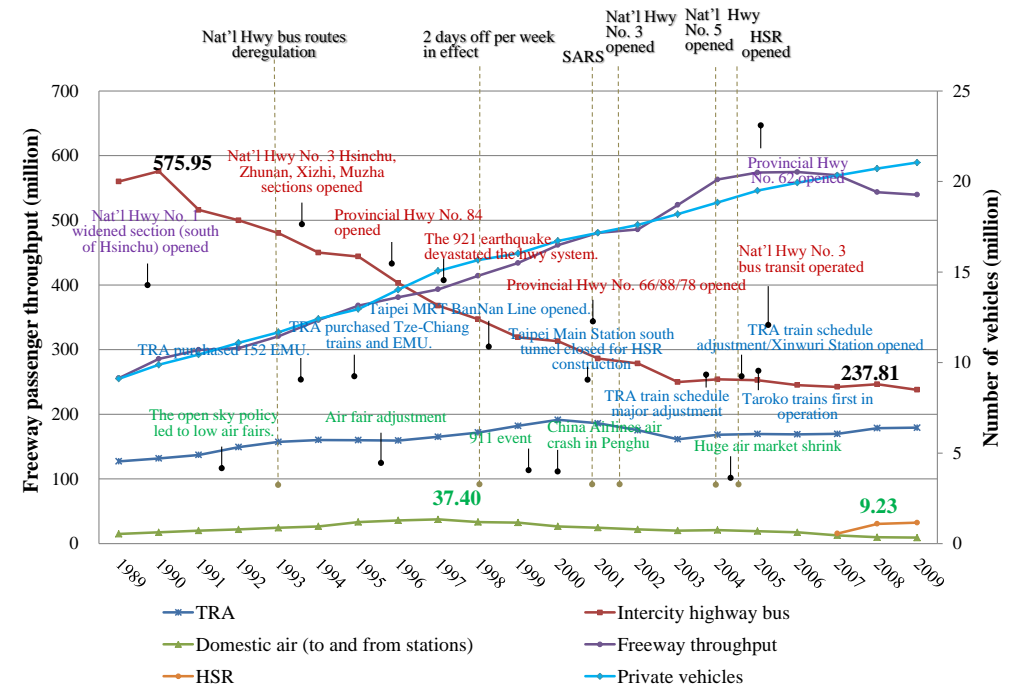
10. Transportation Market Trends

10.1 Transportation system trends

- (1) An overall complete highway network exists due to continuous construction over the past 20 years. However, the rapid growth of motor vehicle registration and freeway traffic has been slowed down by the operation of HSR.
- (2) The number of TRA passengers has grown slowly.
- (3) The number of intercity highway bus passengers has declined steadily.
- (4) The number of domestic air passengers decreased sharply after the operation of HSR.

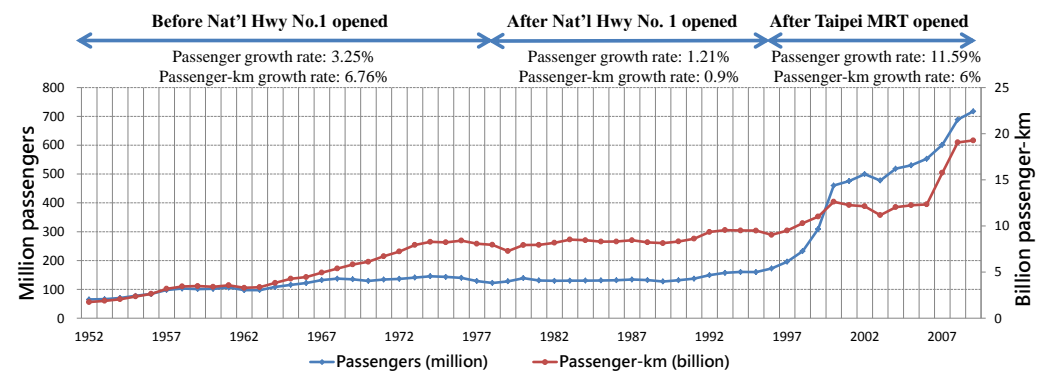
10.2 Rail system trends

- (1) Rail transportation in Taiwan grew from 64.94 million passengers and 1,750 million passenger-km in 1952 to 717.53 million passengers and 19,286 million passenger-km in 2009.
- (2) Before National Highway No. 1 was opened, the annual growth rates of rail passengers and passenger-km were 3.25% and 6.76%, respectively, but dropped to 1.21% and 0.9% afterwards, which indicates the impact of highways on rail passengers and trip length reduction.
- (3) Rail passengers and passenger-km have been increasing rapidly with annual rates of 11.59% and 6%, respectively, since the Taipei MRT began operation. MRT passengers accounted for 70.5% of the total rail transportation, followed by TRA (25%) and HSR (4.5%) in 2009.
- (4) The transportation market was dramatically restructured for trips over 150 km after initiating the operation of HSR.
 - Most domestic air routes serving western Taiwan have been canceled.
 - The market share of private cars for long-distance trips has dropped by 12%.
 - The market share of the national highway's buses and TRA in long-distance trips has dropped by 4%.
 - TRA restructured its market with a focus on daily commuters; the market share for trips over 150 km dropped while that for trips between 20 and 50 km increased from 9% to 14%.



Source: A Study on Prospect Analysis of Intercity Transportation Observation (3/3), Institute of Transportation, MOTC, 2008.

Intercity trips and major events chronicle (1989-2009)



Major rail construction investment and annual trips by year in Taiwan

11. Transportation Demand Characteristics

11.1 Rail market share trends in intercity transportation

- (1) The rail passenger demand on weekends is higher than that on weekdays, but the market share is the opposite, which indicates that the rail system has the potential to serve more passengers on weekends.
- (2) The increasing rail passenger demand and market share show that rail travel is becoming more popular both for commuting and business trips.

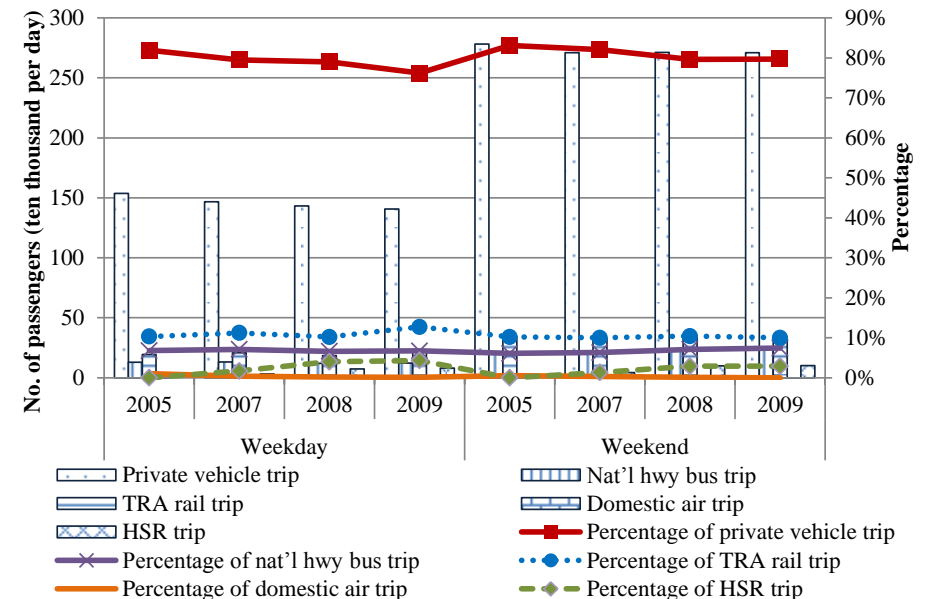
11.2 Regional transportation

- (1) The rail demand in western Taiwan is generally decreasing from north to south and from the regional centers to exteriors. Screen line trips increase as the trips approach the main cities of the northern, central, and southern metropolitan regions.
- (2) The TRA rail is the most important public transit system in eastern Taiwan.
- (3) The rail market share on weekdays is higher than that on weekends because:
 - weekend trips are spatially less concentrated than weekdays, and
 - weekend trips are longer than those on weekdays.
- (4) See below for the intra- and inter-regional mode preferences.

Intra- and inter-regional transportation mode preferences

Intra-regional trips			Inter-regional trips		
Region	Choice set		Corridor	Choice set	
	Public transit	Rail transit		Public transit	Rail transit
Northern	--	--	Northern-Central	TRA	TRA
			Northern-Southern	HSR	HSR
Central	Nat'l hwy bus	TRA	Northern-Eastern	TRA	TRA
			Central-Southern	TRA	TRA
Southern	TRA	TRA	Central-Eastern	TRA	TRA
			Southern-Eastern	TRA	TRA
Eastern	TRA	TRA	--		

Source: Compiled from the trip data of “The Demand Model of Intercity Transportation Systems under National Sustainable Development in Taiwan”, Institute of Transportation, MOTC.

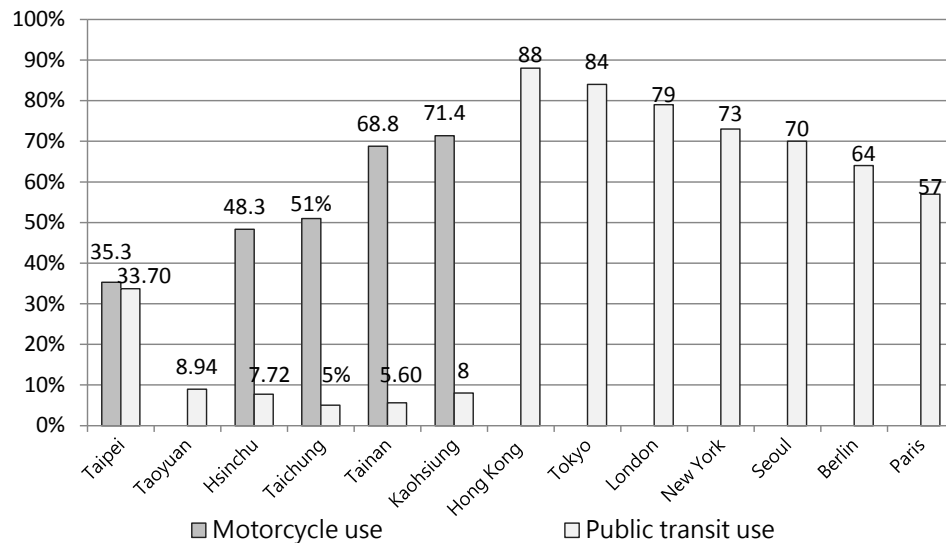


Source: Compiled from the intercity transportation market and trend observation data of the “Study on Establishing a Decision Support System and Integrated Database for Transportation Infrastructure Deliberations (2/3)”, Institute of Transportation, MOTC, 2008.

Intercity trips and mode split (2005-2009)

11.3 Urban transportation

Among Taiwan's six largest metropolitan areas—Taipei, Taoyuan, Hsinchu, Taichung, Tainan, and Kaohsiung, motorcycle ownership and ridership progressively increases from north to south. Public transit ridership in each area is less than 10%, except for in Taipei where it is at 30%. Compared to many international cities that have about 70% of public transit ridership, Taiwan has huge potential for public transit growth.



Source: 1. The Survey, Calibration, and Validation on Basic Data of Transportation Planning in Metropolitan Taipei (II).
2. Taoyuan Metropolitan Public Rapid Transit Network Evaluation and Development Plan.
3. Hsinchu City/County and Miaoli County LRT Feasibility Study.
4. Taichung Metropolitan Public Rapid Transit Priority Network Plan
5. New Tainan Urban Center LRT Corridor Study and Preliminary Plan.
6. Kaohsiung Metropolitan Household Interview Survey and Trip Characteristics Analysis, Transportation Bureau, Kaohsiung City Government.
7. Taiwan Area Comprehensive Transportation Development Planning, Institute of Transportation, MOTC, 2009.

Motorcycle and public transit use in Taiwan's six largest metropolitan areas and major cities around the world

12. High Speed Rail

12.1 HSR route utilization was 47% in 2010.

12.2 Demand and supply of passenger transport

(1) The northbound and southbound demand-supply (D/S) ratios are below 0.63 on weekdays and weekends. The weekday southbound D/S ratio is slightly higher than northbound; the weekend northbound D/S ratio is higher than southbound.

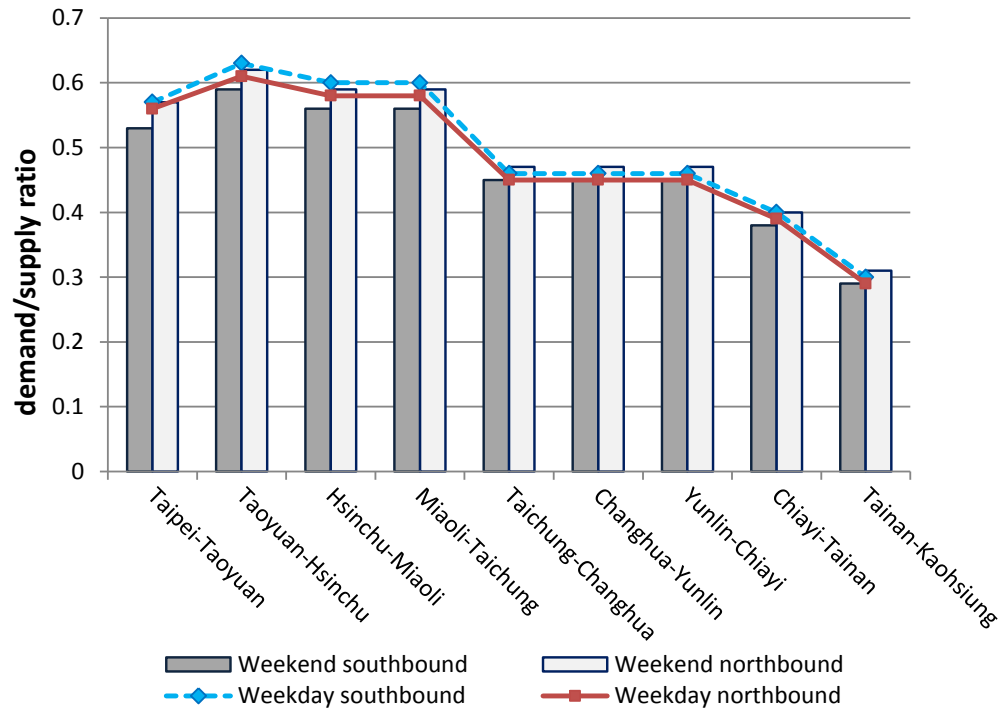
(2) Seat use in sections north of Taichung is over 50% while that in other sections is not.

12.3 Major origins and destinations

Taipei is the main HSR trip end. The most important routes are Taipei-Kaohsiung and Taipei-Taching, which together account for about 40% of total passenger transport. It should be pointed out that Taipei-Hsinchu is the only intra-regional route on the top-ten list.

12.4 Public transit access

- (1) HSR stations are provided with acceptable shuttle services (bus and/or rail) every 20 minutes or less.
- (2) HSR stations are accessible through the TRA electric multiple units (EMU) feeder service with acceptable frequency.
- (3) Taichung and Zuoying Stations, provided with the EMU feeder service that connects major and secondary urban centers, have greater public transit ridership to and from the stations.



Source: The intercity transportation market and trend observation data of the “Study on Establishing a Decision Support System and Integrated Database for Transportation Infrastructure Deliberations (2/3)”, Institute of Transportation, MOTC, 2008.

HSR demand and supply in 2009

13. National and Regional TRA Rail Supply and Demand

13.1 Route utilization

TRA route utilization is not uniform. The overall capacity is higher than its demand; however, certain sections are approaching their capacities, which could potentially ruin the system in the future.

TRA rail route capacity and utilization

Route	Section	Peak hour utilization (%)	Daily utilization (%)
Trunk Line southbound	Keelung→Badu	52.04	32.52
	Badu→Cidu	94.26	62.74
	Cidu→Hsichih	88.85	82.85
	Hsichih→Nangang	84.75	71.13
	Yingge→Taoyuan	90.18	62.03
	Changhua→Yuanlin	96.53	51.14
Trunk Line northbound	Hsinchu→Jhubei	97.37	55.06
	Taoyuan→Yingge	91.19	63.32
	Nankang→Hsichih	92.44	69.53
	Hsichih→Cidu	92.88	85.39
South Link	Taimali→Chihpen	92.38	38.49

Note: 1. The route capacity of the single-track section (Taimali-Chihpen) is the total capacity of southbound and northbound directions.

2. Utilization = current number of trains ÷ route capacity × 100%.

3. Route capacity = peak hour route capacity × daily operating hours (16.8 hr).

13.2 Passenger transport supply and demand

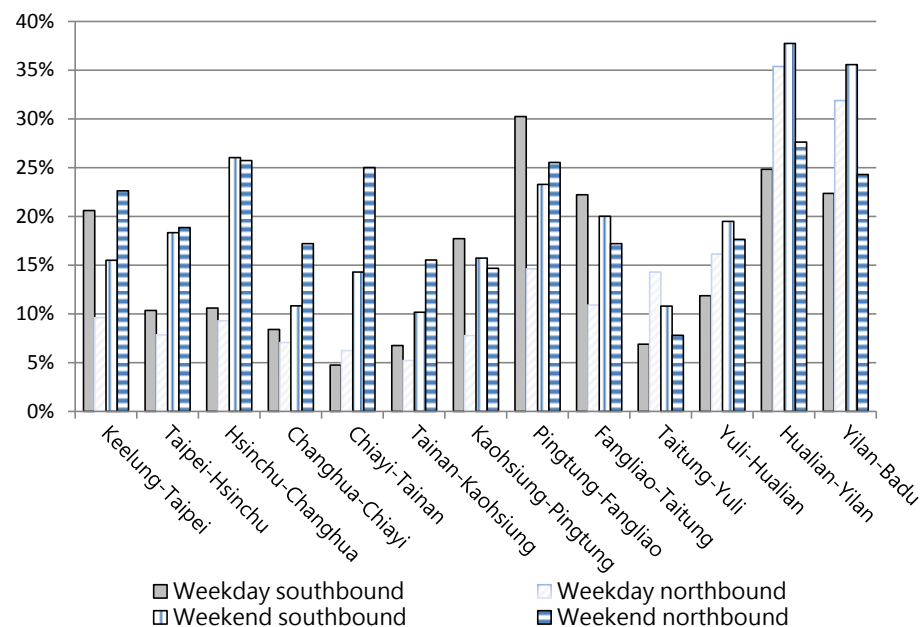
Demand on certain routes, such as Taipei-Hsinchu, Hsinchu-Changhua, Pingtung-Fangliao, Hualien-Ilan, and Ilan-Badu, is approaching capacity. Furthermore, the ability to increase seats during peak hours in these sections is limited.

TRA weekday and weekend screen line demand and supply in 2009

Screen line	Weekday peak hours				Weekend peak hours			
	Time of day	Northbound	Time of day	Southbound	Time of day	Northbound	Time of day	Southbound
Taipei Taoyuan	6~8	159%	17~19	118%	18~20	107%	17~19	122%
Hsinchu Miaoli	7~9	76%	17~19	68%	16~18	116%	19~21	78%
Miaoli Taichung	6~8	38%	17~19	32%	18~20	106%	19~21	91%
Taichung Changhua	7~9	65%	17~19	57%	16~18	105%	16~18	83%
Changhua Yunlin	17~19	47%	16~18	31%	18~20	103%	16~18	130%
Yunlin Chiayi	16~18	34%	17~19	32%	15~17	81%	17~19	123%
Chiayi Tainan	17~19	45%	17~19	37%	18~20	99%	17~19	114%
Tainan Kaohsiung	7~9	98%	6~8	85%	18~20	129%	18~20	106%
Yilan Hualien	18~20	76%	9~11	45%	17~19	73%	18~20	108%
Taitung Pingtung	17~19	77%	8~10	40%	17~19	124%	16~18	146%

Note: The demand/supply ratios were estimated from TRA ticketing records, time tables, and train dispatch tables. The supply does not include standing capacity but seats only.

Source: The intercity transportation market and trend observation data of the “Study on Establishing a Decision Support System and Integrated Database for Transportation Infrastructure Deliberations (2/3)”, Institute of Transportation, MOTC, 2008.



Note: Congestion percentage = the number of trains with over 100% of seat utilization ÷ the total number of trains in the respective section.

Source: Compiled from TRA data in September 2010.

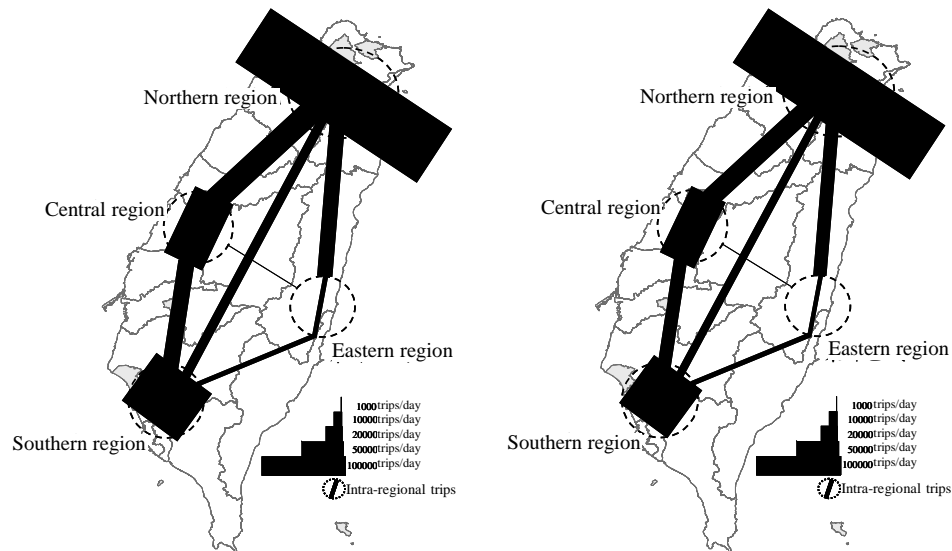
Congestion percentage regarding the seat utilization of TRA express trains by section

13.3 Passenger trip origins and destinations

(1) Trip distribution on weekdays is similar to that on weekends.

- Intra-regional trips are more frequent than inter-regional trips.
- Most trips occur in the northern region.
- Mid-distance inter-regional trips decrease from north to south.

(2) The top 20 origin-destination pairs are primarily related to adjacent cities/counties, showing that TRA's main customers are metropolitan passengers.



Source: Preliminary Planning of the Northern, Central, and Southern Metropolitan Commuter Rail System Development, CEPD, Executive Yuan, 2009.

TRA trip distribution with respect to the four major regions in Taiwan

14. Urban TRA Rail Supply and Demand

14.1 Trip distribution on weekdays is similar to that on weekends.

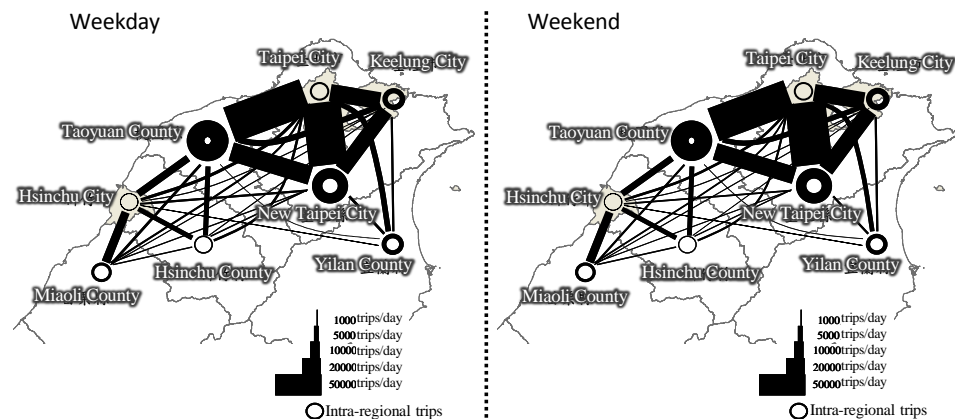
14.2 The top 10 routes in each metropolitan area are primarily 30 to 50 km long and associated with adjacent cities/counties, showing that TRA's main customers are metropolitan commuters.

14.3 The major corridors in each metropolitan area are shown below.

Major cross-city/county corridors in the three metropolitan regions

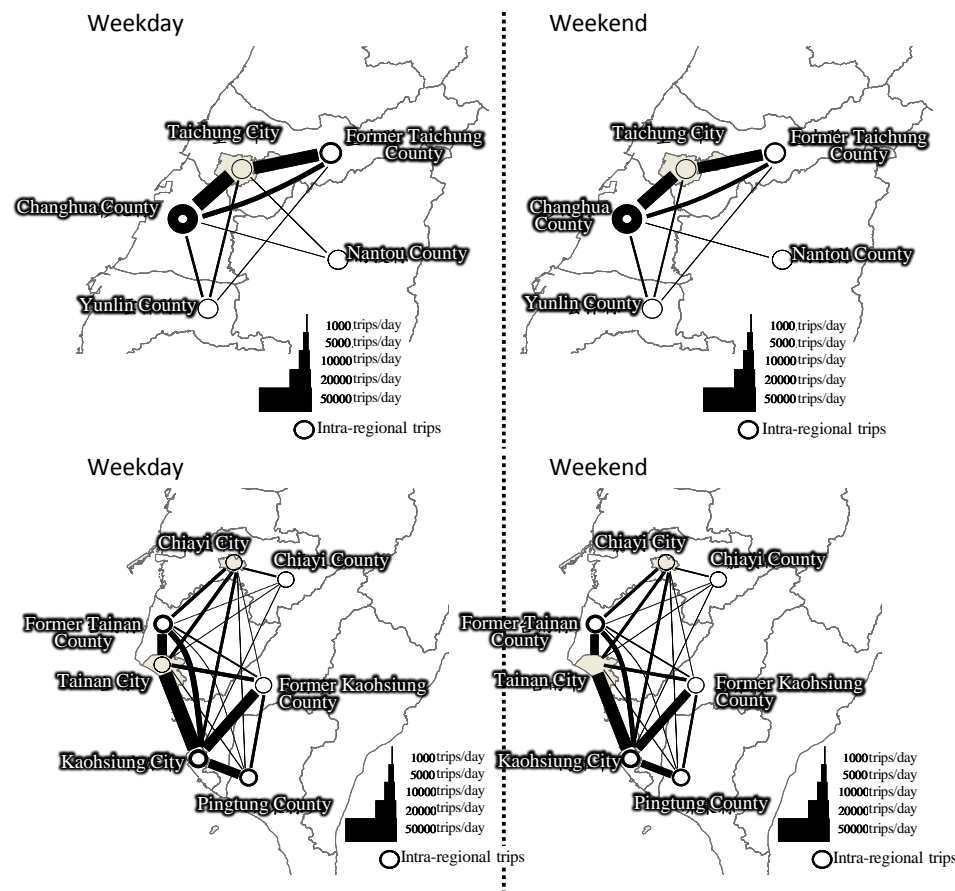
Metropolitan Region Category	Northern	Central	Southern
Primary corridor	New Taipei City – Taipei City	Taichung City – Changhua County	Kaohsiung City – Tainan City
Secondary corridor	Taoyuan County – Taipei City	Taichung City – Former Taichung County	Kaohsiung City – Former Kaohsiung County
Sub-secondary corridor	Taoyuan County – New Taipei City	Changhua County – Former Taichung County	Tainan City – Former Tainan County Pingtung County – Kaohsiung City

Source: Preliminary Planning of the Northern, Central, and Southern Metropolitan Commuter Rail System Development, CEPD, Executive Yuan, 2009.



Source: Preliminary Planning of the Northern, Central, and Southern Metropolitan Commuter Rail System Development, CEPD, Executive Yuan, 2009.

TRA weekday and weekend trip distribution in the northern metropolitan region



Source: Preliminary Planning of the Northern, Central, and Southern Metropolitan Commuter Rail System Development, CEPD, Executive Yuan, 2009.

TRA weekday and weekend trip distribution in the central (top) and southern (bottom) metropolitan regions

15. Urban MRT

15.1 Taipei MRT

(1) Route utilization

- Route utilization of the sections between Nangang and Far Eastern Memorial Hospital of the Banqiao-Nangang Line and between Beitou-Guting of the Danshui-Xindian Line is greater than 70% during weekday peak hours.
- The rest of the MRT system registers between 15% and 50% usage, regardless of weekday peak or off peak hours.
- Weekend route utilization is primarily lower than weekday utilization, ranging from 15% to 63%.

(2) Train space utilization

- High-volume trains have decreased space utilization (and thus increased comfort) from 5.95 passengers per square meter in 2001 to its current 4.12.
- Through 2009, mid-volume trains had increasing space utilization below five passengers per square meter, providing acceptable comfort.

15.2 Kaohsiung MRT

Route utilization is approximately between 25% and 42% with plenty of excess capacity. The Red and Orange Lines are high-volume systems with a capacity of 24 TU per hour. Current service frequency is 6 minutes during peak periods and 10 minutes during off-peak periods.

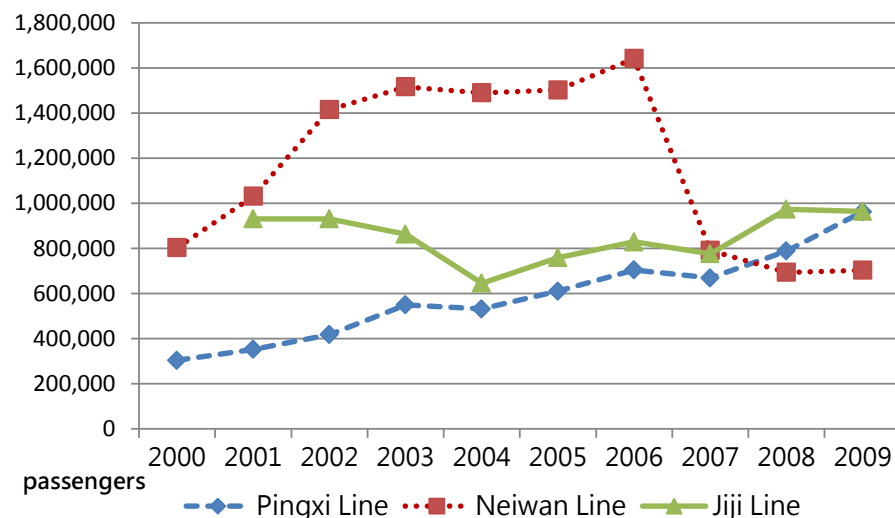
16. Other Rail Systems

16.1 Scenic railways

- (1) Scenic railways currently in operation include three TRA branch lines: Pingxi, Neiwan, and Jiji. The Shen'ao Branch Line between Ruifong and the National Museum of Marine Science and Technology was ready to resume passenger operations in 2010.
- (2) The TRA passenger branch lines have increased passenger transport, albeit the total amount is still sparse. Ridership on the Pingxi Line has been growing and currently leads other branch lines, followed by the Jiji Line's quite stable operations. Ridership in the Neiwan Line has dramatically dropped due to its reconstruction project.

16.2 Freight railways

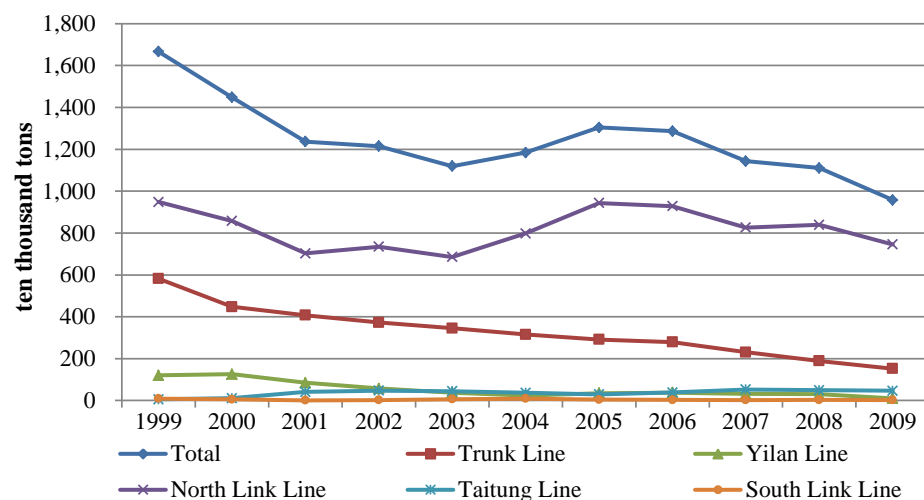
- (1) Rail freight is mainly operated by TRA, with smaller items served by the Taiwan Sugar Corporation (TSC) Railways and Forest Railways. Express delivery service is provided by the THSRC in cooperation with the Chunghwa Post and other courier companies.
- (2) The freight demand in 2009 was 61.08 million train-km, of which 41.8% (i.e., 25.50 million train-km) was heavy freight. Freight demand was less than half of the supply.
- (3) TRA's freight demand has generally been decreasing over the past ten years. Freight dropped about 12% and more in the Trunk Line, Yilan Line, and South Link Line. On the contrary, the North Link Line and Taitung Line experienced slight fluctuations because of the consistent demand to transport gravel and lime.
- (4) The Linkou and Taichung Port Freight Branch Lines have remained stable while the Keelung Port and Kaohsiung Port Lines have significantly dropped in recent years.
- (5) Inbound and outbound freight analysis: TRA's top five stations regarding inbound freight are Heping, Xincheng, Hanren, Longjing, and Dong'ao; these stations account for 82.7% of TRA's total freight. The top five stations regarding outbound freight are Hualian Port, Yong'le, Qidu, Linkou and Dong'ao; these stations account for 79.5% of TRA's total freight.



Note: The Jiji Line was closed in 2000 due to the 921 earthquake in 1999

Source: TRA, September, 2010

The number of on- and off-board passengers on TRA branch lines



Source: TRA, Sep. 2010.

TRA freight growth by line (1999-2009)

17. Transportation Demand Projections

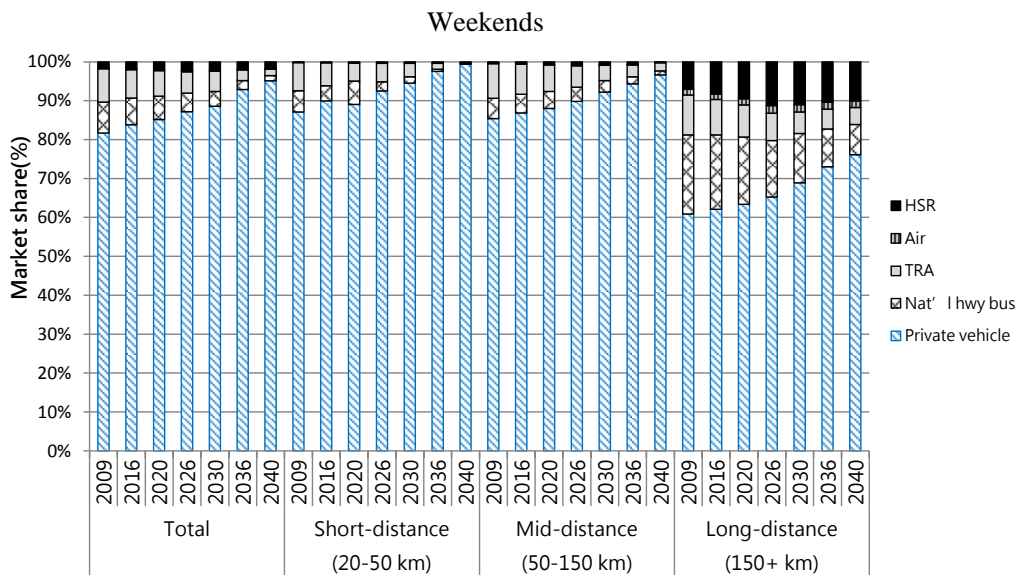
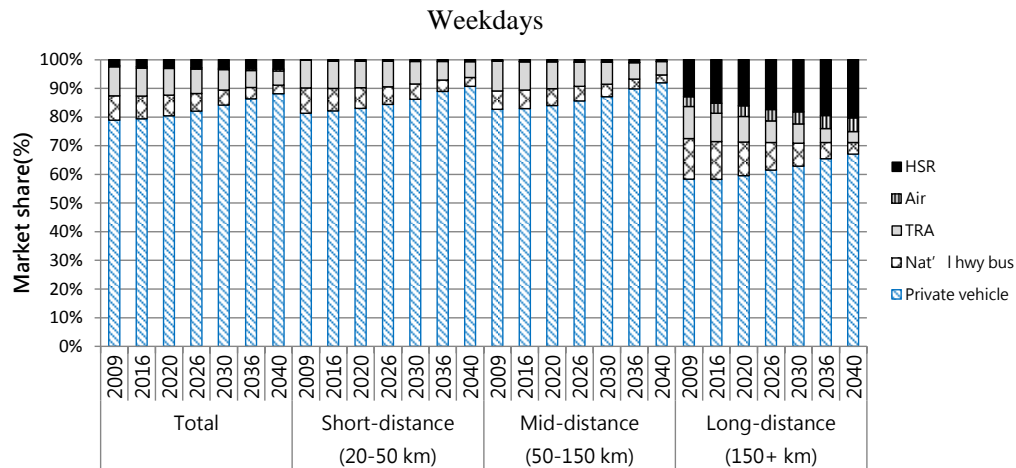
“The Demand Model of Intercity Transportation Systems under National Sustainable Development in Taiwan” (Institute of Transportation, MOTC) has estimated the transportation demand and trip structures for the next 30 years. According to that study, future vehicle ownership and the highway private mode market share will continue to increase. Furthermore, the railway market share will decrease if no effective public transit policies are adopted to redirect transportation development.

17.1 Total trips

- (1) Weekday trips are estimated to reach their peak in 2026 with 2.21 million passengers daily. Daily trips will noticeably decrease in 2036 and be down to 2.11 million passengers by 2040.
- (2) Weekend trips will be stable until 2030 but will also drop significantly in 2036. In 2040, such trips will have 3.24 million passengers per day.

17.2 Mode split

- (1) Without effective policies to support public transit development, the estimated market share of private cars will gradually rise while that of public transit will drop to just 11.9% on weekdays and 4.9% on weekends in 2040.
- (2) According to predictions, TRA will have the greatest market share among the public transit modes, followed by national highway buses. However, their market shares will generally be decreasing. On the contrary, the market share of the HSR is estimated to grow slightly, especially for long-distance trips.
- (3) Short- and mid-distance trips will be served primarily by TRA and secondarily by national highway buses. The HSR and national highway buses will respectively lead weekday and weekend long-distance trips.



Soure: The Demand Model of Intercity Transportation Systems under National Sustainable Development in Taiwan (4/4), Institute of Transportation, MOTC

Predicted mode split trend

18. Future Demand and Supply Analysis

This study predicts seat utilization of the HSR and TRA based on “The Demand Model of Intercity Transportation Systems under National Sustainable Development in Taiwan.”

18.1 HSR will have vacant seats available in the future.

- (1) All-day demand and supply analysis: the HSR seat utilization rate (D/S ratio) will increase each year with the highest rate in the section between Taoyuan and Hsinchu of 0.43 to 0.46 by 2040. The rate in the section south of Chiayi will remain below 0.2 due to limited demand growth. Weekend utilization will decrease.
- (2) Peak-period demand and supply analysis: the section between Taoyuan and Hsinchu will have the greatest seat utilization on both weekdays and weekends. The peak period rate on weekdays will increase to 0.58 to 0.67 by 2040 while that on weekends will slightly drop due to less total demand and greater car ownership after 2036.

18.2 TRA will encounter insufficient supply in the peak period.

- (1) All-day demand and supply analysis: the TRA seat utilization rate will decrease. The Taipei-Taoyuan screen line will have a relatively higher rate than other lines; the weekday and weekend rates will both reach their peak in 2016 and then decrease afterward. Seat utilization in eastern Taiwan will suffer a more severe drop than that in western Taiwan as a result of the increasing supply and stable demand.
- (2) Peak-period demand and supply analysis: the weekday seat utilization rate will be over-saturated for the section between Taipei and Taoyuan at 1.49 (southbound) and 2.61 (northbound) in 2020. The weekend rates will be higher than those on the weekday. The utilization rates of the screen lines in western Taiwan and the Taitung-Pingtung screen line in eastern Taiwan will both be greater than one by 2026, and then decrease afterward.

18.3 MRT/LRT

The MRT and LRT demand predictions are summarized in the chart below.

Summary of MRT and LRT demand predictions in each metropolitan area

Metropolitan area	Taipei	Taoyuan	Hsinchu	Taichung	Tainan	Kaohsiung
Prediction year	2031	2041	2031	2031	2033	2030
MRT/LRT trips (10 thousand passengers/day)	240	80.59	24.6	59.7	50	111.6

Source: 1. LRT corridor study for Shezi, Shilin, and Beitou areas. DORTS, Taipei City Government, 2009.

2. Taoyuan Metropolitan Public Rapid Transit Network Evaluation and Development Plan. DORTS, Taipei City Government.
3. Hsinchu City/County and Miaoli County LRT Feasibility Study, Hsinchu City Government, 2009.
4. Taichung Metropolitan Public Rapid Transit Priority Network Plan, BOHSR, MOTC, 2002.
5. New Tainan Urban Center LRT Corridor Study and Preliminary Plan, Tainan County Government, 2004.
6. Kaohsiung Metropolitan MRT Long-term Network Planning, MRTB, Kaohsiung City Government, 2004.

VISION

19. Market Positioning of Rail Transportation

19.1 Market positioning

(1) Facilitating the trans-island loop and intercity transportation

- Long-distance trips in western Taiwan will be served primarily by the HSR, with the TRA rail and national highway buses supplementing services.
- Mid-distance trips in western Taiwan will be served primarily by the TRA, with the HSR and national highway buses supplementing services.
- North-southbound regional connections and intra-regional trips will be served primarily by the TRA.
- HSR stations shall be accessible with TRA services to form a complete intercity rail network.
- Taipei and Zuoying HSR stations shall be properly connected with the TRA Valley Line to provide residents in the east with access to the HSR.

(2) Providing flawless trunk line services in the metropolitan areas

- Hub areas shall be completely configured with rail networks, as well as supplemental bus services.
- Rail trunk lines shall link hubs and city centers with supplemental bus services.
- Depending on the corridor transportation demand and conditions, city centers shall offer rail services to suburban and rural areas. Remote areas shall be accessible with community shuttle buses or non-typical public transit such as dial-a-ride transportation services (DRTS).

(3) To connect national gateways with major cities

- National gateways shall be accessible to adjacent hubs or city centers via rail.
- Regional gateways shall also be accessible to adjacent hubs or city centers via rail.
- National and regional gateway areas shall have rail connections.

19.2 Cooperation

Based on the characteristics of individual rail systems, long-distance trips shall be principally served by the HSR; mid-distance trips shall be principally served by the HSR and TRA; short-distance trips shall be principally served by the TRA, MRT, and LRT systems.

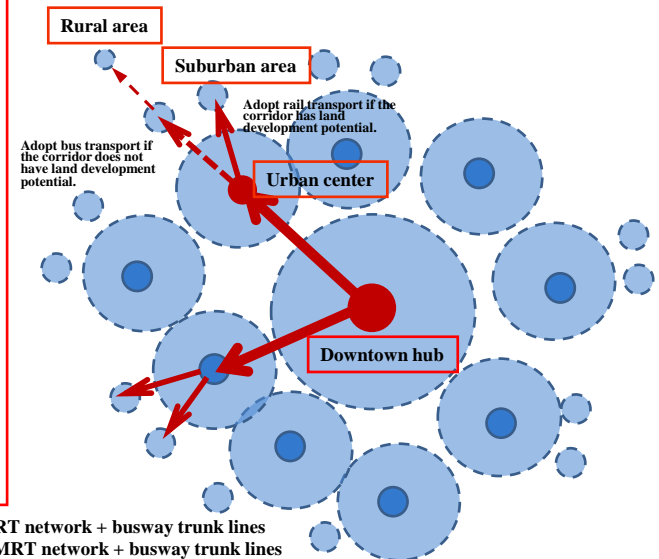
Suggestions for rail market positioning

Transportation pattern		Trip pattern	Trip distance (km)	Potential mode	Suggested mode
Intercity		Long	150-500	HSR, TRA	HSR
		Mid	50-150	HSR, TRA	HSR, TRA
Metropolitan area	Suburban/rural area	Mid	30-50	TRA, (MRT)	TRA
	Urban area	Short	<30	TRA, MRT/LRT	TRA, MRT/LRT

Note: These distances are for reference only, and may vary with local attributes.

Hierarchical transportation service concept for the multi-center area:

- TRA is the major transportation supplier along its corridor.
- The downtown hub area shall have an intensive rail network and services.
- Each urban center shall have at least one rail line along with a complete feeder bus system.
- The suburban areas may or may not have rail services, depending on the demand.
- The rural areas shall be served primarily by buses and secondarily by DRTS.



Downtown hub: intensive MRT network + busway trunk lines
 Urban center: less intensive MRT network + busway trunk lines
 Suburban area: busway major lines (or light rail) + feeder bus
 Rural area: bus + DRTS

Conceptual diagram of railway-oriented flawless metropolitan trunk lines

20. Core Values

20.1 To satisfy travelers' expectations with *safe*, *reliable*, and *customer-centered* rail services

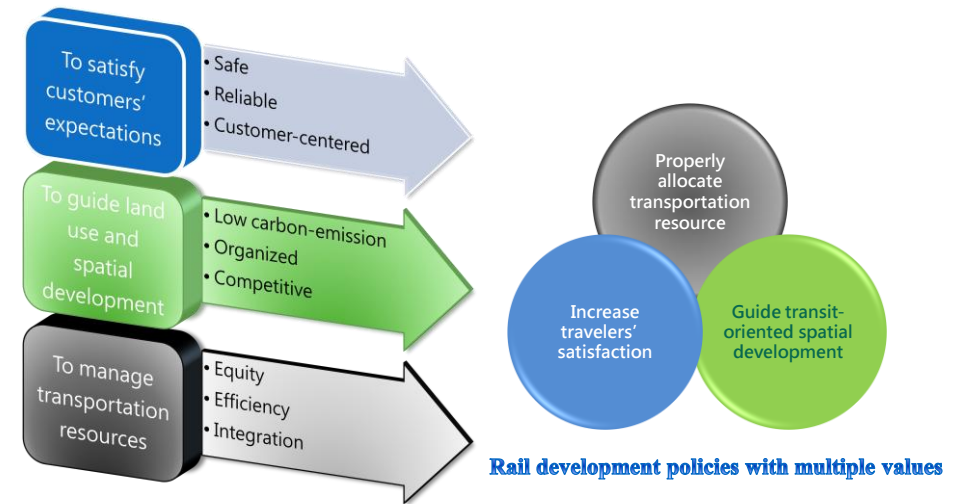
Safe and reliable services are determined by rail-related deaths and operating delays within the average numbers from advanced countries. Meanwhile, customer-centered services are evaluated by sufficient transportation supply, disabled- and senior-friendly trains and stations, and pedestrian-friendly station areas.

20.2 To guide transit-oriented land use and networks by developing a *low carbon-emission*, *organized*, and *competitive* rail system

Such a rail system can reduce carbon emissions, inhibit urban sprawl and disorder, and connect international airports with nearby cities to enhance regional mobility.

20.3 To manage transportation resources by enhancing rail *equity*, *efficiency*, and *integration*.

Rail equity is determined by rail service coverage and accessibility to remote areas. Efficiency is gaged by rail travel time, market share, and financial performance. Transportation integration is measured by flawless public transit services.



Conceptual diagram of rail transportation core values

21. Indicators and Criteria

This study, in accordance with the above three core values and nine aspects, has selected 19 indicators with specific criteria to measure rail progress. These criteria consider not only the local needs but also the prompts from advanced countries, and can serve as targets for Taiwan's rail development.

Three-stage rail development criteria settings

Core value	Aspect	Indicator	Existing condition (2009)			1 st stage ~2020	2 nd stage ~2030	3 rd stage ~2040
			System	Existing value				
To satisfy travelers’ expectations	Safety	Deaths per million passenger-km	HSR	--		-10%	-10%	-10%
			TRA			-50%	-40%	-30%
			TMRT			-10%	-10%	-10%
			KMRT			-10%	-10%	-10%
		Rail crossing accident rate	TRA	7.78%		-10% (annually)	-5% (annually)	-5% (annually)
	Reliability	Train on-time rate	HSR	99.25%		>99%	>99%	>99%
			TRA	Passenger transport	95%	97%	98%	>99%
			TMRT	High volume	99.9 1%	>99%	>99%	>99%
				Mid volume	99.8 8%			
			KMRT	99.69%		>99%	>99%	>99%
		Average delay	HSR	21 sec		<5min	<5min	<5min
			TRA	151 sec		-5% (annually)	-5% (annually)	-5% (annually)
			TMRT	High volume	0.66 sec	<1-3 min	<1-3 min	<1-3 min
				Mid volume	3.22 sec			
			KMRT	0.86 sec		<2-3 min	<2-3 min	<2-3 min

Three-stage rail development criteria settings (continued)

Core value	Aspect	Indicator	Existing condition (2009)			1 st	2 nd	3 rd
			System	Existing value		stage ~2020	stage ~2030	stage ~2040
To satisfy travelers’ expectations	Customer-centered	Average seat utilization during peak periods	HSR	47.7		<80%	<80%	<80%
			TRA	--		90%	80%	<80%
			TMRT	High volume	69%	<80%	<80%	<80%
				Mid volume	76%			
			KMRT	--		<80%	<80%	<80%
		Average route utilization during peak periods	HSR	--		<80%	<80%	<80%
			TRA	97.37%		90%	80%	<80%
			TMRT	High volume	--	85%	80%	<80%
				Mid volume	--	<80%	<80%	<80%
			KMRT	--		<80%	<80%	<80%
		Ratio of trains with standard disabled-friendly space	HSR	100%		100%	100%	100%
			TRA	59%		70%	80%	100%
			TMRT	100%		100%	100%	100%
			KMRT	100%		100%	100%	100%
		Ratio of stations achieving disabled-friendly standards	HSR	100%		100%	100%	100%
			TRA	13.7%		35%	65%	100%
			TMRT	100%		100%	100%	100%
			KMRT	100%		100%	100%	100%
		Percentage of pedestrian right-of-way within the 400m radius of the station	HSR	--		+5%	+5%	>35%
			TRA			+5%	+10%	>40%
			TMRT			+5%	+10%	>40%
			KMRT			+5%	+10%	>40%

Three-stage rail development criteria settings (continued)

Core value	Aspect	Indicator	Existing condition (2009)		1 st stage	2 nd stage	3 rd stage
			System	Existing value	~2020	~2030	~2040
To guide transit-oriented land use and network	Low carbon emissions	Carbon dioxide emissions per passenger-km	HSR	0.0267kg	-5%	-10%	-5%
			TRA	0.0515kg	-5%	-10%	-5%
			TMRT	0.0830kg	-10%	-10%	-5%
			KMRT	0.3384kg	-10%	-20%	-5%
	Organized	Residential density within a 400 m radius of the station	HSR	--	+10%	+10%	+5%
			TRA		Western Taiwan +5%	Western Taiwan +5%	Western Taiwan +10%
			TMRT		Eastern Taiwan +2%	Eastern Taiwan +5%	Eastern Taiwan +2%
			KMRT		+5%	+5%	+10%
			TMRT		+5%	+5%	+10%
			KMRT		+5%	+5%	+10%
	Competitive	Rail travel time from the major int'l airport to its nearby city centers	Taoyuan Airport	--	40 min	35 min	20 min
			Taichung Airport	--			
			Kaohsiung Airport	25min			
To manage transportation resources	Equity	Public transit travel time from the most remote life circle centroid in the island to the HSR station	--	Miaoli City–Hsinchu (Taichung) HSR station: 60~70min	Western Taiwan: 50 min	Western Taiwan: 35 min	Western Taiwan: 30 min
			--	Taitung City–Zuoying HSR station: 141~180min	Eastern Taiwan: 130 min	Eastern Taiwan: 110 min	Eastern Taiwan: 100 min
		Rail transportation coverage	--	65.62%	69%	73%	75%
			--	65.62%	69%	73%	75%

Three-stage rail development criteria settings (continued)

Core Value	Aspect	Indicator	Existing condition (2009)		1 st stage	2 nd stage	3 rd stage
			System	Existing value	~2020	~2030	~2040
To manage transportation resources	Efficiency	Rail travel time between each life circle centroid	--	52,219 分	-5%	-5%	-10%
			HSR	<0.3% (nationwide)	+5%	+5%	+10%
		Rail market share	TRA	1.0% (nationwide)	+10%	+10%	+10%
			TMRT	11% (Taipei metropolitan area)	+10%	+10%	+5%
			KMRT	1.6% (Kaohsiung metropolitan area)	+10%	+20%	+10%
			KMRT	1.6% (Kaohsiung metropolitan area)	+10%	+20%	+10%
		Average operating expense/revenue ratio	HSR	1.31	+3%	+3%	+5%
			TRA	0.73	+10%	+5%	+5%
			TMRT	1.04	+3%	+3%	+5%
			KMRT	0.33	+5%	+10%	+5%
	Integration	Arrival or departure by public transit	HSR	--	+10%	+10%	+5%
			TRA	--	+10%	+15%	+5%
			TMRT	33.9%	+10%	+10%	+5%
			KMRT	--	+10%	+20%	+10%
		Convenience of station transfers	HSR	--	<20 min	<15 min	<10 min
			TRA		Intercity <20 min; Urban <15 min	Intercity <15 min; Urban <10 min	Intercity <10 min; Urban <8 min
			TMRT		<15 min	<10 min	<8 min
			KMRT		<15 min	<10 min	<8 min

Note: 1. These criteria should be updated based on periodical examinations. 2. For criteria with a positive or negative sign, they are being compared with the values of the previous year's prior stage; for first-stage criteria, they are being compared with existing values in 2009.

22. Vision– Moving towards a New Era of Exceptional Rail Services

- 22.1 To become travelers' first transportation choice by providing superior services
- 22.2 To provide the foundation for flawless transportation through an integrated transit network
- 22.3 To direct main development along rail corridors through tight connections with urban and rural activities
- 22.4 To become a sustainable transportation system by inheriting and innovating rail culture

Rail transportation visions suggested by 10 experts

Expert	Suggested vision
Expert 1	A sustainable rail service plan without accidents, delay, gaps, or bottlenecks.
Expert 2	1. Rail riders: one of the world's safest and most convenient systems. 2. Government: provision of a satisfying rail system for the general public. 3. Operator: provision of customer-oriented rail services.
Expert 3	A safe, reliable, flawless and sustainable rail system and services.
Expert 4	Defined rail authorities and responsibilities; localized rail design and services.
Expert 5	A safe, reliable, convenient, fast, sustainable, and affordable rail system.
Expert 6	A mutual memory for all citizens after two generations.
Expert 7	1. Stable (reliable) operations. 2. A sustainable, safe, and customer-centered rail system.
Expert 8	1. A sustainable environment that is safe, worry-free, and comfortable. 2. A flawless transportation environment regarding space, time, information, and services.
Expert 9	Sustainable passenger and freight transport services that are safe, convenient, and fast, and conserve energy.
Expert 10	Economically, socially, environmentally, and culturally sustainable rail development.

Integrated information systems



Disabled- and bike-friendly environments



Intelligent stations powered by green energy and smart phones



Convenient transfer stations and networks



Four-rail co-structured and stylish stations



Locally featured and innovative station designs



- Source: 1. <http://daniel.fallman.org/portfolio.html>
2. <http://gizmodo.com>
3. http://www.nmrailrunner.com/handicap_access.asp
4. <http://www.solarfeeds.com>
5. <http://cellsuite.jp/news/news/6>
6. <http://www.wired.com>
7. <http://www.imaginativeamerica.com/category/mit>
8. <http://www.designforlondon.gov.uk>
9. <http://www.european-architecture.info/A-HIST.htm>
10. <http://www.arcspace.com>

Visions for future rail transportation systems

23. Intercity Rail System

23.1 Principles

- (1) Remove existing TRA bottlenecks by increasing route capacity, which can improve both service reliability and operational flexibility.
- (2) Enhance system integration between the HSR and TRA, possibly with physical route connections and service upgrades such as ticketing and information incorporation.
- (3) Increase intercity rail service coverage by refining TRA service. Constructing new branch lines for areas without HSR service may be considered to reduce the rail service gap between western and eastern Taiwan.

23.2 Blueprints

(1) Focus of the HSR network

- Complete the network by building Miaoli, Changhua, and Yunlin Stations in accordance with the financial conditions and transportation demands.
- Connect HSR stations with TRA feeders or truck line services.
- Develop flawless transportation in each station and accelerate the progress of station areas.

(2) Focus of the TRA network

- Complete the network.
- Eliminate bottlenecks.
- Enhance operational efficiency.

24. Urban Rail System

24.1 Principles

In order to determine whether metropolitan rail services are complete, the following six phases are examined.

- (1) Node: effectively connect international airports, HSR stations and major cities.
- (2) Line: provide rail services in the major transportation corridors.
- (3) Surface: provide complete rail networks in metropolitan center areas.
- (4) Integration: provide a flawless transportation environment.
- (5) Improvement: rail projects in construction and planning stages shall be economically and financially beneficial, especially for the TRA rail grade separation projects.
- (6) Revitalization: redevelop existing branch lines or rail facilities and routes that have special functions.

24.2 Blueprints

(1) Northern Taiwan metropolitan region

- Continuously carry out approved projects of TRA commuter stations and grade separation, and enhance public transit feeder services.
- Rail sections that have not been approved for grade separation can implement grade separated roads to reduce the number of urban crossings.
- Differentiate each branch line: the Linkou Line is primarily for commuters and secondarily for tourism; the Shen'ao, Pingxi, Neiwan, Keelung Port, and Yilan Lines are primarily for tourism and secondarily for commuting.
- Create co-stations and integrate services of the TRA Fengfu Station and HSR Miaoli Station.
- The greater Taipei area: railways in the planning stage shall comply with new township development or urban renewal by adapting route/system design and construction timing to form transit oriented development (TOD) corridors.

- Keelung: add new TRA tracks to serve commuters between Keelung and Taipei, and turn the TRA Keelung and Badu Stations into multi-purpose transfer centers.
- Taoyuan: the MRT Red Line should be allowed to use TRA's route, and the Brown Line may be substituted by the Linkou Line. Railways in the planning stage shall comply with new township development or urban renewal by adapting route/system design and construction timing.
- Hsinchu and Miaoli: the TRA Coast Line, Mountain Line, and Neiwan Branch Line shall serve as the basic network, and the operation schedule shall be adjusted to improve its commuting functions.

(2) Central Taiwan metropolitan region

- Continuously carry out approved projects of TRA commuter stations and grade separation, and enhance public transit feeder services.
- Improve the TRA Coast Line to serve mid- and long-distance trips. A cross line study could potentially investigate connecting the TRA Coast and Mountain Lines, to serve as part of the greater Taichung rail network in the long term.
- Rail sections that have not been approved for grade separation can implement grade separated roads to reduce the number of urban crossings.
- Differentiate each branch line: the Jiji Line is primarily for tourism with proper connections to the HSR Changhua Station and Sun Moon Lake Ropeway. The Taichung Port Line is primarily for commuters and may be integrated into the greater Taichung rail network.
- TRA could add a new station between the Shetou and Tianzhong Stations with a link to the HSR Changhua Station. An alternative to that is to build a short line from one of the existing TRA stations to connect to the HSR.

- The greater Taichung area: since Taichung County was merged into Taichung City, previous rail network plans shall be reexamined. To comply with new township development and urban renewal, the network shall adapt a route/system design and construction timing to form TOD corridors. New rail corridors shall connect with the existing TRA network to develop a flawless loop system.
- Changhua: the current spatial development is multi-centered. More frequent transportation services to and from Taichung are highly encouraged.
- Nantou: The Jiji Branch Line has been attracting scenic crowds and its sustainable operations are showing promise. The line shall connect the HSR Changhua Station to the Sun Moon Lake Ropeway, thus forming a vital scenic corridor.
- Yunlin: the HSR Yunlin Station and TRA Dounan Station could be connected by rail, potentially by the TSC Dounan Line.

(3) Southern Taiwan metropolitan region

- Continue to carry out approved projects of TRA commuter stations and grade separation, and enhance public transit feeder services.
- Rail sections that have not been approved for grade separation can implement grade separated roads to reduce the number of urban crossings.
- The Kaohsiung Port and Dong'gang Branch Lines are primarily for tourism and secondarily for commuters. The Kaohsiung LRT Harbor Line may be turned to a scenic coast line to match the future development of the Kaohsiung Port. The Dong'gang Branch Line shall provide tourists with access to the Dapeng Bay National Scenic Area.

- Chiayi: the most important corridor, from Chiayi County Hall to downtown Chiayi City, is currently served by bus rapid transit (BRT). The BRT system may be considered being upgraded in the long run into a rail that connects the Alishan Forest Railway in the east and Puzi in the west, forming a cross rail network with TRA.
- The greater Tainan area: there are several transportation corridors between downtown Tainan and its satellite cities. The basic rail network consists of the TRA Trunk Line and Shalun Branch Line. Future rail plans shall comply with new township development and urban renewal to form TOD corridors.
- The greater Kaohsiung area: since Kaohsiung County was merged into Kaohsiung City, previous rail network plans shall be reexamined. The basic network could consist of the TRA rail and Kaohsiung MRT. Other potential lines shall comply with new township development and urban renewal by adapting a route/system design and construction timing to form TOD corridors.
- Pingtung: in addition to TRA rail services, highway buses could be upgraded to serve the Pingtung-Kaohsiung corridor.

25. Other Rail Systems

25.1 Concepts

- (1) For those railways already in operation, improve their facilities and services. Pass on rail history and culture to sustain operation.
- (2) For those that may be reopened, investigate their potential to serve as intercity or urban rail feeder lines, or their ability to become three-in-one (cultural, scenic, and transportation) railways.
- (3) For those unfit to be reopened, turn the corridors/stations/facilities into people-centered greenways and leisure spaces for walking and bike riding.

25.2 Principles

- (1) Maintain or construct facilities based on local culture and features and using ecological engineering and design methods for better quality. In addition to purchasing new materials, revitalizing and reutilizing existing resources is an important element.
- (2) Those railways with scenic potential shall be linked to rail history and local industries to provide visitors with a unique tourism experience.
- (3) Those lines/corridors with commuter potential shall be reserved and integrated into the intercity or urban rail network. A bus transit system could be an option in the short term to foster a greater demand for rail.
- (4) Rail can be more than just passenger transport, but rather multi-purpose.



New York High Line (Before)



New York High Line Greenway (After)



An old Paris railway turned into a garden



Kaohsiung Harbor Line turned into a bikeway

Source: The bottom right picture was taken by this study; the others come from “Ideal Kaohsiung City” by Y. Z. Wu, <http://www.wretch.cc/blog/genewu5568>

Successful cases of industrial railways and branch railways reutilization

25.3 Blueprints

(1) Maintain existing operations and improve facilities, including

- TRA branch lines: the Pingxi, Neiwan, Chengzhui, Jiji, and old Mountain Lines.
- Forest railways: the Alishan, Taipingshan, and Lintianshan Lines.
- TSC railways: the sugar factory scenic railways in Xihu (Changhua), Suantou (Yunlin), Xinying (Tainan), Wushulin, and Qiaotou (Kaohsiung).

(2) Be used as potential corridors for intercity or urban rails, including

- the TRA Linkou Branch Line that may be primarily for commuters and secondarily for tourism.
- the TRA Taichung Port Branch Line that may be primarily for commuters.
- the TSC Dounan Line that may be the feeder line for the HSR Yunlin Station and TRA Dounan Station.
- other TSC lines that may potentially provide local public transit services.

(3) Serve tourism trips, including

- the TRA Shan'ao, Keelung Port, Kaohsiung Port Branch Lines that may be primarily for tourism and secondarily for commuters.
- the TRA Hwalian Port Branch Line (old) that was turned into a co-constructed railway and bikeway, the first case in Taiwan.
- the TRA Dong'gang Line that may potentially be reopened to provide transit access to the Dapong Bay National Scenic Area.

(4) Other rail lines/corridors may become people-centered leisure spaces and greenways.

TOPICS

26. Domestic and Foreign Environmental Differences

26.1 Highway social (external) costs are not internalized

Highway social costs, such as construction and maintenance costs, environmental pollution, and so on, are not internalized. People rely on highways but underpay for their trips. More highway funding causes more traffic and takes away from the rail budget, leading to a vicious cycle.

26.2 Inter- and intra-departmental integration does not work well

The planning processes of major infrastructure construction projects lack effective and regular programs to integrate inter- and intra-departmental opinions. Case-by-case communication does exist but is not able to improve infrastructure quality during its life cycle.

26.3 Highways are the main form of transportation

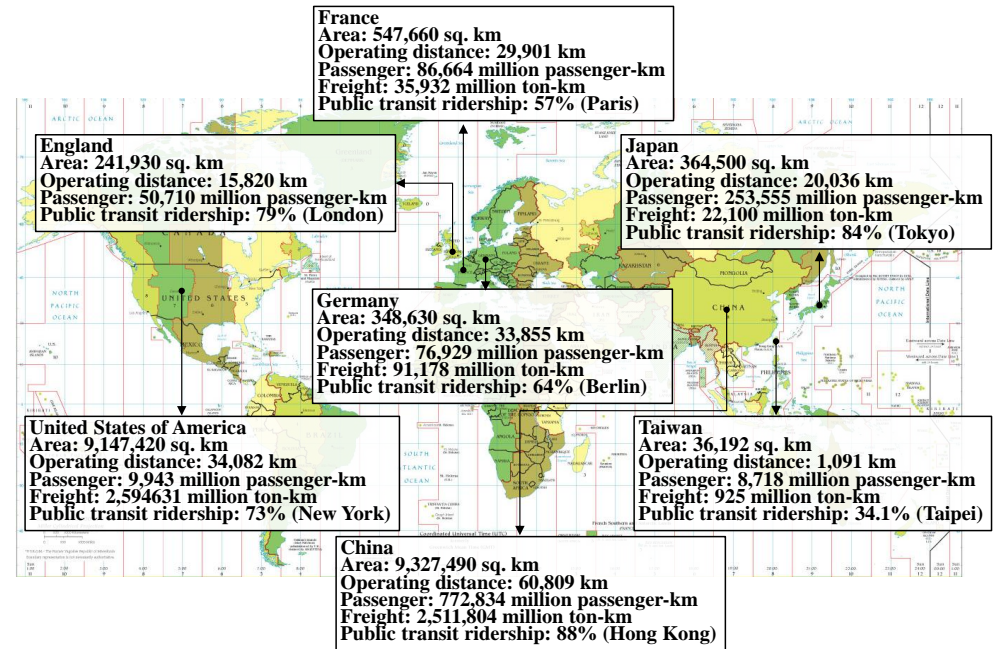
Because highway construction is relatively inexpensive and popular with the general public, the government generally consider highway construction ahead of railways. The rail market has been eroded by the continuous building of highways, which in turn causes insufficient ridership to sustain the rail system.

26.4 System selection depends on the benefit/cost ratio and technical feasibility

The budgeting and examination mechanisms of major infrastructure construction projects focus on benefit/cost ratio and technical feasibility. Costly railways thus appear inferior to inexpensive highways, regardless of such aspects as the cultural and social values brought by rail services.

26.5 Rail transportation is more competitive in the longer-distance market

The maximum operating distances for the HSR and TRA are 345 km and 1085.3 km, respectively, not long enough to reduce the total operating costs while still offering appealing rail fares.



Note: 1. The operating distance, passenger-km, and freight ton-km come from 2008 data associated with the major rail companies in each country.

2. Public transit ridership data refer to different years: 2009 for Taiwan, 2007 for China, 2006 for Japan, Great Britain, and the U.S.A., and 2000 for Germany and France.

Source: 1. Taiwan Comprehensive Transportation Development Planning, Institute of Transportation, MOTC, 2009.

2. MOTC transportation statistics
<http://www.motc.gov.tw/mocwebGIP/wSite/np?ctNode=538&mp=1>, retrieved 2010.

3. Photius Coutsoukis and Information Technology Associates,
<http://www.theodora.com/maps/new5/802649.jpg>, retrieved 2010.

27. General Development

27.1 There is not enough integration among individual rail systems to increase rail ridership.

- (1) Intercity rail services are limited because the routes, ticketing, information, and train schedules are not well integrated between the TRA and HSR.
- (2) Metropolitan rail planning usually ignores the existing TRA system and loses the opportunity for integration.
- (3) Revitalization of the existing TRA branch lines and special lines should be considered in comprehensive rail planning.

27.2 There is not enough integration between the rail and highway bus systems to provide flawless public transit.

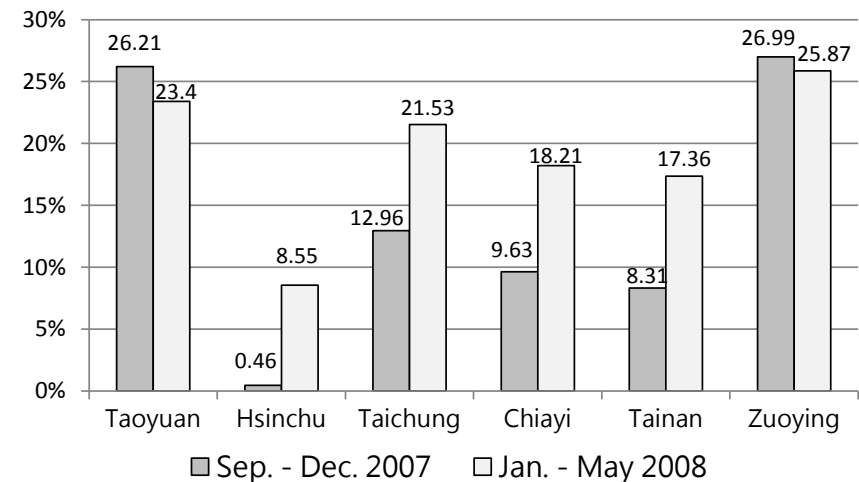
- (1) HSR station access through public transit should be better utilized.
- (2) Issues such as malfunctioning circulation, inadequate facilities, and long distances make transferring difficult in the TRA stations.
- (3) Bus transit is neither well developed nor utilized outside of the Taipei area. More public transit riders should be created through bus systems before introducing rail transportation.

27.3 There is a lack of supporting measures to maximize the benefit of rail transportation.

- (1) The social costs derived from private modes are not internalized. Also, regional and urban public transit networks are not complete. These factors obstruct rail development.
- (2) The rail system and spatial development are not sufficiently integrated to support each other.
- (3) It is essential to implement a customer-centered green transport environment.

27.4 The multiple values provided by rail transportation have not yet been discovered.

- (1) More innovation and creativity is necessary for scenic rail development.
- (2) More studies are needed to investigate the potential of green rail logistics.
- (3) The forest railways have great tourism and cultural potential under a refined operating and administrative model.
- (4) The TSC railways shall be systematically revitalized with innovative ideas.
- (5) The role of railways on cross-strait freight has not yet been identified.



- Source: 1. Study on Establishing a Decision Support System and Integrated Database for Transportation Infrastructure Deliberations (2/3), Institute of Transportation, MOTC, 2009.
2. Passenger origins and destinations data (Sept 2007 ~ Aug. 2008) were from TRA, Oct. 2008.
3. Public transit access data (Jan. 2007 ~ May. 2008) were from the Directorate-General of Highways, MOTC, July 2009.

Public transit ridership to and from HSR stations



Source: 1. Left: The Council for Cultural Affairs (Executive Yuan), Cultural Tourism Taiwan.

<http://tour.cca.gov.tw/frontsite/scenery/sceneryDetailAction.do?method=doDetail&serNo=200907020101&subMenuId=301&siteId=101#>, retrieved 2011.

2. Right: taken by this study.

Obsolete TSC rail facilities

28. Intercity Rail

28.1 The HSR project has not accomplished its original policy goals.

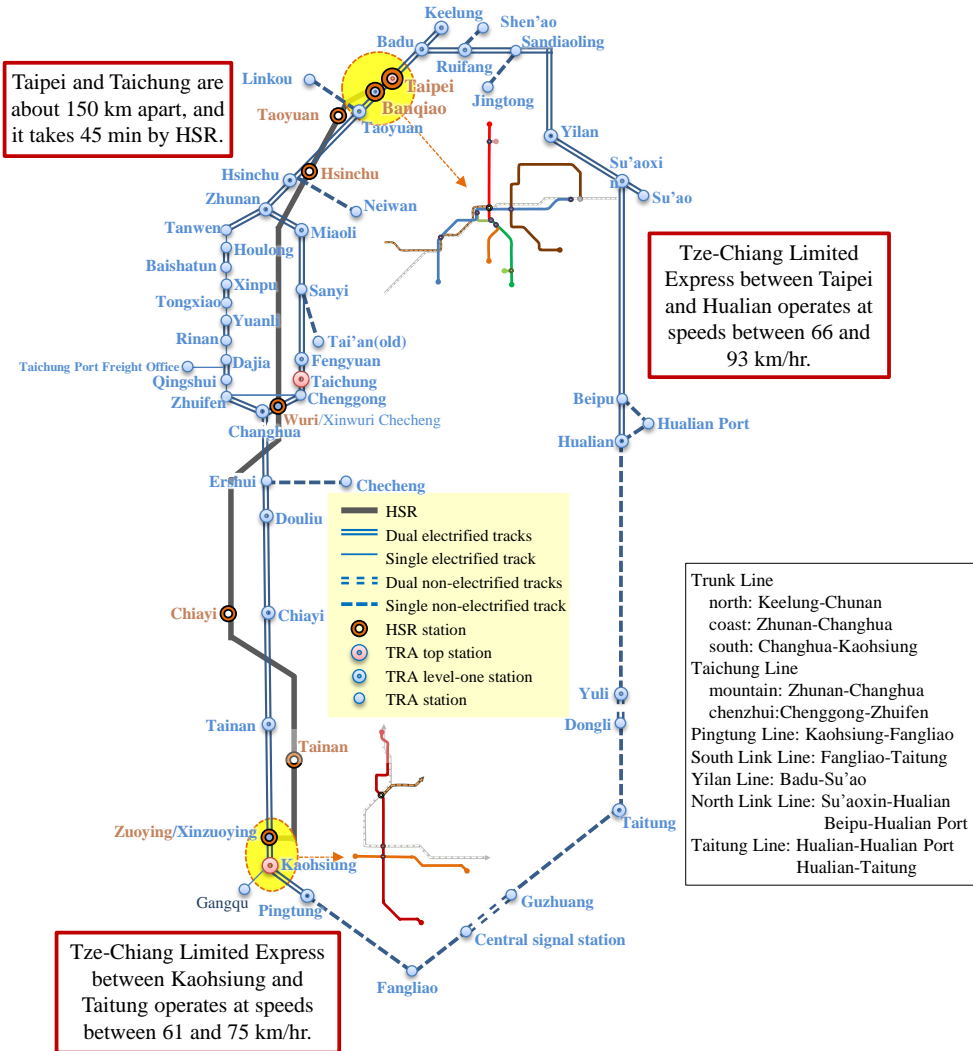
- (1) The HSR policy goals have not been fully realized due to not reaching the expected ridership.
- (2) Some areas do not have easy access to the HSR.
- (3) The three approved HSR stations may affect the operation of HSR and bring severe competition between the TRA and HSR.
- (4) Reaching a general agreement on building HSR extensions or branch lines is essential.

28.2 The TRA intercity services need updated facilities and refined quality.

- (1) The existing bottlenecks reduce the route capacity and reliability.
- (2) Some non-electrified and single-track sections still require upgrades.
- (3) Such factors as various train types, worn-out trains, and an insufficient amount of trains affect the route capacity, scheduling, and system reliability.
- (4) The station configurations should be reexamined, and the facilities updated.
- (5) Rail safety needs to be improved.
- (6) Adjusting rail positioning and fares for better regional rail services is essential.
- (7) The TRA Valley Line shall serve as the transportation trunk in eastern Taiwan.
- (8) Issues such as insufficient space, malfunctioning circulation, limited choices, and dated facilities make transferring difficult in TRA stations.
- (9) The TRA branch lines are usually underutilized and in debt.
- (10) Various restrictions on affiliated businesses make it difficult for TRA to diversify its business.

28.3 The rail services in eastern Taiwan and the east-west links shall be upgraded qualitatively and quantitatively.

- (1) The east-west rail link in northern Taiwan shall be upgraded.
- (2) The east-west rail link in southern Taiwan shall be upgraded.



Intercity rail efficiency gap between eastern and western Taiwan

29. Urban Rail

29.1 The TRA's role in urban transportation needs to be defined.

- (1) The TRA commuter rail should be the trunk lines in urban transportation.
- (2) The existing route capacity has dropped due to insufficient supporting measures for the TRA commuter rail project.
- (3) Reexamining the benefit and cost items of the TRA grade separation project is essential, as is clarifying the authorities between the central and local governments, as well as between the transportation and urban planning departments.
- (4) The TRA branch lines could potentially be vitalized as part of the regional network.

29.2 The conditions for sustainable urban rail operations have not been met.

- (1) Previous urban rail network planning needs reexamination as a result of temporal and spatial changes.
- (2) There are no specific criteria for approving an urban rail construction project. Also, a larger consensus is needed to properly place railways in the urban public transit system.
- (3) Actions to support urban rail development, e.g. private mode management, public transit service improvement, and rail-related land development, have long been insufficient.
- (4) Supply-oriented rail policies and tools have not been established.



Source: TRA,

<http://service.tra.gov.tw/Sijhih/CP/15788/%E6%B1%90%E7%A7%91%E7%AB%99%E7%B0%A1%E4%BB%8B.aspx>, retrieved 2010.

TRA commuter rail station without train passing space



Source: Railway Reconstruction Bureau, MOTC,

<http://www.rrb.gov.tw/04100.aspx?id=5&lan=ch>, retrieved 2010.

The new TRA Taichung Station with elevated commuter railways (simulation)

30. Institutional Environment

30.1 Institutional authorities need to be adjusted.

- (1) There is no central supervisory institution to administrate the rail operators, who are currently supervising themselves.
- (2) The TRA does not have a flexible organization to adjust its operations within a dynamic market.
- (3) There is no dedicated rail institute for research and development. Core technology and facilities rely on foreign import.
- (4) There is no central institution that coordinates transportation policies and public transit development, making it difficult to achieve policy goals and horizontally integrate each mode.
- (5) There is no local public transit agency in charge of planning and administrating rail management and operations.

30.2 The planning and management programs are idle and insufficient.

- (1) There is no comprehensive planning and policy guidance to maximize individual projects' benefits.
- (2) The rail project review process is not open enough to receive joint opinions to create a better outcome.
- (3) There is no reassessment or post-evaluation program to adjust decision making afterward or to pass on the experiences.
- (4) Construction projects do not clearly define the responsibilities of local governments, which compete for limited rail resources without cautious planning.
- (5) Investment efficiency is jeopardized due to a lack of regular programs that coordinate rail construction and operations.

30.3 Rail-related laws need to be revised.

- (1) The Railway Law does not sufficiently guide rail system operations.
- (2) The Railway Law restricts land management and affiliated businesses from running properly, making it difficult to integrate rail transportation and spatial development.
- (3) The existing legal policy tools are inadequate in prioritizing rail's right of way, as well as in directing people to public transit.

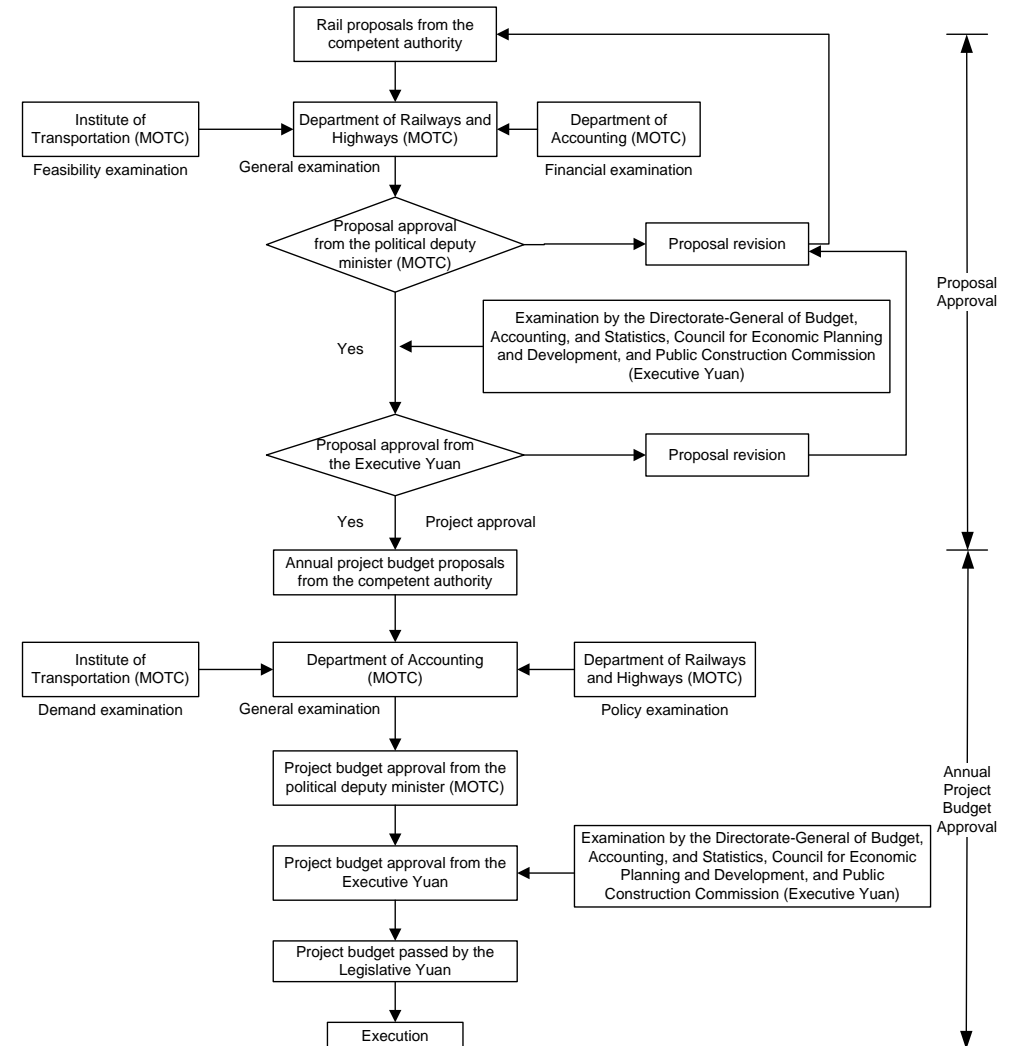
(4) The rail laws are not flexible enough to cope with new technology for better rail development.

30.4 The financial tools are insufficient and rigid.

- (1) There are various approved rail projects, but the budget will not be sufficient to carry out those approved projects until 2021, needless to say for the new proposals in the approval process.
- (2) Construction and operation subsidies rely on a fair and objective program to direct rail development.
- (3) The fare structure is rigid and unreasonable, making it difficult to place each rail system properly in the market.
- (4) The TRA rail has long been in debt and solutions need to be keenly sought.
- (5) There is no reasonable link between rail construction, land development, and fund raising. The benefits derived from rail projects will have to be properly distributed.

30.5 The passion for running a sustainable business is missing.

- (1) There is no long-term planning or general agreement on rail development, but only case-by-case approval processes.
- (2) Conventional vehicle-centered thinking obstructs rail development.
- (3) Rail knowledge and professionals are insufficient and available only in a few agencies. This jeopardizes rail planning, design, and decision making quality.
- (4) The rail industry relies heavily on foreign technology and importing facilities, which does not completely fit with local needs.
- (5) Rail culture resources are neither well explored nor utilized, making it difficult to refine and pass on rail culture.
- (6) TRA's corporate image needs to be improved.



Source: Railway System Development Master Plan, Institute of Transportation (MOTC), 2008.

Rail proposals and budget approval process without reassessment or post evaluation procedures

31. Key Issues: Policy Indicators for Safety, Reliability, and Capacity

From travelers' perspectives, the rail system should be safe, on time, and fast. Therefore, this study proposes some indicators to determine rail safety, reliability, and capacity for future improvement.

31.1 Safety

(1) Safety issues

- Rail safety policies do not have action plans or objectives.
- Insufficient professionals in various institutions cause rail safety administration to be less effective.
- There is no independent rail accident investigation institution, only temporary duty assignment. Passing on accident investigation skills and experiences or conducting systematic and chronic investigations on individual accidents is practically impossible because of this.
- Unclear definitions of rail accidents make it difficult to analyze causes and propose countermeasures.
- Non-standardized safety data formats and reports make it difficult to compare each system or set safety standards for new systems.

(2) Policy indicator

The literature review suggests that safety indicators should be associated with passengers, employees, and crossings regarding the accident rates and the number of deaths/injuries.

■ Passenger safety

The number of accidents involving passenger deaths or injuries per million passenger-km = the annual number of accidents involving passenger deaths or injuries / the annual passenger-km in million

The number of passenger death equivalent per million passenger-km = the annual number of passenger death equivalent / the annual passenger-km in million

■ Employee safety

The number of accidents involving employee deaths or injuries per million working hours = the annual number of accidents involving employee deaths or injuries / the annual employee working hours in million

The number of employee death equivalent per million working hours = the annual number of employee death equivalent / the annual employee working hours in million

■ Rail crossing safety

The average number of accidents per crossing = the total number of crossing accidents / ((the number of crossings in the beginning of the year + the number of crossings in the end of the year) ÷ 2)

The average death equivalent of crossing accidents = the total death equivalent of crossing accidents / ((the number of crossings in the beginning of the year + the number of crossings in the end of the year) ÷ 2)

31.2 Reliability

- (1) The Taipei and Kaohsiung MRT define “on-time” differently, so a new standard definition is required in order to compare the MRT systems nationwide.
- (2) Reliability is measured by the average delay and on-time rate. The adoption of both indicators is necessary to avoid having misleading results.
- (3) Policy indicator

- Average delay: Average delay of trains arriving at the terminal station.

Average delay = total delay of trains arriving at the terminal station / total number of train services

Criteria for the train delay indicator

One-way operating distance	Criteria
distance < 10 km	> 1 min
10 km ≤ distance < 20 km	> 2 min
20 km ≤ distance < 30 km	> 3 min
30 km ≤ distance < 40 km	> 4 min
40 km ≤ distance	> 5 min

- On-time rate: the number of on-time train services divided by the total number of train services

On-time rate = the number of on-time train services / the total number of train services

Criteria for the train on-time indicator

One-way operating distance	Criteria
distance < 10 km	deviation < 1 min
10 km ≤ distance < 20 km	deviation < 2 min
20 km ≤ distance < 30 km	deviation < 3 min
30 km ≤ distance < 40 km	deviation < 4 min
40 km ≤ distance	deviation < 5 min

Note: Deviation is the difference between the actual and scheduled arrival times.

31.3 Capacity

(1) Existing conditions

- Every rail system, except the Kaohsiung MRT, is concerned with insufficient capacity.
- The most critical capacity insufficiency occurs in the TRA Keelung-Hsinchu section that serves the west and east trunk lines, as well as the high-frequency commuter rail.
- Various train types and stop schedules reduce the TRA’s rail capacity and do not allow the TRA trains to operate like MRT.
- The newly built commuter stations have only two tracks that do not allow following express trains to pass, reducing the operating speed and route capacity.
- The bottleneck of the HSR operation lies in an insufficient amount of trains.
- The bottleneck of the Taipei Main Station (Taipei MRT Ban-Nan Line) lies in long off- and on-boarding times.

(2) Policy indicator

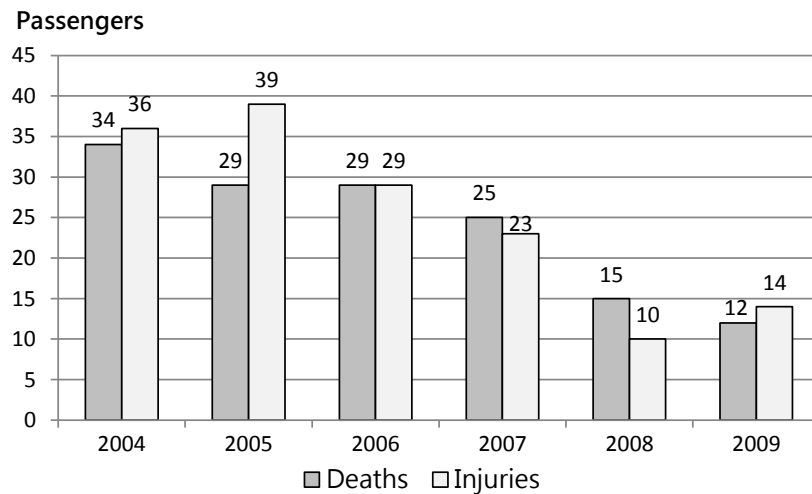
Insufficient capacity will affect the frequency, reliability, and comfort of rail services. Two indicators, route utilization and passenger occupancy, are proposed for systematic and passengers’ aspects.

- Route utilization is the ratio of actual supply over maximum supply.

Route utilization = the scheduled rail frequency / the route capacity

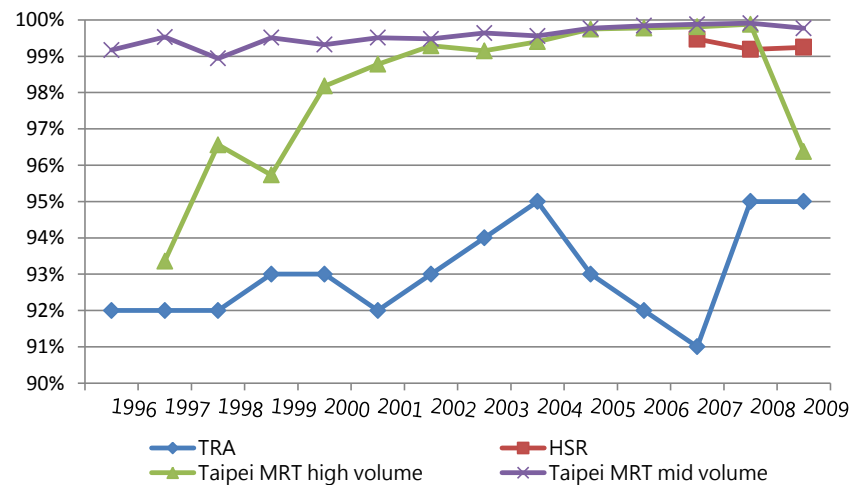
- Average passenger occupancy

Average passenger occupancy =
(the number of passengers * average riding distance) / (the scheduled service capacity * train operating distance)



Source: TRA, <http://www.railway.gov.tw/admin/admin-8-2.3.aspx>, retrieved 2010.

Injuries and deaths in TRA rail accidents by year



Note: Data of the Kaohsiung MRT are not available.

Source: 1. TRA, <http://www.railway.gov.tw/aay00/excel/97busi/t12.pdf>, retrieved 2010.

2. THSRC, http://www.thsrc.com.tw/tc/about/ab_operate_year.asp, retrieved 2010.

3. TRTC, Taipei Rapid Transit Corporation 2009 Annual Report, 2010.

Taiwan's rail system on-time rates by year

POLICIES

32. Policy Framework

- 32.1 Providing safe, reliable and efficient rail services
- 32.2 Developing organized and flawless rail transportation
- 32.3 Enhancing intercity rail services
- 32.4 Improving urban rail services
- 32.5 Embracing green transportation
- 32.6 Completing institutional infrastructure



Taiwan's rail system development goals and visions

33. Providing Safe, Reliable and Efficient Rail Services



Source: The National Transportation Safety Board (NTSB) Training Center, <http://www.nts.gov/TC/TrainingCenter.htm>, retrieved 2010.

The NTSB Training Center



Title	Accident Investigation Orientation for Rail Professionals
Description	This course, led by NTSB investigators, details how the Safety Board investigates railroad accidents and what it expects of participants in an investigation.
Overview	<ul style="list-style-type: none"> ■ NTSB overview and history ■ Authority and limitations of the NTSB Office of Railroad, Pipeline and Hazardous Materials ■ NTSB go-team and the on-scene investigation ■ The "party" process ■ Post on-scene investigation ■ Services and support provided to families of accident victims ■ Role of the NTSB board member and the Office of Public Affairs ■ Safety recommendations
Performance Results	<p>Upon completion of this course the participant will be able to:</p> <ul style="list-style-type: none"> ■ Discuss how the NTSB investigators work on-scene at an accident and the role of a "party" member ■ Work in a close and coordinated manner with the NTSB investigators on-scene ■ Describe the NTSB accident investigation from initial notification to final board meeting and recommendations ■ Explain what types of services and support are available to family members of victims of railroad accidents ■ Describe the role of the NTSB Office of Public Affairs in the release of relevant and appropriate information to the public

Source: The National Transportation Safety Board (NTSB) Training Center, http://www.nts.gov/TC/CourseInfo/2011-Courses/RPH301_2011.html, retrieved 2010.

NTSB course planning

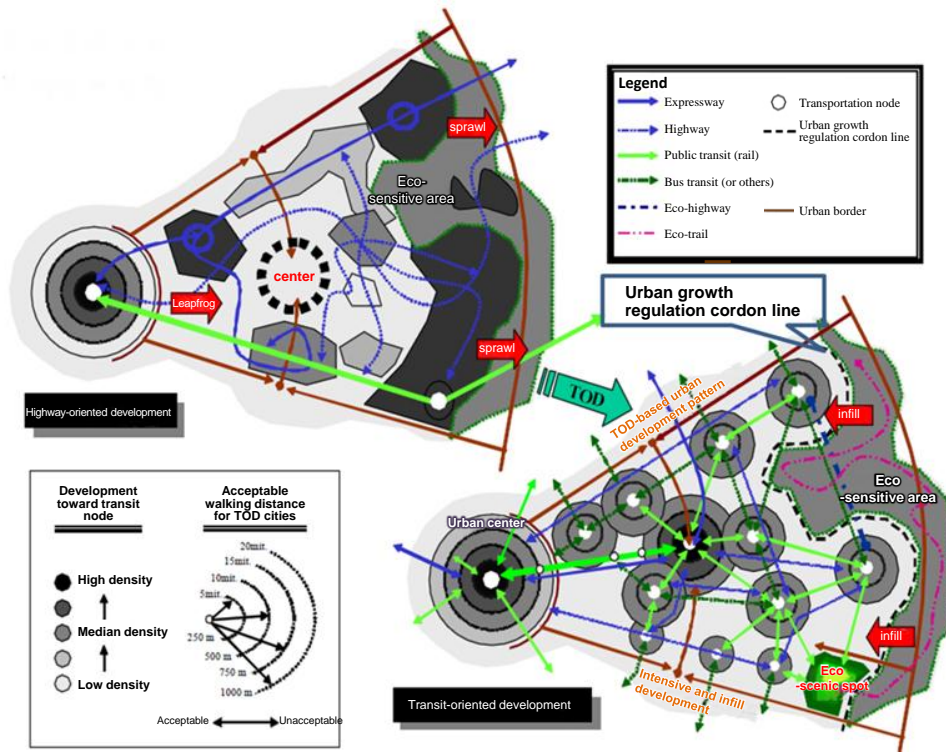
Policy summary: Providing safe, reliable and efficient rail services

Goal	Initiative	Objective	Strategy	Policy content	Stage
Providing safe, reliable and efficient rail services	Increase system safety.	Reduce rail accidents, as well as injuries and deaths.	Establish complete programs, laws, and guidelines for a safe rail system.	Establish a sound administrative program between central and local rail authorities.	Short/Mid term
				Define important rail safety terms.	Short term
				Establish safety databases and information platforms.	Mid/Long term
				Establish rail accident investigation institutions.	Short/Mid term
				Investigate rail safety issues and countermeasures.	Short term
				Adopt any administrative measures that may enhance safety.	Short term
	Increase service reliability.	Reduce delay of each rail system to provide on-time services.	Encourage the operation department to increase system reliability through operational measures.	Reserve operational flexibility through a better train schedule.	Short term
				Reduce work zone impact through train schedule adjustment.	Short term
				Improve professional training to shorten system reboot time.	Short/Mid term
				Improve crowd management in rail stations.	Short/Mid term
				Simplify TRA train types and services.	Short/Mid term
				Improve mechanical and electrical system stability to reduce signal errors and system failures.	Mid/Long term
				Improve maintenance and replacement.	Short/Mid/Long term
				Increase route capacity.	Long term
	Provide comfortable, convenient, and express services.	Balance system efficiency and comfort with optimum capacity.	Investigate the causes of bottlenecks. Improve route and control devices to increase system capacity.	For TRA, simplify train types, improve train performance, increase the number of tracks within stations, reduce at-grade crossings, improve the signal system, and increase tracks between stations. Sections without sufficient capacity due to intensive commuter rail services should consider the train specs and provide extra space in the station area to reduce delay and waiting time.	Short/Mid/Long term
				For the HSR, purchase more trains, reduce the retooling time in the end terminals, and open the Nankang Station or build the Hengke Base to avoid train retooling in the platform areas.	Long term
				For the Taipei MRT, adopt effective crowd management strategies and upgrade the signal and control system to reduce train headway.	Short/Mid term

34. Developing Flawless Rail Transportation

Policy summary: Developing organized and flawless rail transportation

Goal	Initiative	Objective	Strategy	Policy content	Stage
Developing organized and flawless rail transportation	Define a transportation market positioning for each mode.	Segment the market to create a win-win situation.	Complete public transit institutional infrastructure. Place each mode properly in the market based on its features.	Establish a dedicated transit institution for national and regional public transit planning.	Short term
				Reasonably allocate the budget and subsidy funding for public transit.	Short/Mid term
				Segment the HSR, TRA, and national highway bus markets.	Short/Mid term
				Improve the convenience of transit services.	Short term
				Improve land transit connections to airports and harbors.	Mid/Long term
	Construct friendly and flawless rail services.	Provide a flawless transportation environment regarding time, space, information, and services.	Reduce transfer waiting time. Improve the transfer environment. Enhance service information integration, accessibility, and friendliness. Make transfers easier and less expensive.	Improve transfer circulation and facilities within the station areas.	Short/Mid term
				Improve the disabled-accessible environment of TRA stations and trains.	Short term
				Integrate the schedules of TRA, HSR, and buses to reduce the waiting time for transfers.	Short/Mid term
				Integrate the public transit information lookup system and provide multiple access points to transit information.	Mid/Long term
				Integrate the ticketing systems among various public transit systems to enhance efficiency and make transfers smoother through proper passenger flow design.	Short/Mid term
	Build TOD corridors along railways.	Properly integrate rail construction and space development to form multi-purpose TOD corridors.	Directly plan urban and transportation systems via TOD. Formulate the rail system into a legal plan that can guide national land development.	Promote urban-rural clusters to avoid scattered development.	Long term
				Reduce lane widths to turn vehicle-centered planning into people-centered.	Long term
				Major city centers shall be planned and developed along transit terminals and facilities.	Short term
				Reduce the thresholds of land acquisition around transit terminals and free up restrictions on land use categories.	Short/Mid term
				Paradigm shift on the thinking of comprehensive national land development.	Long term
				Establish a program for growth management or urban growth boundary setting.	Short/Mid term
				Equip comprehensive transportation planning with statutory backing.	Short term
				Integrate land use and transportation planning via green transportation development strategies.	Short/Mid term
				Major transportation construction projects shall be based on comprehensive transportation planning. CEPD shall coordinate major construction and national land development.	Mid term
				The program for urban growth boundary setting shall be the foundation of integrating rail construction, land development, and fund raising.	Mid/Long term
				Establish urban design guidelines for station areas to pass on rail culture.	Mid/Long term



Source: Revised from the “Urban Transit Oriented Development Planning Model”, J. N. Li, 2003.

Conceptual scheme of the urban growth boundary and Taiwan’s regional and metropolitan TOD development structures

35. Enhancing Intercity Rail Services

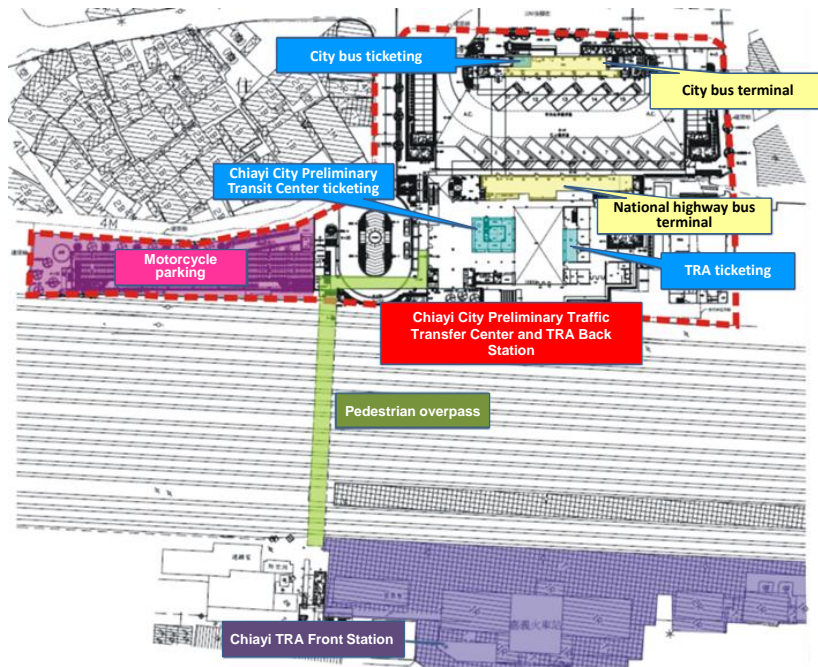
Policy summary: Enhancing intercity rail services

Goal	Initiative	Objective	Strategy	Policy content	Stage
Enhancing intercity rail services	Extend and upgrade TRA services.	Improve TRA's network coverage, efficiency, and service quality.	Remove system bottlenecks. Complete the intercity network. Increase the speed of the Taipei-Yilan Line and North Link Line. Complete electrified and double-track railways.	Investigate the bottleneck sections and propose countermeasures.	Short term
				Timely promote the Hengchun Branch Line given sufficient demand.	Mid/Long term
				Evaluate the cross line between the Coast and Mountain Lines.	Mid/Long term
				Propose alternatives for the Taipei-Yilan Straight Rail Line.	Mid/Long term
				Continue to complete electrified and double-track railways around the island to improve operating efficiency.	Mid/Long term
				Readjust the train schedules and operating plans to comply with demand.	Short term
				Improve scheduling efficiency.	Short term
				Accelerate the purchase of intercity passenger trains and simplification of train types.	Short/Mid term
	Integrate the TRA and HSR to maximize efficiency.	Continue to increase rail ridership.	Complete the connection between the TRA and HSR stations. Establish a regular bi-rail corporation and negotiation program. Identify the market segments of the TRA and HSR for better development.	Establish feeder rail lines between the HSR and TRA stations, preferably by the TRA system.	Mid/Long term
				Timely construct Miaoli, Changhua, and Yunlin HSR stations.	Mid/Long term
				The TRA station that connects the HSR station shall provide intensive and various train services.	Short term
				Integrate the ticketing and information systems of TRA and HSR.	Mid/Long term
				Establish a mechanism to synchronize TRA and HSR schedules' adjustment.	Short term
				Accelerate the transformation of TRA services so that it will become the regional commuting trunk line in western Taiwan and the scenic trunk line in eastern Taiwan.	Short term
				Examine the TRA and HSR fare systems and structures for better market segmentation.	Short term

36. Improving Urban Rail Services

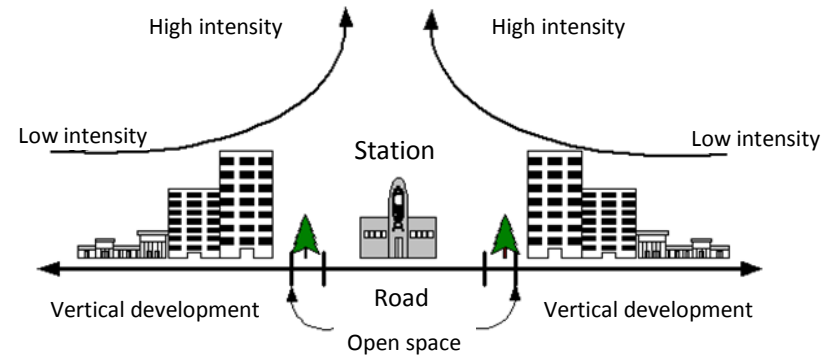
Policy summary: Improving urban rail framework

Goal	Initiative	Objective	Strategy	Policy content	Stage
Improving urban rail framework	Construct the metropolitan rail framework.	Provide a sound foundation for metropolitan rail development through building fundamental networks and supporting systems.	Rail development and improvement shall comply with comprehensive urban planning. Reassess rail network plans to comply with urban space development. Fulfill the components of sustainable rail operations.	Assess the optimum scale of the MRT network and the effects of the newly operating lines.	Short term
				Avoid urban MRT/LRT lines parallel to TRA corridors.	Short term
				Metropolitan rail investment shall focus on improving existing services first.	Short term
				Grade separation of the TRA lines shall serve as a supporting measure of urban sewing.	Short term
				Reexamine the unexecuted rail grade separation projects based on MOTC's rail grade separation review mechanism.	Short term
				Establish criteria and a review mechanism for sustainable metropolitan rail operations.	Short/Mid term
				Reconsider and restructure the rail networks in the five new municipalities.	Short/Mid term
				Assess the necessity of the existing branch lines with joint consideration of major development projects and network reorganization in the five new municipalities. Conduct comprehensive scenic railway planning.	Short/Mid term
				Enhance TRA's existing system operations.	Short
				Address the concerns of railway operation deficits and propose effective strategies to reduce the financial burden.	Short/Mid term
				Buses should be considered first in those cities without approved MRT/LRT systems and lines.	Short term
				Improve rail crossing safety management and education.	Short term
	Major rail stations serve as space and transportation centers.	Reorganize urban space structures to enhance public transit ridership.	Provide satisfactory services and environments in and around the station. Adjust land use and patterns around the station. Provide incentives for utilizing the transportation centers.	Establish local primary and secondary transfer centers around the HSR stations and major TRA stations.	Short/Mid term
				Continue to promote rail connection between the TRA Taichung Station and Taichung International Airport.	Long term
				Provide a pedestrian and bike friendly environment around the transfer centers.	Mid/Long term
				Establish park and ride lots.	Mid/Long term
				Examine the land-use plans of rail stations.	Short term
				Provide incentives for utilizing the transportation centers.	Short term
				Diversify the businesses and industries around the station.	Short/Mid term
				The international airports, HSR stations, and TRA stations should provide diversified public transit services.	Mid/Long term



Source: Revised from the “Chiayi City Preliminary Traffic Transfer Center Design and Construction Supervision Project”, Chiayi City Government, 2010.
<http://www.chiayi.gov.tw/index.asp>

Chiayi City preliminary traffic transfer center layout



Source: Z. J. Xu, and Y. Z. Lin, Transit Oriented Urban Development Objectives and Strategies, a Case Study in Taipei City, Economic Outlook Bimonthly, March, 2003.

Land use around public transit terminals

37. Embracing Green Transportation

Policy summary: Embracing green transportation

Goal	Initiative	Objective	Strategy	Policy content	Stage
Embracing Green Transportation	Guide green transportation via rail systems.	Increase the rail market share and decrease the rail impact on the environment.	Increase the rail market share. Decrease the negative impact due to rail construction and operations.	Establish the green tax structure and subsidy program in the transportation sector.	Mid/Long term
				Investigate new energy generation and guidelines.	Mid term
				Institutionalize surveys on the environmental sustainability indicators and sustainability improvement program.	Mid term
				Specify the duty of each sector.	
				Adjust train schedules to avoid the bottlenecks and delays.	Short term
				Encourage energy-saving technology and facilities on the trains and in the stations.	Short/Mid term
				Teach the general public that rail transport is environmentally friendly.	Mid/Long term
	Enhance TRA's scenic potential to sustain operation of the branch lines.	Create multiple funding sources. Turn the branch lines from indebted operations into financial sustainability.	Increase rail attractions via discovery of nearby scenic and historical potential. Enhance the internal system and external environment of the railways.	Establish a reconstruction model of co-existence and differentiability for the new and old rail stations, facilities, and routes.	Short term
				Formulate the theme of industrial heritage for the Pingxi, Neiwan, Old Mountain, and Jiji Branch Lines.	Mid term
				Improve the financial condition of scenic branch lines through flexible schedules, updated operation models and fares, and private mode management.	Mid term
				Examine and reduce the restrictions of rail-related laws on developing scenic railways.	Mid/Long term
				Develop integrated services of railways, other transit modes, and biking.	Mid term
				Establish an official railway scenic information platform.	Mid/Long term

Policy summary: Embracing green transportation (continued)

Goal	Initiative	Objective	Strategy	Policy content	Stage
Embracing Green Transportation	Develop the Alishan Forest Railway to be national scenery and a historical asset.	Unite the Alishan Forest Railway and the National Alishan Recreation Area to attract international visitors.	Increase the rail attraction via its scenic and historical potential. Enhance the internal system and external environment of the railways. Develop a world-class tourism spot.	Repair the Alishan Forest Railway.	Short term
				Formulate the theme of industrial heritage for the forest railway.	Mid term
				Adjust the operation and administration model. Assess the feasibility of transferring the forest railway to be under MOTC's supervision.	Short term
				Confirm the Alishan Forest Railway as cultural heritage.	Mid/Long term
				Improve the National Alishan Recreation Area through the joint efforts between the Tourism Bureau (MOTC) and Chiayi County Government.	Short term
				Market the railway to attract international visitors.	Short term
				Examine and reduce the restrictions of rail-related laws for developing scenic railways.	Mid/Long term
				Private mode management.	Short/Mid term
	Reserve and utilize the TSC railways to maximize potential.	Reserve and utilize the TSC railways to be a moving historical landscape.	The TSC railways can either be part of the intercity or metropolitan rail system to avoid the construction of new rail lines, or be a leisure/people-centered transportation space.	Conduct asset and inventory investigations on the TSC railways.	Short term
				Assess the TSC railways based on their socio-economic conditions and demand attributes. The railway that meets intercity or metropolitan transportation needs shall be reserved for future redevelopment. The railways with less transportation potential shall be reserved for people-centered green transportation or leisure space.	Short term

Policy summary – Embracing green transportation (continued)

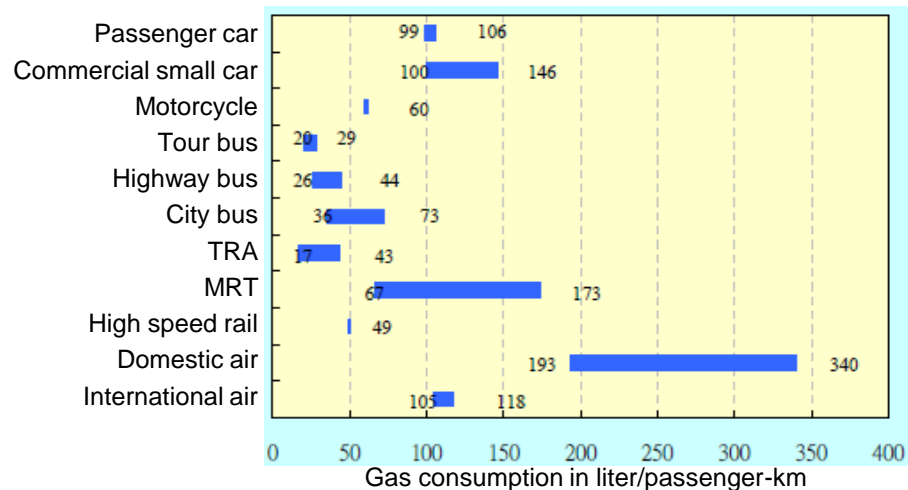
Goal	Initiative	Objective	Strategy	Policy content	Stage
Embracing Green Transportation	Turn TRA freight transport into green logistics.	Reduce the carbon emissions of freight transport. Increase highway safety via a greater rail freight market share.	Improve the rail freight environment. Consider local characteristics and differences. Develop the potential market and assess the feasibility of business diversity.	Reserve corridor space for potential cross-strait freight business and improve major freight terminal facilities.	Short/Mid term
				Reexamine the freight demand distribution and plan potential routes.	Short term
				Establish the rail freight role as an auxiliary mode for western Taiwan and a major mode for eastern Taiwan.	Short term
				Examine the rail freight laws and regulations.	Mid/Long term
				Establish the freight management department under TRA, and the research department under the Railway Bureau.	Short term
				Conduct a feasibility study of rail freight privatization.	Short term
				Internalize the social costs of highway freight.	Short/Mid term
				Continue to purchase advanced freight trains and equipment to enhance capacity and efficiency.	Mid/Long term
				Accelerate the development of express and fresh food delivery and assess the feasibility of developing diversified affiliated businesses.	Mid/Long term
				Establish a green logistic mark system and encourage the general public to purchase products transported by railways with the green mark.	Mid term
				The military and TRA shall evaluate the need of a military freight rail continuously provided by TRA.	Short term



Source: 1. TRA's first solar powered station, Nanke Station, officially opened on 7/14/2010. News press, TRA (MOCT) and Tainan County Government, 2010.

2. Soundpower Corporation website,
<http://www.soundpower.co.jp/products/products1.html#pgf>, retrieved 2010.

Energy conservation technology in rail terminal facilities: solar powered station (left), power-generation floor (right)



Source: Strategies and effects of energy conservation and emission reduction by applying APTS to highway buses, CTCI, 2008.

Energy consumption per passenger-km by mode in Taiwan



Source: the Taiwan Coal Mine Museum, <http://www.coalmine.com.tw/>, retrieved 2010.

The Coal Mine Museum originated from the Xinpingxi coal mine



Steam-powered locomotive with wood box cars

Chiayi rail depot

No. 18 steam-powered locomotive

Source: J. Z. Zhang, Feasibility Study of Alishan Forest Railway Sustainable Operations, Thesis, Graduate School of Tourism, Ming Chuan University, 2008.

Alishan Forest Railway and its facilities



Huwei iron bridge

before reconstruction

after reconstruction

Taiwan Sugar Corporation rail bridge

Source: 1. Left picture: <http://canandmap.pixnet.net/blog/post/23273375>

2. Center and right pictures:

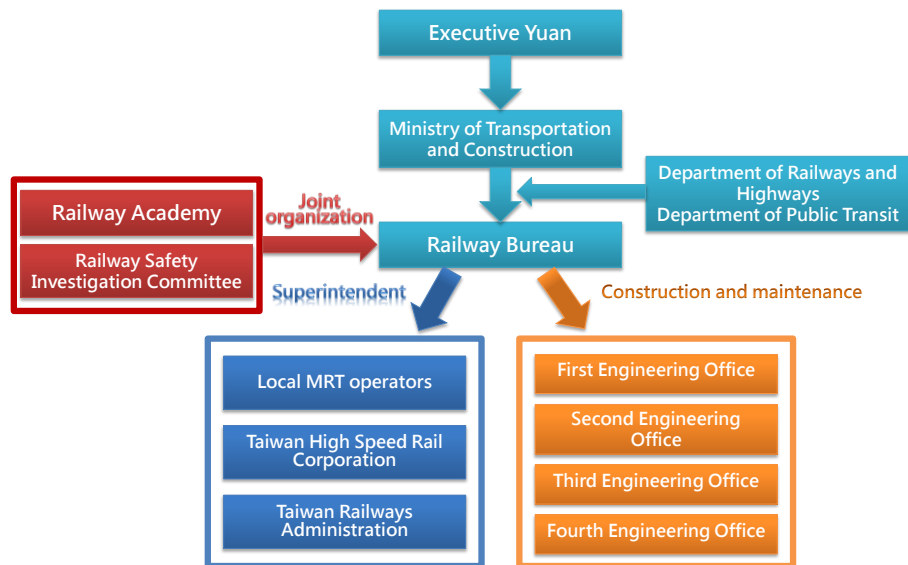
<http://tw.myblog.yahoo.com/yore4/article?mid=26022&prev=26062&next=25970>

The TSC old rail bridge reconstruction cases

38. Completing Institutional Infrastructure

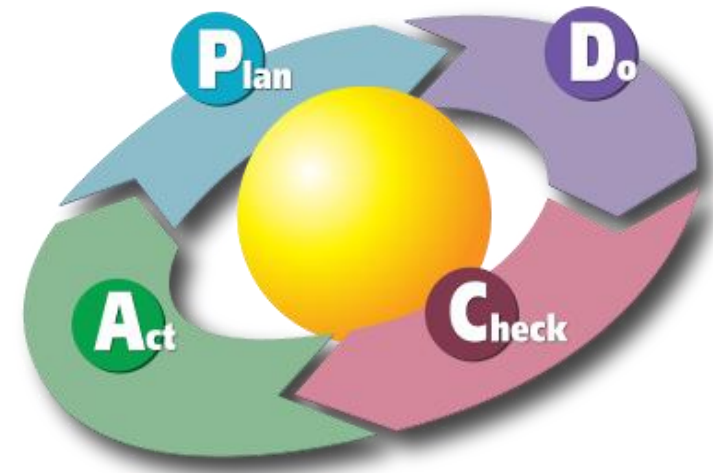
Policy summary: Improving institutional infrastructure

Goal	Initiative	Objective	Strategy	Policy content	Stage
Completing institutional infrastructure	Redefine institutional authorities and responsibilities.	Define specific duties within and between the central and local governments (horizontal and vertical teamwork).	Turn mixed duties into separate construction, administration, and operation units. Turn mode isolation into service integration. Reorganize central institutions and reinforce local institutions.	Establish the central Railway Bureau, Railway Academy, and Railway Safety Investigation Committee.	Short term
				Reorganize TRA as a state railway operation institution.	Mid term
				Define the responsibilities of the transportation policy planning and transit management authorities.	Mid/Long term
				Establish the central, regional, and local public transit operation programs.	Mid/Long term
				Specify the duties of the central and local institutions, and develop localized transportation.	Short/Mid term
	Establish a railway PDCA mechanism.	Establish a PDCA mechanism based on the railway life cycle.	Replace single projects with comprehensive planning. Replace sole decision making with joint decision making. Replace beforehand evaluation with three-stage evaluation. Replace centralized predomination with localized autonomy. Replace irregular communication with regular coordination.	Initiate national railway policies and comprehensive planning with periodical examinations.	Short term
				Establish railway policy and plan evaluation mechanisms.	Short term
				Establish railway audit guidelines and subsidy rules. Build the rail's professional training and rotation system.	Short/Mid term
				Periodically address the rail construction, administration, and operation issues through a regular railway meeting.	Short/Mid term
	Refine rail laws and policy tools.	Satisfy current needs and guide future development.	Replace incompleteness with comprehension. Replace anti-fraud with win-wins. Replace passive management with active innovation. Replace conservative responses with liberal guidance.	Fix the railway administration mechanism and relax the constraints on land development and affiliated businesses.	Short/Mid term
				Create policy tools that are in favor of rail development.	Short/Mid term
				Adjust rail laws to correct improper development.	Short term
				Revise rail laws and guidelines to timely comply with the progress of advanced technology.	Mid/Long term
	Improve the financial structure.	Implement a cost control and funding generation. Distribute funding rationally. Invest for the future.	Avoid running short via cost control. Replace dependence on the budget with multiple funding sources. Replace demand orientation with rational distribution. Turn market followers into market leaders. Turn the debt structure into financial sustainability.	Reassess approved but delayed projects.	Short term
				Create multiple funding sources to reduce dependence on the government budget.	Mid/Long term
				Periodically adjust the subsidy mechanism for rail projects.	Short/Mid/Long term
				Initiate stable funding for public transit subsidies and allow flexible transit fare.	Short term
				TRA should define its operational duties and create multiple funding sources to avoid going heavily into debt.	Short term
	Create a passion for sustainable operations.	Reinforce capability, root culture, and empowered marketing.	Turn skill reliance into research/development independence and skill inheritance. Turn rail transport from a mode into a culture. Turn inward reflection into active marketing.	Budget for rail research/development and training, and enable skills inheritance and transfer.	Mid/Long term
				Internalize and innovate rail culture into daily life.	Mid/Long term
				Integrate and market customer-centered public transit and rail transportation.	Short/Mid term



Source: Revised from the “Railways Organization Reform and Strategic Plan”, Railway Reconstruction Bureau, MOTC, 2010.

Proposal of the Railways Bureau organization scheme



Source: Karn G. Bulsuk , <http://blog.bulsuk.com>

The PDCA iterative cycle

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