台灣高鐵BOT專案之回顧

To

5070精英網友

By

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December 21, 2011

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1966-1971	國立成功大學土木工程學系	學士
1974-1977	台灣工業技術研究院	副工程師
1977-1980	美國德州大學奧斯汀校區 營建工程與計劃管理	碩士
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1980-1983	美國德州大學奧斯汀校區營建工程與計劃管理	博士
1983-1985	美國佛羅里達大學建築學院建築營建系	助理教授
1986-1992	美國普渡大學工學院土木工程暨營建工程管理系	助理教授
1992-2009	美國普渡大學工學院土木工程暨營建工程管理系	副教授
1993-1994	國立台灣大學 土木工程學系	客座副教授
2001-2001	國立交通大學 土木工程學系	客座副教授
2006-	國立台灣大學土木工程學系	教授
2009-	美國普渡大學工學院土木工程學系	名譽教授

Yes－爺死

Nice－奶死

Bus－爸死

Mouth－媽死

Girls－哥死

Was－我死

Does－都死

Cheese－氣死

Presentation Outline

- High Speed Rail Definition
- Reasons for Taiwan High Speed Rail
- Public-Private-Partnering
- Build-Operate-Transfer (BOT)
- BOT Financing
- Spotlights of Taiwan HSR Project
- Conclusions

Acknowledge

- Many slides are sourced from Taiwan High Speed Rail Bureau, the book entitled " Case Studies of Build Operate Transfer" by S.C.M. Menheere & S.N. Pollalis, and Chinese Engineering Consultants Inc. (CECI).

Definition of High Speed Rail

- USA : >145 km/h (90 mph)
- European : > 200 km/h (125 mph)
- Japan : > 210 km/h (130 mph)
- China, Beijing-Tianjin: 350 km/h (217mph)
- French TGV: 574.8km/h (359 mph)
- USA: 10,325 km/h (6,416 mph) unmanned rocket sled

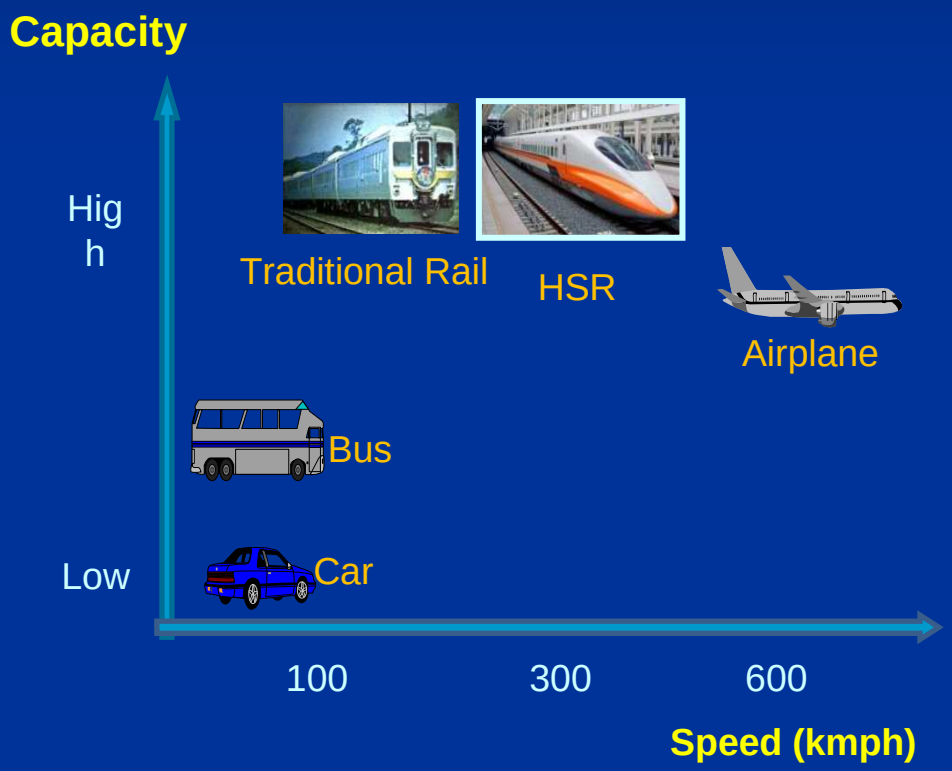
Taiwan Island

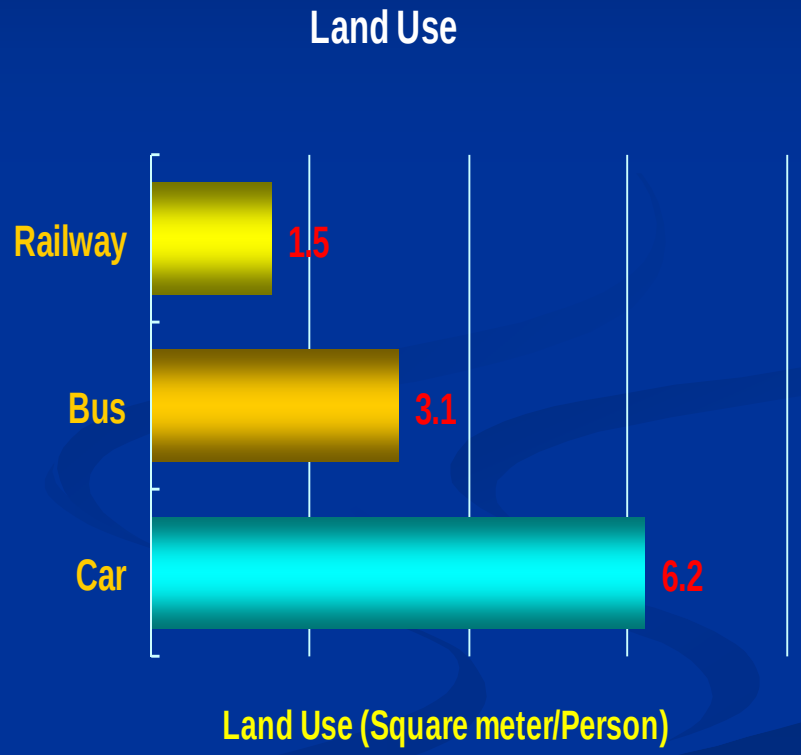
- Total area: 36,000 km^2 (394 km long, 144 km wide)
- Highest elevation: 3,952 m (Jade Mountain Peak)
- Population: 23 millions (640 people/km^2)
- Average annual rainfall depth: 2,500 mm

Reasons for the Need of HSR

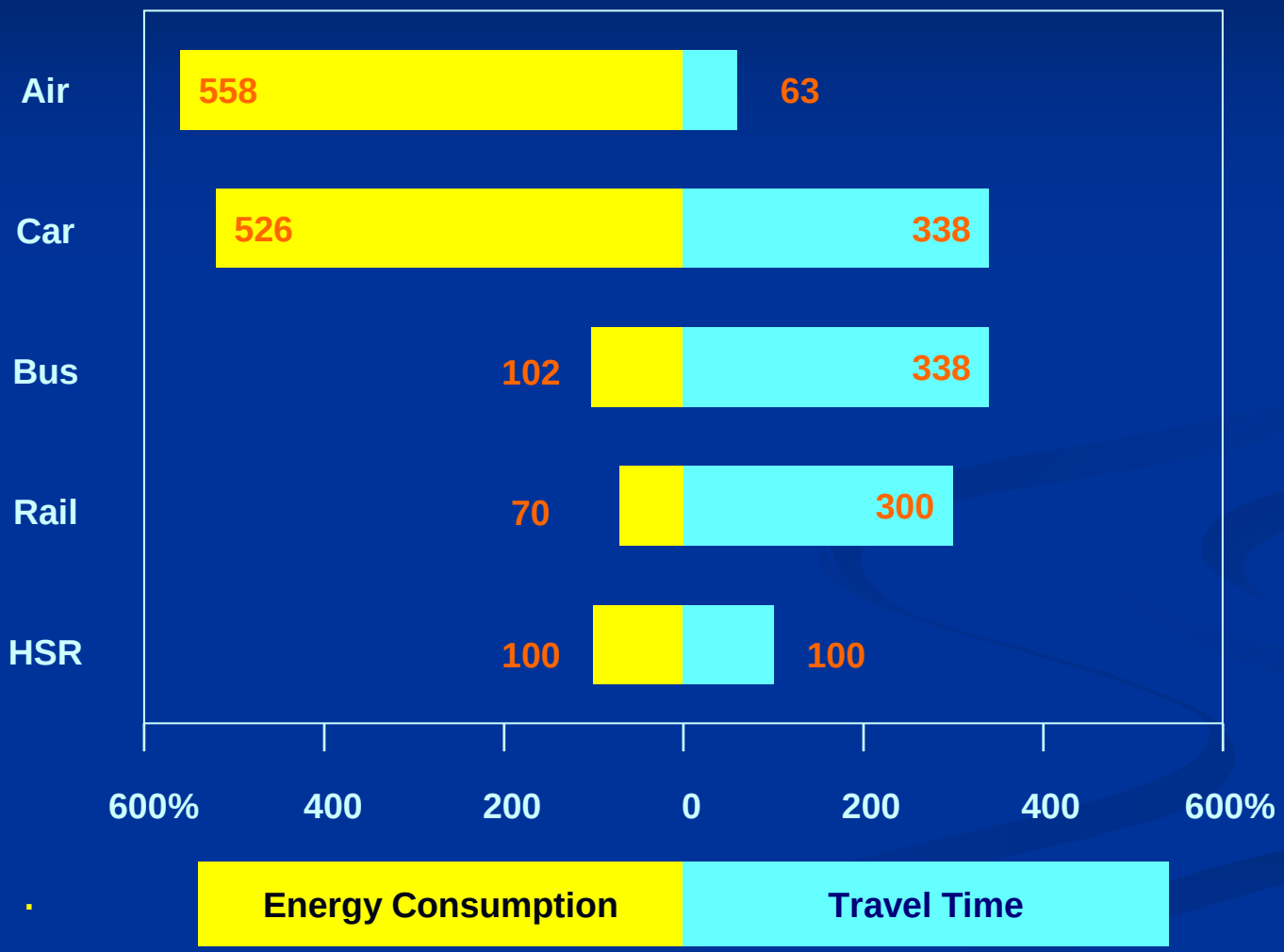
- To speed up the transportation of 185,000 passengers daily on the west corridor of Taiwan
- To reduce the city-country (north-south) difference in Taiwan
- To raise the living standard

High Capacity/Speed & Less Land



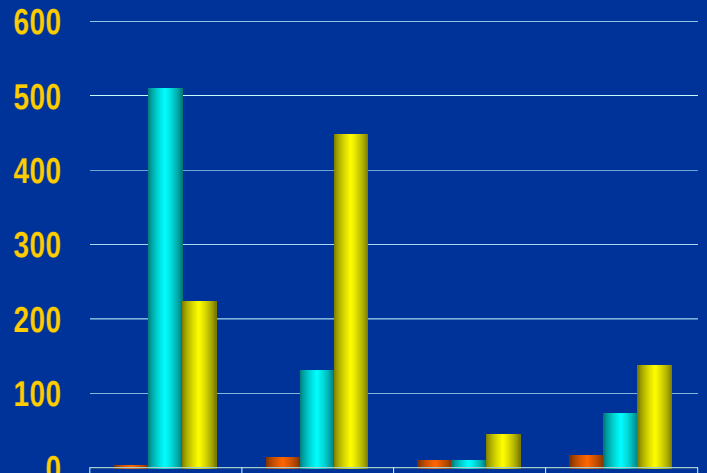


Energy Consumption vs. Travel Time (HSR=100%)



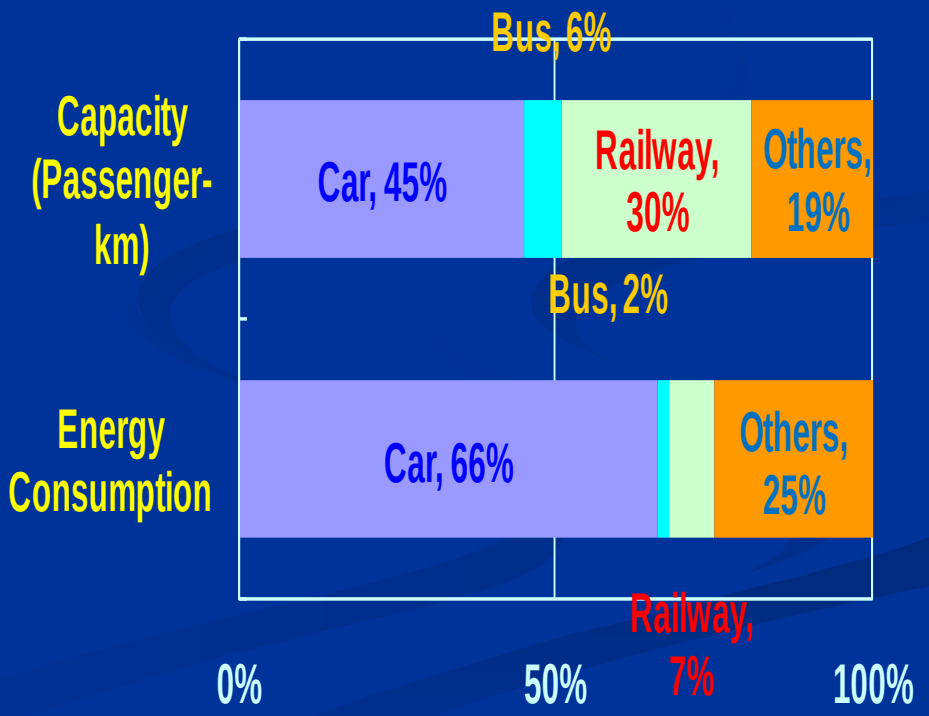
HSR is Green Transportation

- less pollution

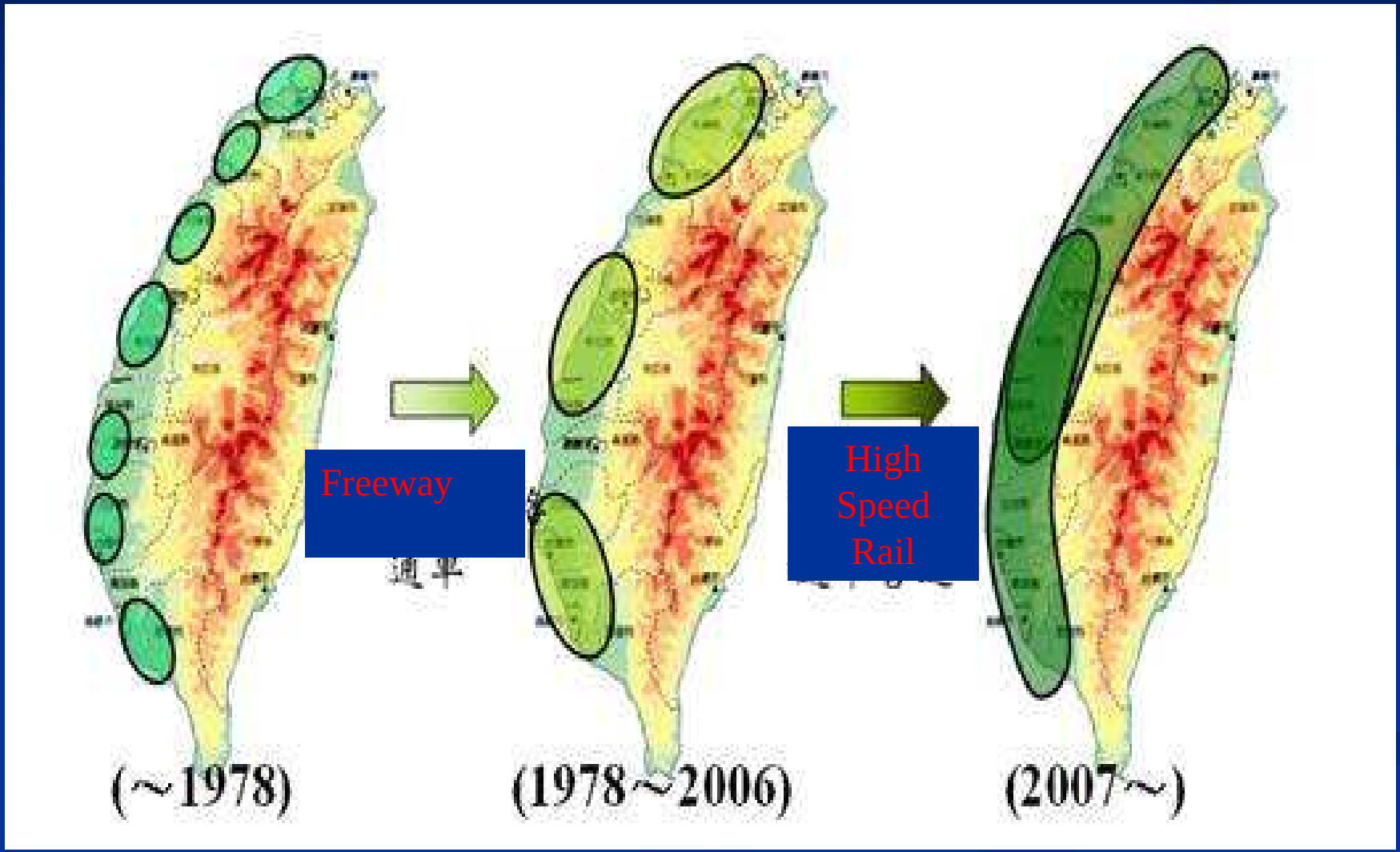


	CO (mg)	NOx (mg)	SO (mg)	CO2 (g)
HSR	3.2	13	11.2	18
Private Car	510	131	11.5	71
Airplane	225	449	44	139

- low energy Consumption.

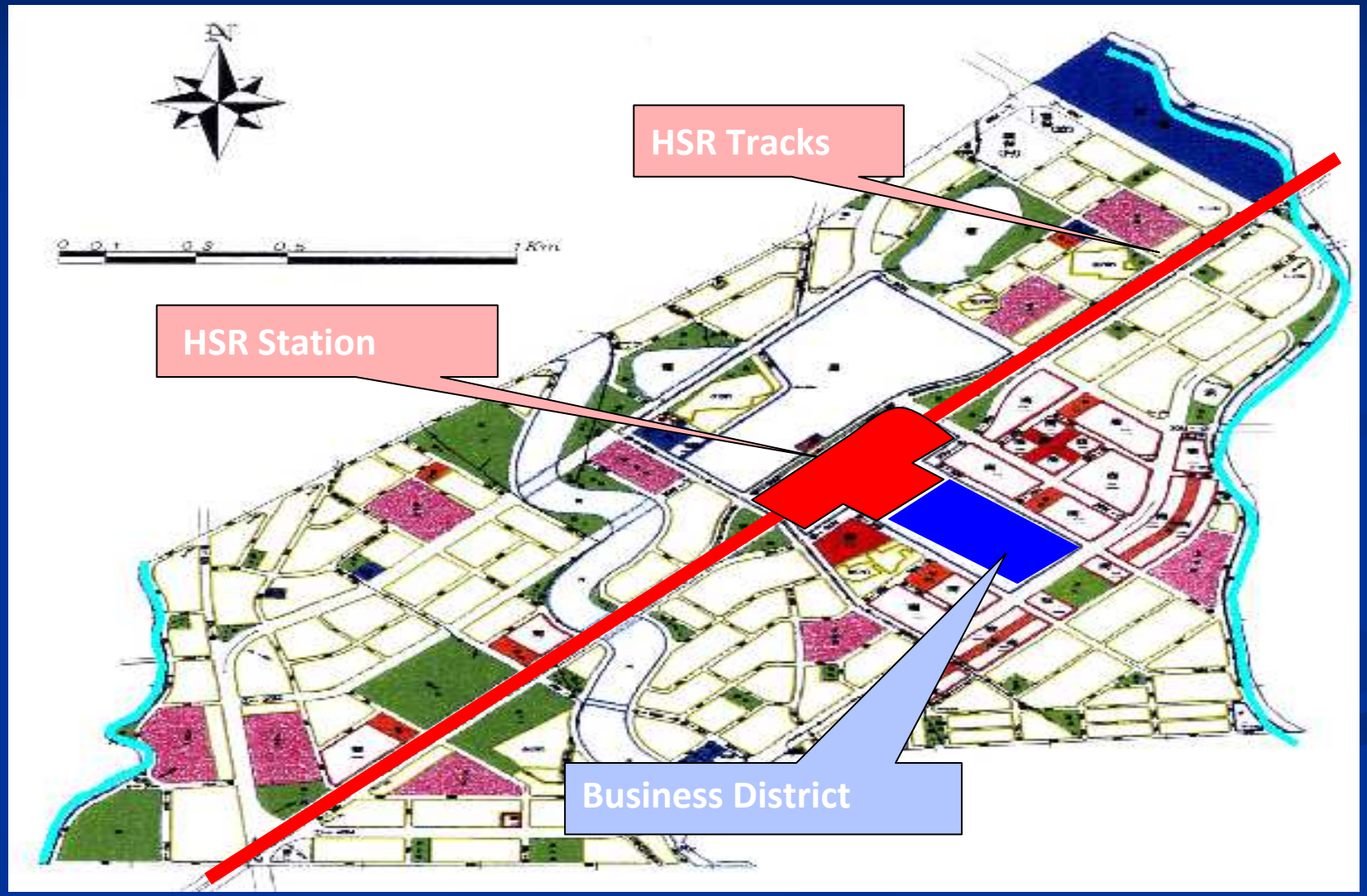


One-day living circle



- **Balanced development**
- Less weather impact

New City Development



Reasons for Adopting PPP (Public-Private-Partnering)

- Economical Aspect
  - High Cost
  - Budget shortage
- Political Aspect
  - Lengthy duration
  - Government inefficiency

民間資源

- 更多的政府資金需投入獲利較低但為必需之基礎建設。(Government has to provide necessary infrastructure, even, it is profitable in the sense of ROR)
- 私人企業的效率。(Bring Private Entrepreneurship and efficiency into government operation)

Build Operate Transfer

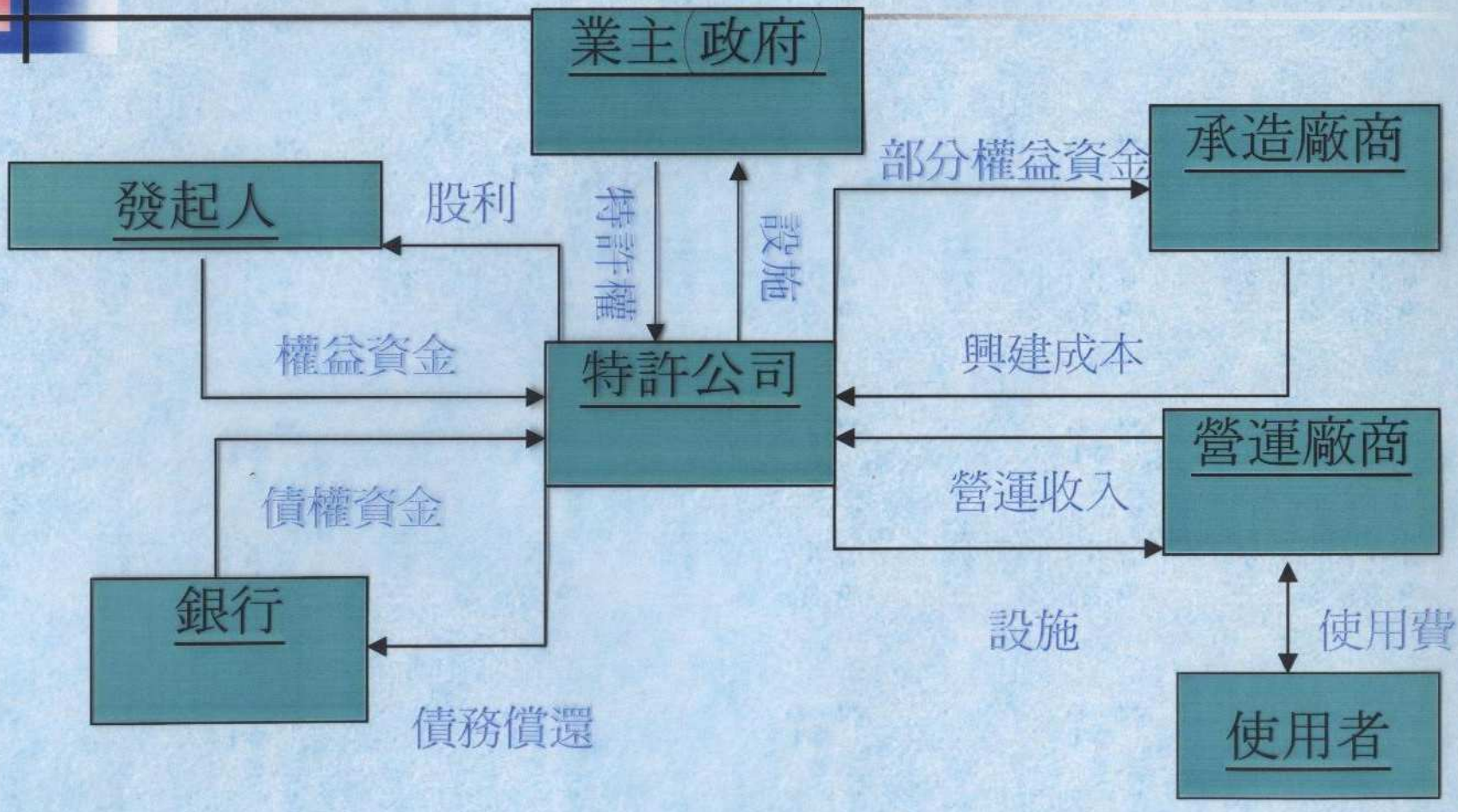
BOT

興建 營運 移轉

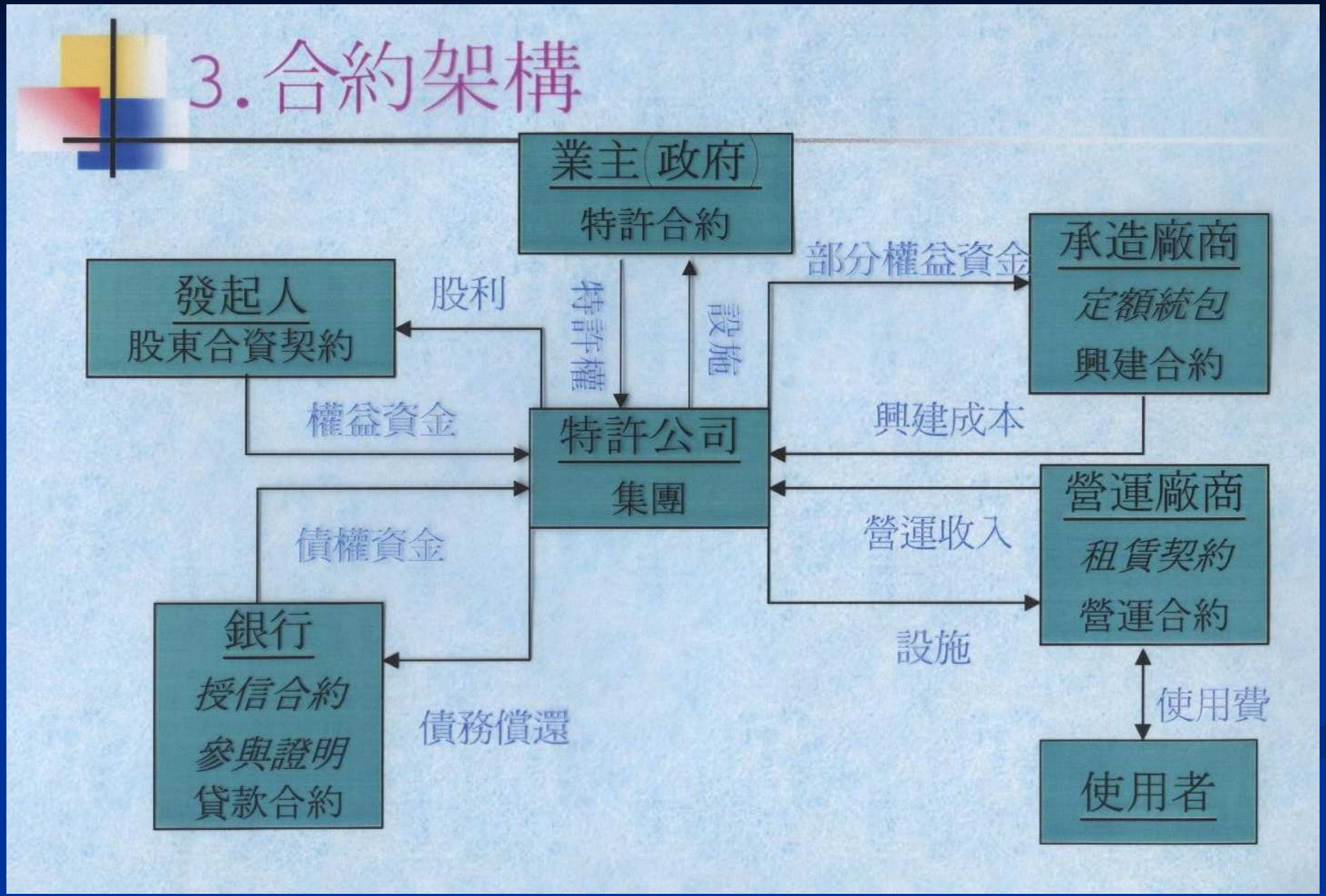
BOT

1. 籌資 (Finance)
2. 設計 (Design)
3. 採購 (Procurement)
4. 興建 (Build)
5. 營運 (Operate)
6. 維護 (Maintenance)
7. 移轉 (Transfer)

結構


業主(政府)
發起人
股利
特許權
設施
部分權益資金
承造廠商
權益資金
特許公司
興建成本
營運廠商
債權資金
營運收入
銀行
設施
使用費
使用者
債務償還

3. 合約架構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營運合約
營運收入
債權資金
銀行
授信合約
參與證明
貸款合約
設施
使用費
債務償還
使用者

優點－政府之觀點

(Merits From Governmental View)

1. 減輕財政與行政負擔(reduce the burden of finance and administration)
2. 引進私人企業的效率(efficiency of private enterprise)
3. 較短之完成時間(decrease project completion time)
4. 較佳之可行性研究(better feasibility analysis)
5. 縮減政府機關之人事編制(staff reduction of government)
6. 較高之經濟成長率(higher economic growth rate)
7. 風險轉移(risk transfer)

缺點 (Disadvantages from Governmental View)

1. 長期收益被減低或是延遲
(delayed or reduces Revenue)

2. 控制力被稀釋—獨占地位轉移
(Diluted Control-monopoly Change)

3. 品質無法保證 (No Guaranty on Quality)

4. 圖利他人之爭議(Favorism)

5. 不公平之政策(Unfair Policy)

6. 若失敗，政府仍須接管
(if failed, government has to take over)

優點－社會大眾之觀點

(Merits from Public View)

1. 減輕稅賦負擔(reduce the tax)
2. 較短之時間即可使用公共建設(provide infrastructure in a short time)
3. 更有效率的服務(more effective service)
4. 提供工作機會(provide job opportunity)
5. 提高使用者與非使用者之利益(raise the profits of the users and non-users)

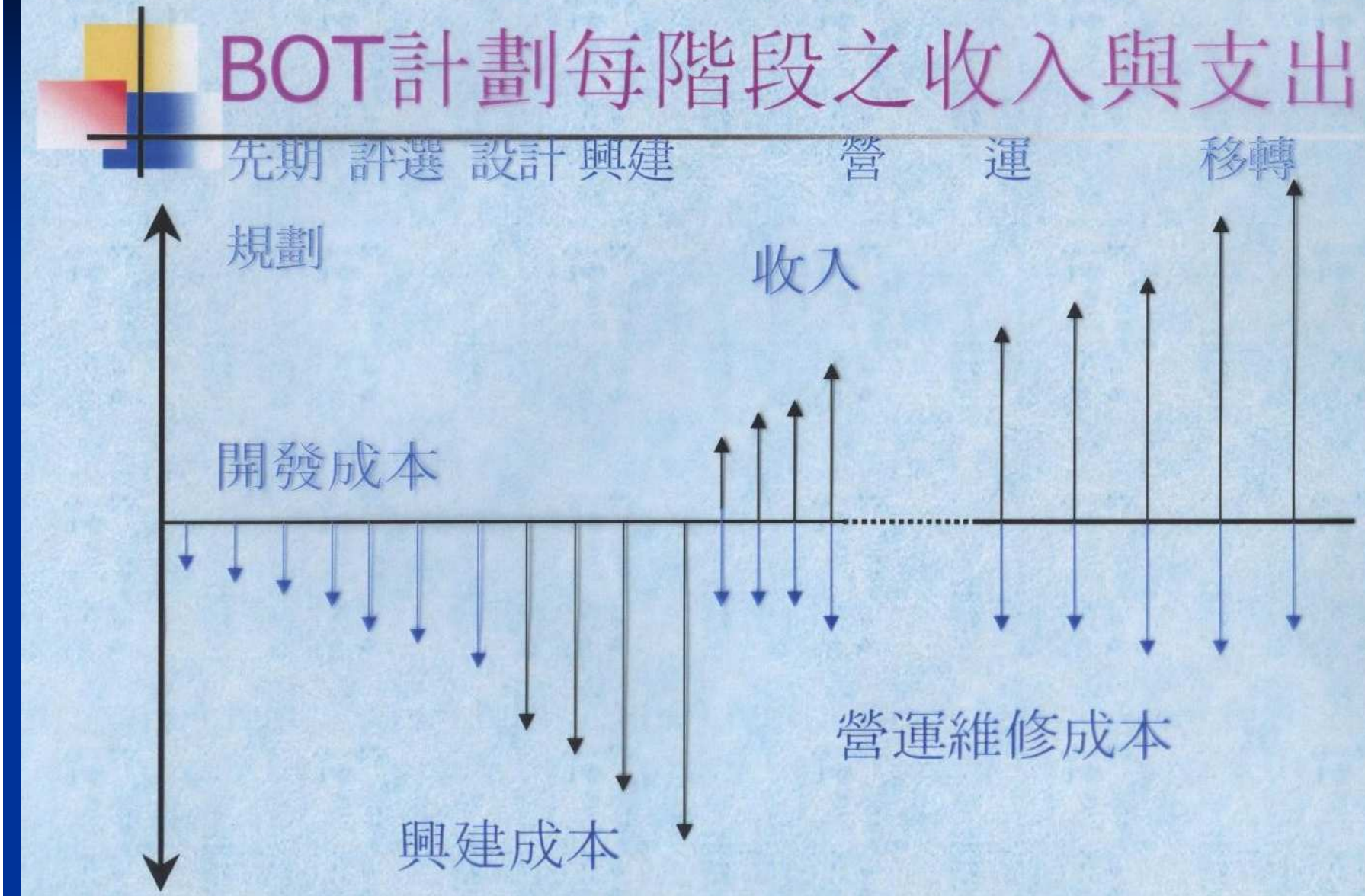
缺點－社會大眾之觀點

(Weakness from Public View)

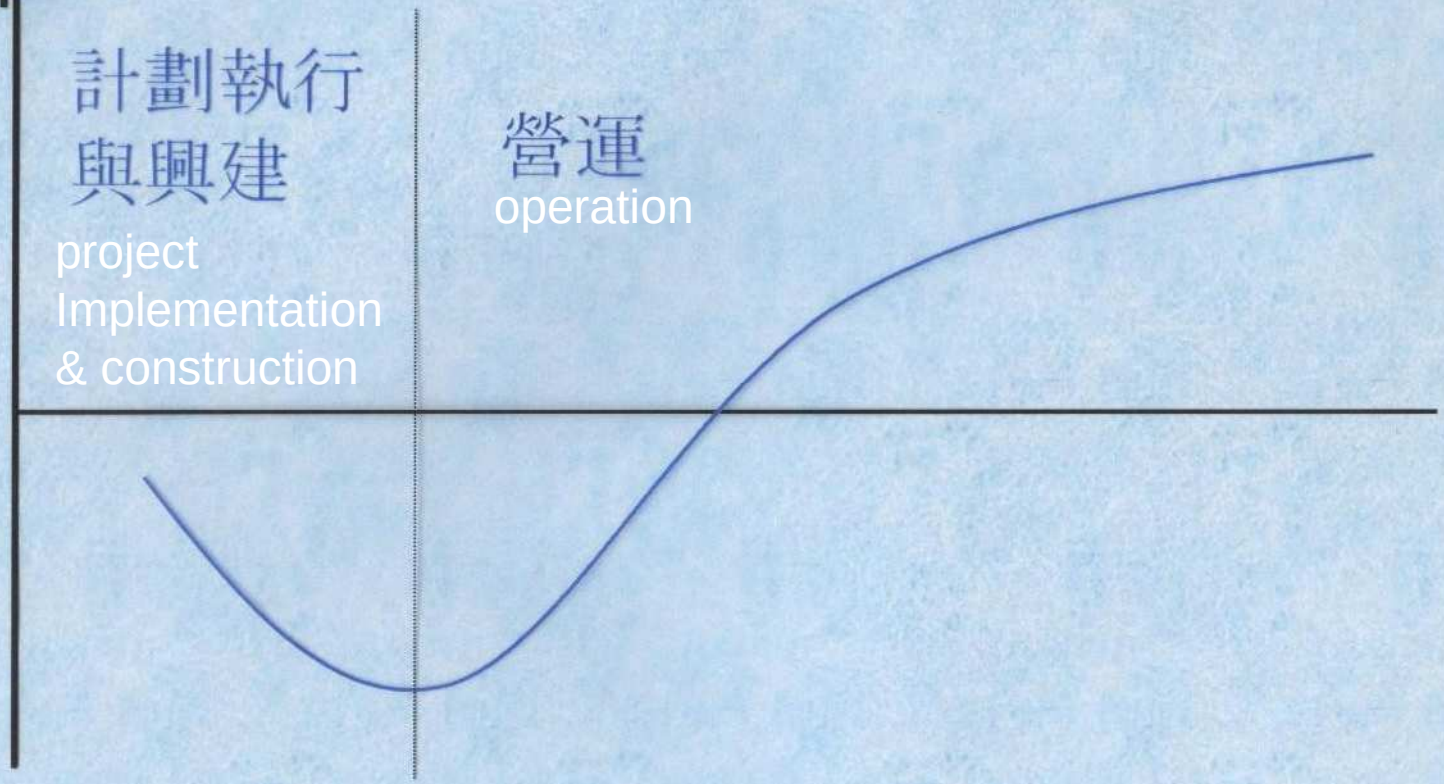
1. 獨占(Molopoly)
2. 低收入使用者可能無法使用
   May not be affordable for Low-Income
3. 藉由出售大眾獨占權力以籌措預算赤字
   Sell out public **Concession to cover up the budget deficit**
4. 若有不當之競爭，易產生任用親信或貪污的情形。
   If improper competition, corruption or favoritism
5. 利益導向, 而非以人為本

   Profit oriented, not human focus.

BOT計劃每階段之收入與支出

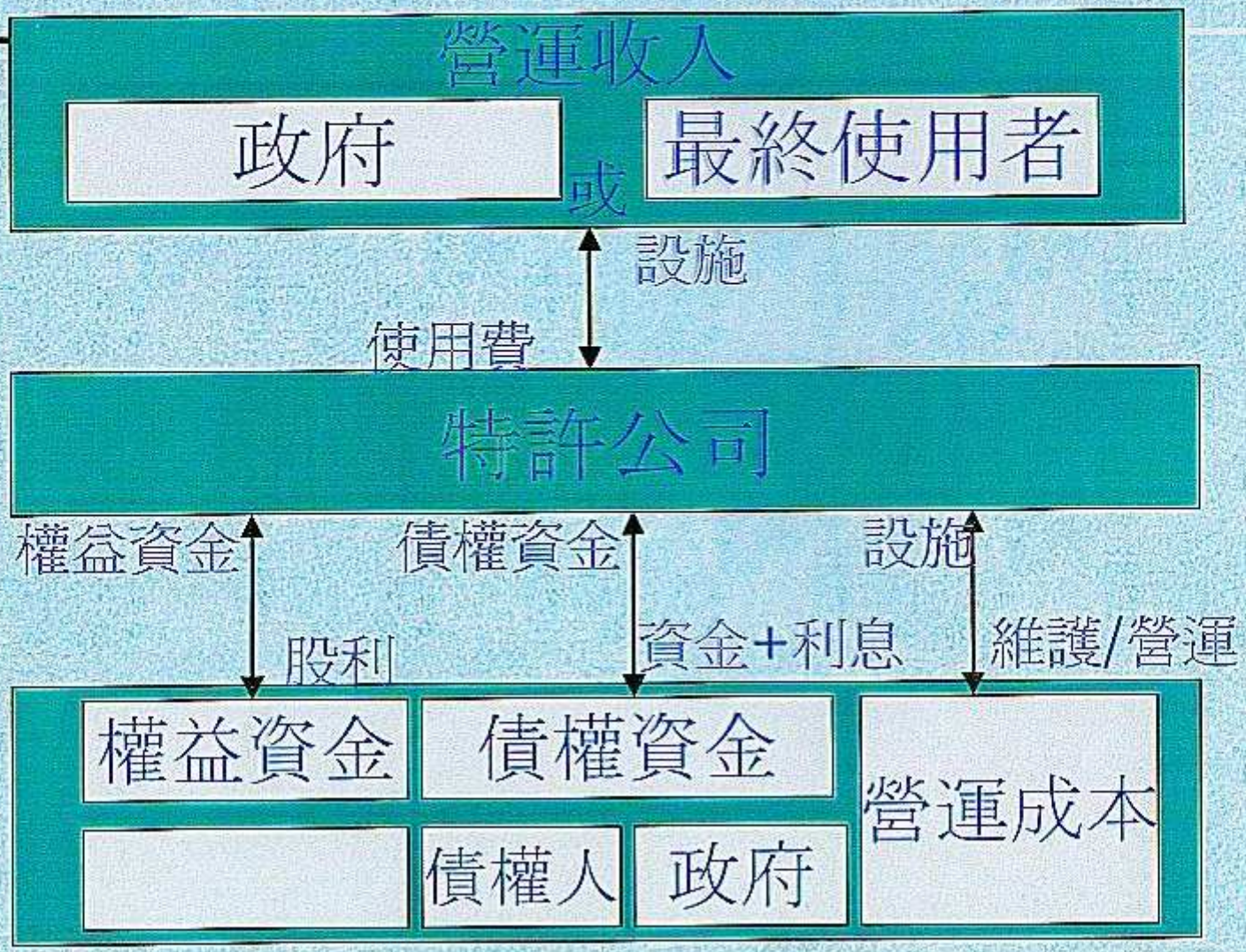


特許期間之現金流量圖



Cash Flow over the concession period

BOT財務結構


營運收入
政府
或
最終使用者
設施
使用費
特許公司
權益資金
債權資金
設施
股利
資金+利息
維護/營運
權益資金
債權資金
營運成本
債權人
政府

4. 融資 (Financing)

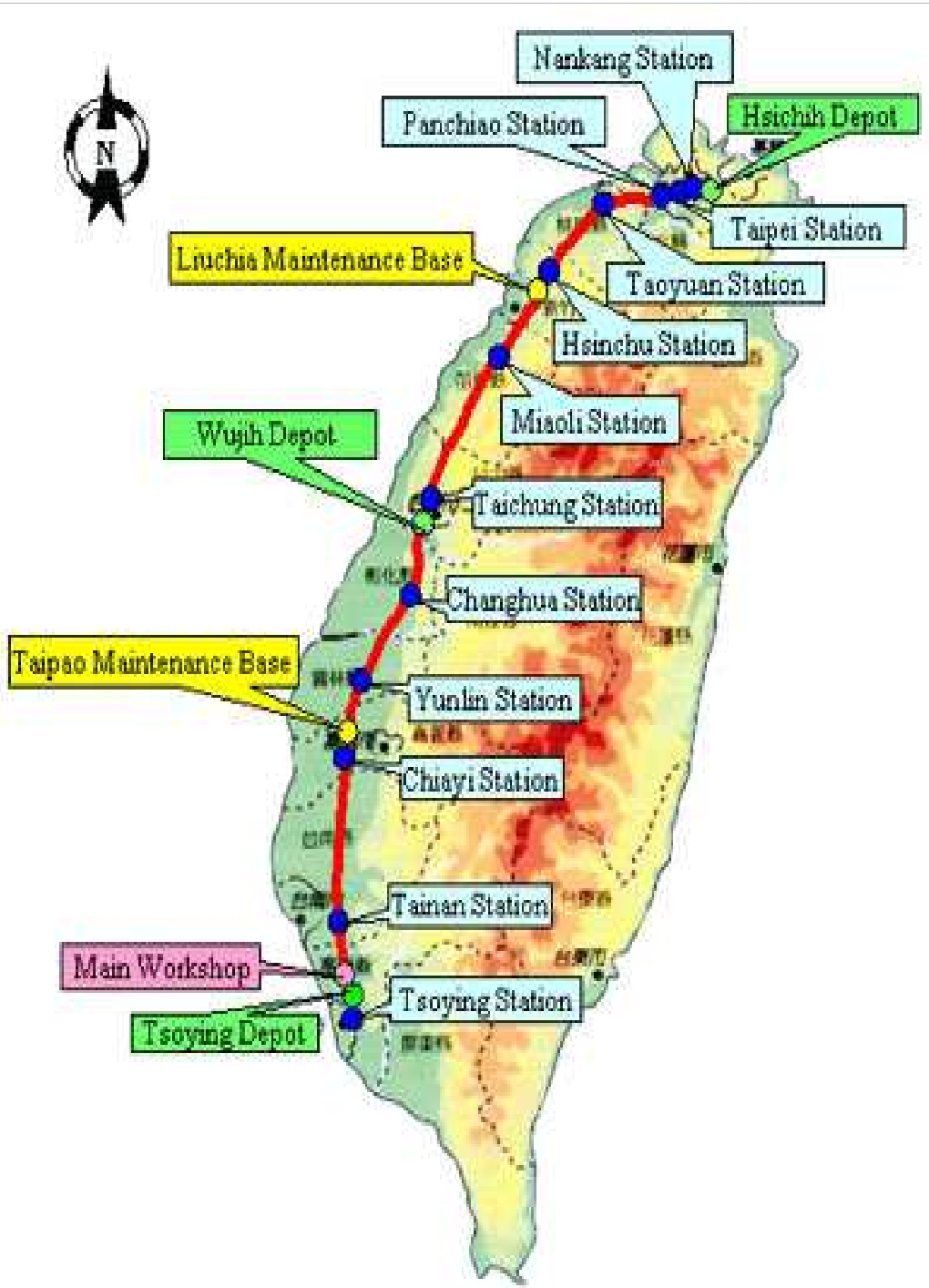
- 專案融資 (Project Financing)
  - 被應用於採礦與能源計劃 (mining and energy resources project)
  - 發起人提供股權資金(equity)；借款人或出租人提供債權資金(debt)
  - 無完全追索權之融資方式(no full recourse financing)
  - 借款人/出租人對發起人之其他資產或現金流量無求償權 (no claim to sponsor's property)
  - 專案融資的評估以計畫之收入為基礎 (financing evaluation based on project income)
  - 借款人通常會限制計劃資金之使用 (lenders usually will limit the use of fund)

優點 (Merit)

1. 藉由限制使用計畫之資金流向，借款人的風險得以降低 (The borrower's risk can be reduced)
2. 發起人之資金成本較低 (less invested capital)
3. 無追索權之融資方式。經理人承擔較高風險之意願較高 (The manager is willing to take higher risk)
4. 透露有版權的資訊給較少之投資者，機密性較佳 (limited investors, more confidential)
5. 可根據個別計畫之表現給予獎勵及成果評估 (provide reward based on project performance)

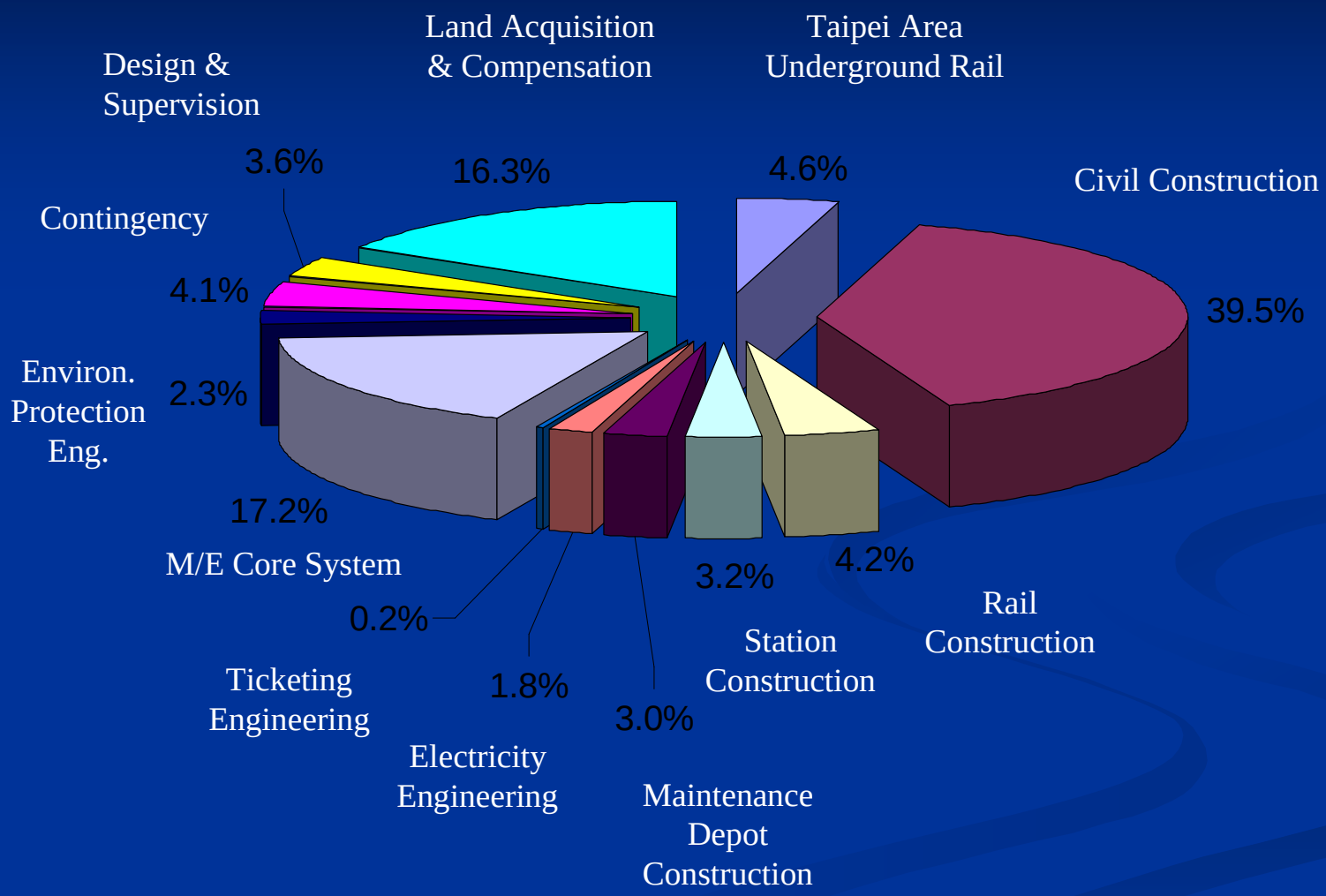
Disadvantages

- Complexity of Risk Allocation
- Increased Lender Risk
- Higher Interest Rates & Fees
- Lender Supervision
- Lender reporting Requirements
- Increased insurance coverage
- Encourages Potential Risk Taking
- Source: The law and business of International Finance by Scott L. Hoffman


N
Nankang Station
Panchiao Station
Hsichih Depot
Taipei Station
Liuchia Maintenance Base
Taoyuan Station
Hsinchu Station
Miaoli Station
Wujih Depot
Taichung Station
Changhua Station
Taipao Maintenance Base
Yunlin Station
Chiayi Station
Tainan Station
Main Workshop
Tsoying Station
Tsoying Depot

System Operating Features of Taiwan HSR Project

Items	Operation & Service Features
Operation Speed	250~300 km/hr (156.3~187.5 mil/hr)
Operation Type	Express Service/Inter-city Service
Stations	Taipei, Taoyuan, Hsinchu, Miaoli, Taichung, Changhua, Yunlin, Chiayi, Tainan, Kaohsiung
Hours of Service	6:00 am ~ 12:00 midnight
Capacity per Trainset	800 seats per train set
Travel Time	90 minutes for Taipei-Taichung-Kaohsiung Express Service with a 3-minute stop at Taichung
Line Capacity	Above 300,000 seats * 340 km per day (single deck train)



Cost Percentage of Taiwan HSR Project

台灣高鐵集團主要成員

大陸工程	土建與站區開發
太平洋建設	土建與站區開發
富邦建設	站區開發
長榮航空	營運與維修
Teco Electric	機電
富邦保險	財務
法國GEC ALSTHOM	運輸與機械系統供應商
德國西門子	電力與電子系統供應商

中華高鐵集團主要成員

- 中華開發　財務
- 榮工處　土木工程
- Tai-Yu Products　站區開發
- Walsin Lihwa　機電
- 日本高速鐵路集團　營運
- 日本三菱重工　系統供應商
- 日本Mitsui　機電與維修
- 日本熊谷組　土木工程

參與者及其目的

參　與　者	主要目的
業　　主	以較低的風險，加快完成公共建設需求
特許公司	取得特許權，賺取利潤
發起人/股東	賺取利潤，按所承擔支風險要求高投資報酬率
借　款　人	長期之安全且賺錢的投資
營造廠商	取得計劃，按顧客需求興建設施
營運廠商	儘可能有效率、有效能的營運設施
使　用　者	經濟上可行的使用設施

5. 風險管理 (Risk Management)

- 台灣高速鐵路之主要風險(Main Risks
  1. 不可抗力之風險 (non-resisted risk)
     - 政治 (political affairs)
     - 天然災害 (nature disaster)
  2. 財務風險 (Financial risk)
     - 若銀行不願擔保該怎麼辦?(bank reject to be guarantor.)
     - 若延遲完工/成本超支該怎麼辦?
       (project delay/cost overspend?)

5. 風險管理 (Risk Management)

- 台灣高速鐵路之主要風險(The main risks)
  3. 技術風險 (technical risk)
     - 如果系統故障該怎麼辦? (system breakdown)
  4. 管理風險 (managment risk)
     - 如果計劃因管理不善而中止該怎麼辦? (project discontinue)
  5. 商業風險 (business risk)
     - 如果乘客不足該怎麼辦? (without enough passengers)

(Non-resist reasons-nature disaster)

不可抗力因素—天然災害

- 颱風、暴風雨、洪水、地震、山崩、森林大火等等

  (typhoon、rainstorm 、flood 、earthquake 、landslide 、forest fire, etc)

(Non-resist reasons-political affairs)

不可抗力因素—政治事件

- 風險的類型 (Types of risk)
  1. 戰爭、革命、內戰、暴動 (war、revolution 、civil war 、riot)
  2. 核子或生化事故所造成之意外(nuclear accident)
  3. 發生在車體、軌道、隧道、橋樑、藝術品之搶劫、炸彈、與恐怖份子相關或竊盜之行為 (Robbing, Stealing and Terrorist Attacking)
  4. 中共入侵 (China Invasion)
  5. 執政黨更迭 (changed governing party)

政治風險 (politics risk)

1. 主權風險(Sovereign Risk)
   - 英法海底隧道—1974年執政黨由原先的保守黨更換為工黨，造成計劃於1975年中斷
2. 不穩定風險(Instability Risk)
   - 1989年天安門事件延遲「廣州珠海高速公路計劃」至1991年

最小化/減輕 (mitigate)

1. 恐懼; 但不知道原因 (indescribable fears)
2. 假若發生， 協商後果 (if happened,negotiate)
3. 出口信用機構保護(protected by export credit institution)
4. 保險—並非最佳之選擇
   (insurance-not the best choice)

財務風險 (Finance risk)

1. 匯兌風險 (currency exchange risk)
2. 利率風險 (interest rate risk)
   - 香港提高基本利率(Prime Rate)
3. 市場風險 (market risk)
   - 原料 (raw materials)
4. 收入風險 (income risk)
   - 墨西哥六千里收費道路，較原先高出四倍 (more than 4 times)
5. 成本超支風險 (cost overspent risk)
   - 英法海底隧道，74億→150億

技術風險 (Technique risk)

1. 興建困難 (difficult to construct)
2. 延遲完工 (project delay)
   - 因訊號系統規範和接駁車設計之變更，造成一年之延遲 (Euro-Channel project delay for 1 year)
3. 營運風險 (operation risk)
   - 運轉時設備故障或發現瑕疵 (equipment breakdown in operation stage)

解決方案 (Solutions)

- 健全的設計 (healthy design)
  - Medium & Recurrent event 30 years
    1. 100年的計劃生命週期 (100-year life cycle)
    2. 50%機會遇上重現週期為200年之事件 (50%)
    3. 地震參數：G=4.0; 最大洪水：200年; 颱風風速250km/hr, 最大風速350km/hr;每輪軸承重25噸; 每公尺最大均佈載重為6噸

解決方案 (Solutions)

- 安全設施 (facilities security)
  1. 物體入侵偵測：在山崩落石、掉落物體、車輛、侵入動物等區域設置圍籬，切斷感應之電網 (detectors for invaders)
  2. 環境異常之偵測器(detect unusual environment)
     a. 風力 (wind force)
     b. 雨量 (rainfall)
     c. 震動 (vibration)

管理風險 (manage risk)

- 若無不可抗力之因素，財務方面正常，技術部份已充分了解；但，由於不良之決策過程和管理仍會使整個計畫變差。
  (non-appropriate decision process and management will still hinder the whole project)

策略上之解決方案 (tactic solutions)

- 成立運作類似私人單位之政府投資公司

  (government invested private corporation)

- 成立危機解決與協調委員會以及獨立危機觀察與解決之組織

  (crisis task force and coordinating committee)

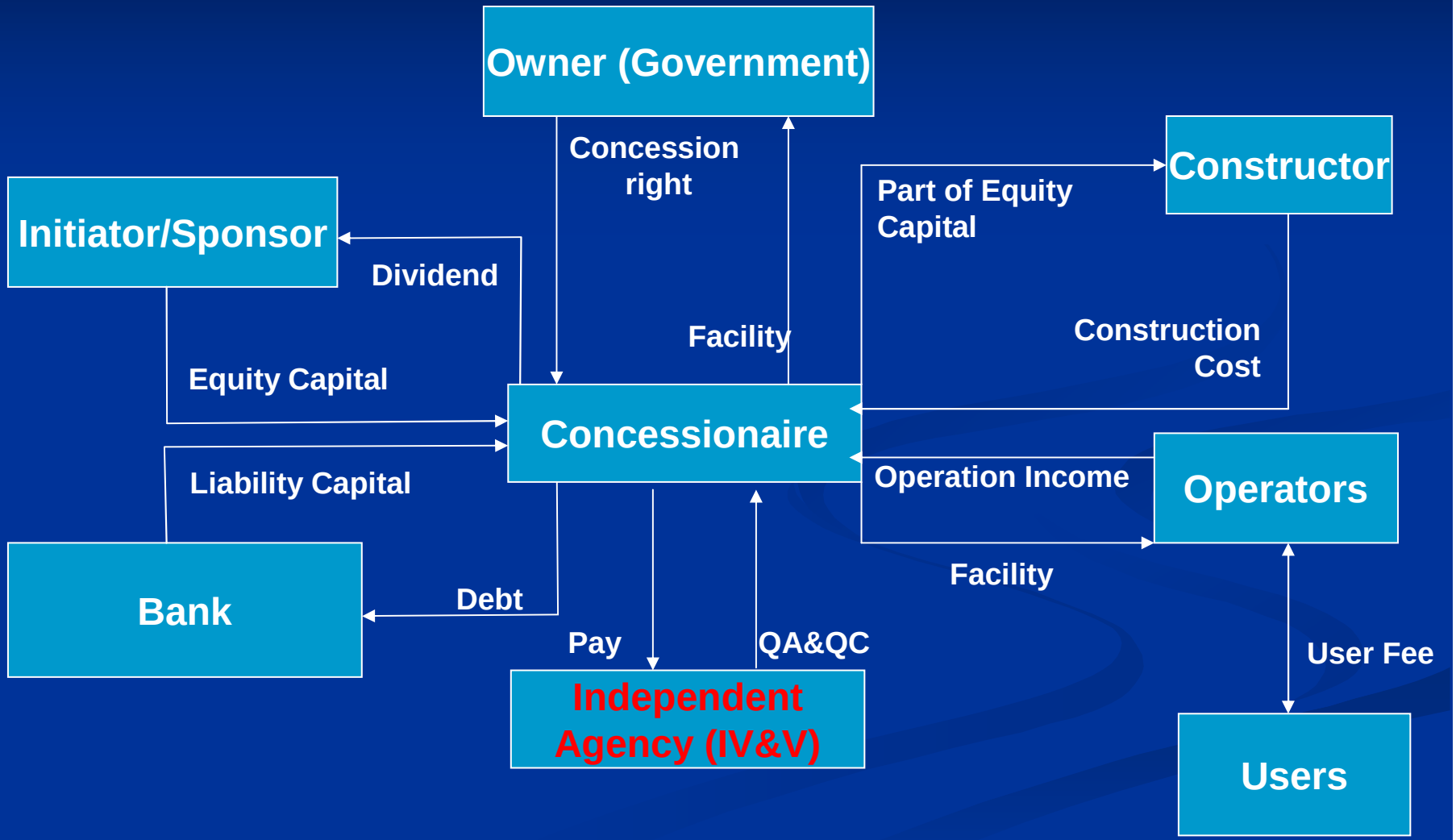
- 較佳之決策和爭議調解

  (better decision making and disputes mediation)

商業風險 (business risk)

- 缺乏乘客 (shortage of passengers)
- 對策 (strategy)
  1. 較佳的市場/利潤調查 (market/profit investigation)
  2. 較佳的營運成本研究(operation cost research)
  3. 計劃形象的改善 (improve the image)
  4. 謹慎訂定價格及促銷計劃(price and sales promotion)
  5. 提昇舒適度 (comfort)
  6. 良好的自由企業政策 (business policy)

Independent Verification & Validation/Peer Review



~領導視察基層~

山東省一領導到基層視察,晚飯安排在一牧民家。

領導客氣讓牧民先進門,牧民受寵說:

“還是領導前面走,俺養豬牛雞鴨的，跟在牲口後面慣了"。

領導聽後不悅。

鄉長連忙請領導坐定,並吩咐牧民趕緊上菜,

牧民端上一盤清炒蕃薯葉放在領導面前,

久吃大魚大肉的領導, 一吃一邊大讚地說:

"真好吃! 這是什麼蔬菜?"！

牧民忙說:"這是土裡隨便拔出來的蕃薯葉賤菜, 平時俺都是拿去餵豬的 "。

領導頓時臉色下沉。

鄉長見狀連忙讓牧民一起吃飯----少說些話,

牧民卻說:

“領導先用,俺不忙,每天這個時間俺得先餵完豬後才吃飯, 都習慣了"！

鄉長氣急:"你會不會說話?“

牧民哭喪著臉:

"俺平時和畜生說話說慣了,不會和人說話..."

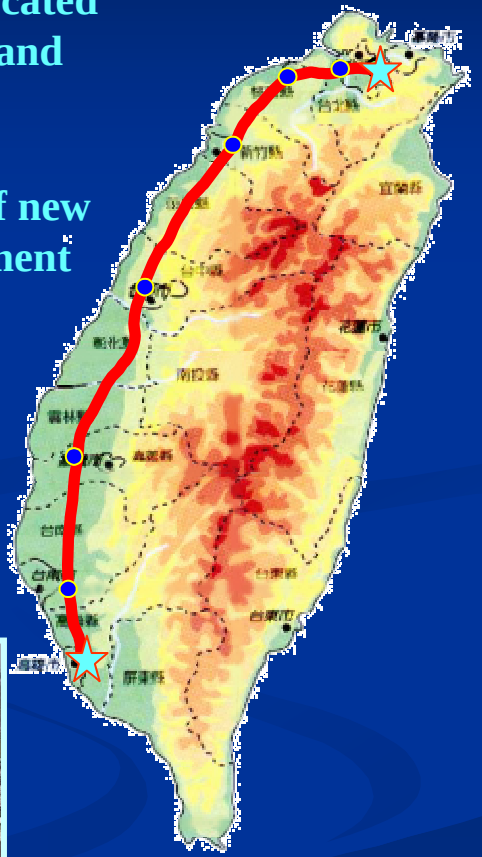
Taiwan High Speed Rail

Standard

Business

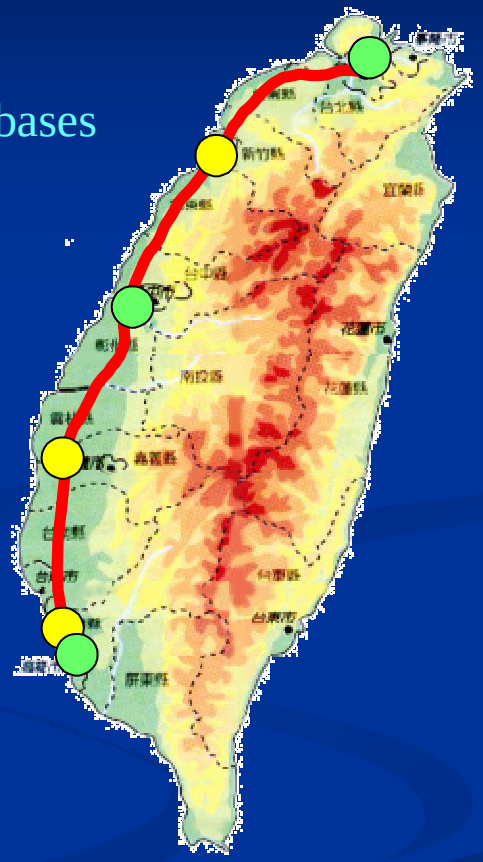
HSR Stations

- **Two major stations:** co-located with Taiwan Rail system and Metro Transit systems
- **Six new stations:** nuclei of new business district development

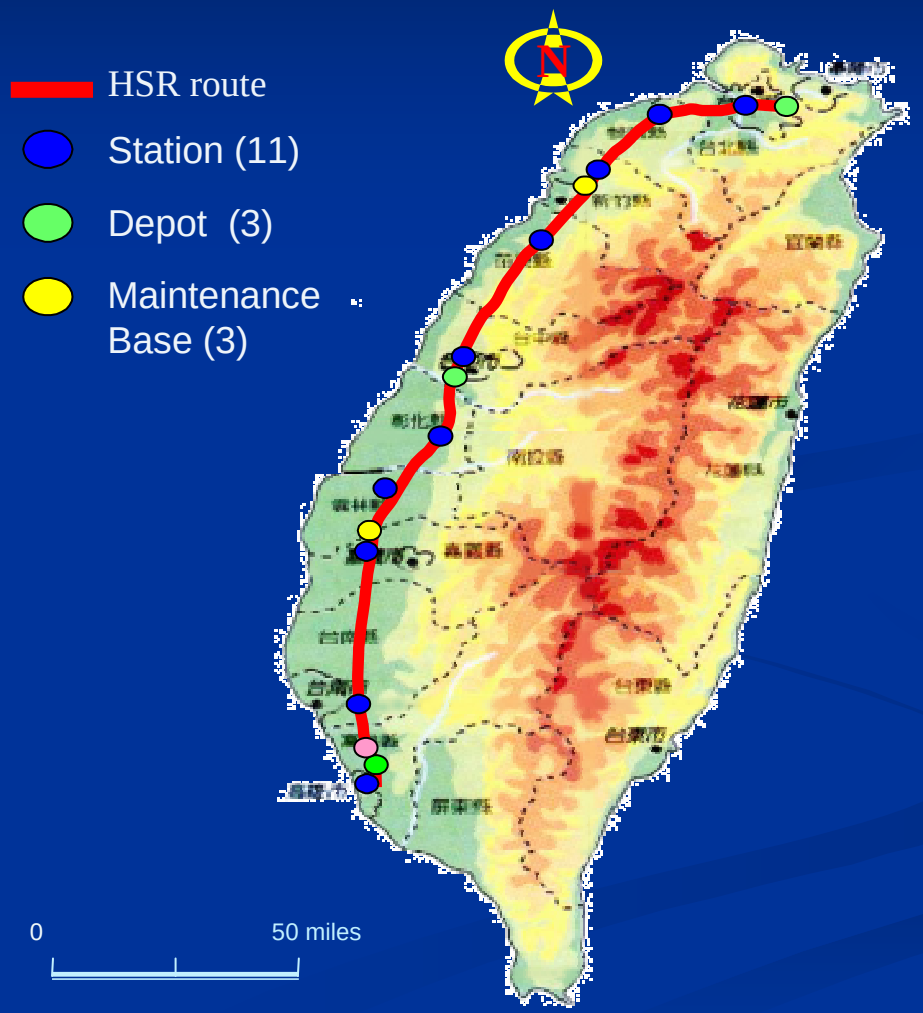


Maintenance Bases and Depots

- Three depots
- Three maintenance bases



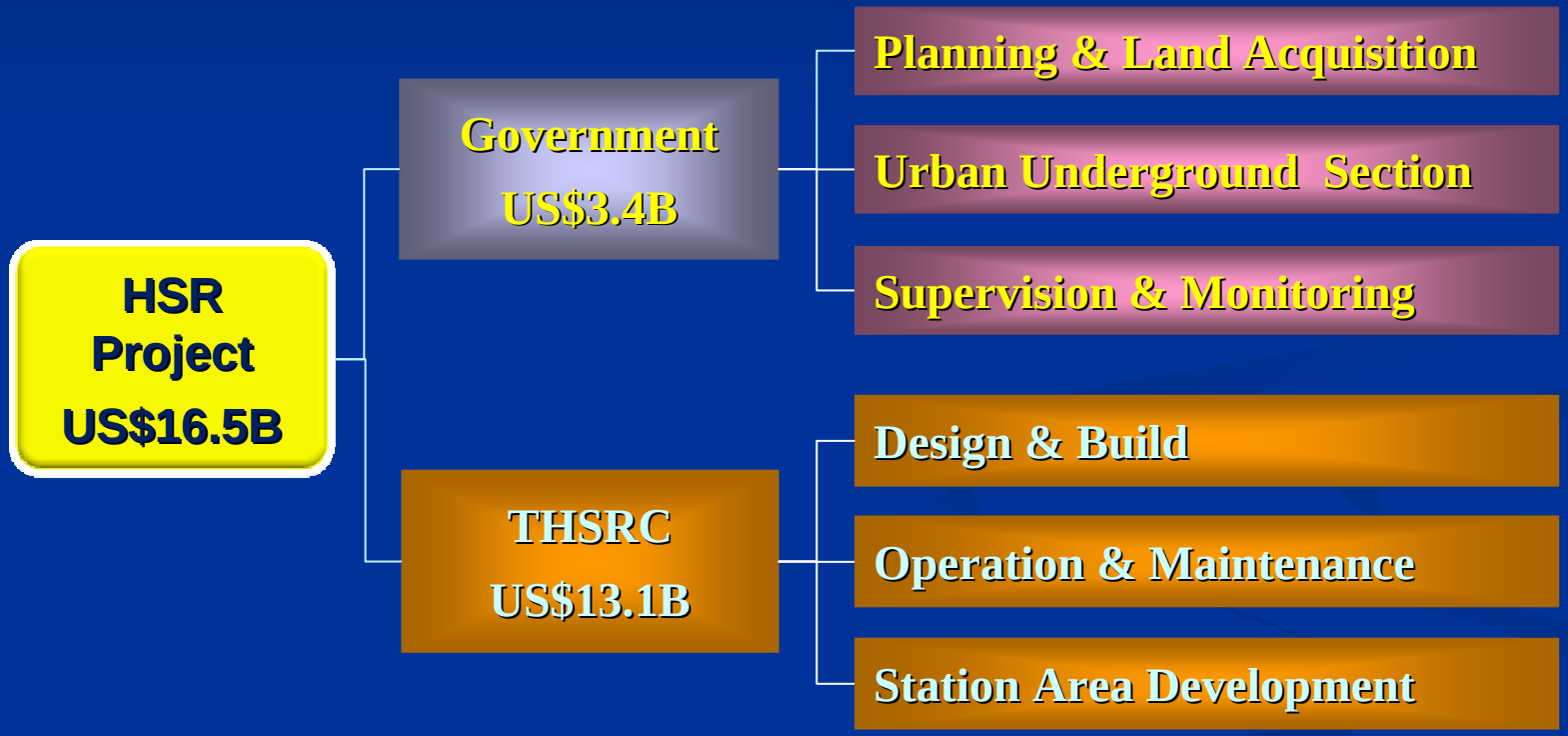
Taiwan HSR Network



System Characteristics

System	Total route length: 340 km (212 miles), Travel time: 90 minutes
Max. Design/Operation Speed	350 kmph (218.75 mph)/300 kmph (187.50 mph)
Design Specs for civil and architecture works	Based on European system requirements and US AASHTO Code
The Japanese Shinkansen Core Systems	Including Rolling Stock, Signaling, Electrification and Telecommunications systems
Trackwork	Standard gauge with interface among civil works, core systems and European turnouts

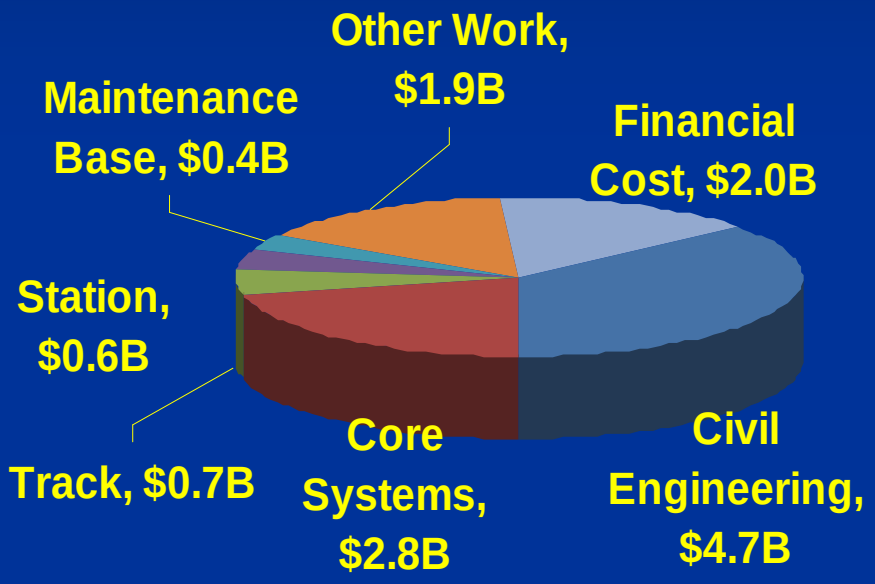
HSR Project Items & Costs



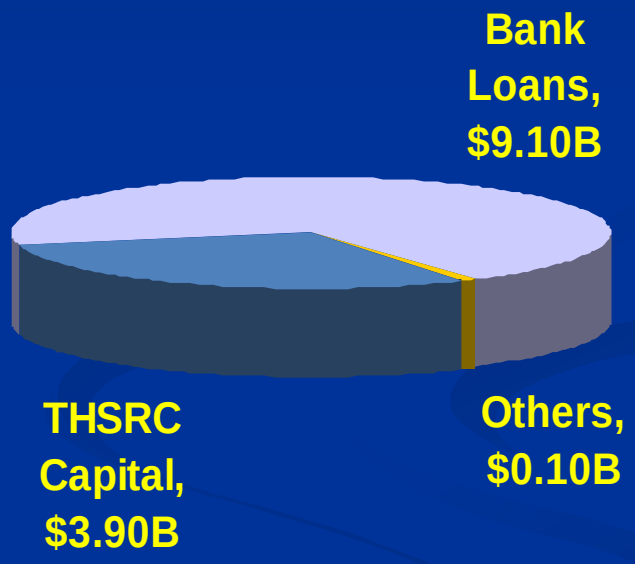
Average: US$65 millions/mile

Construction Budget

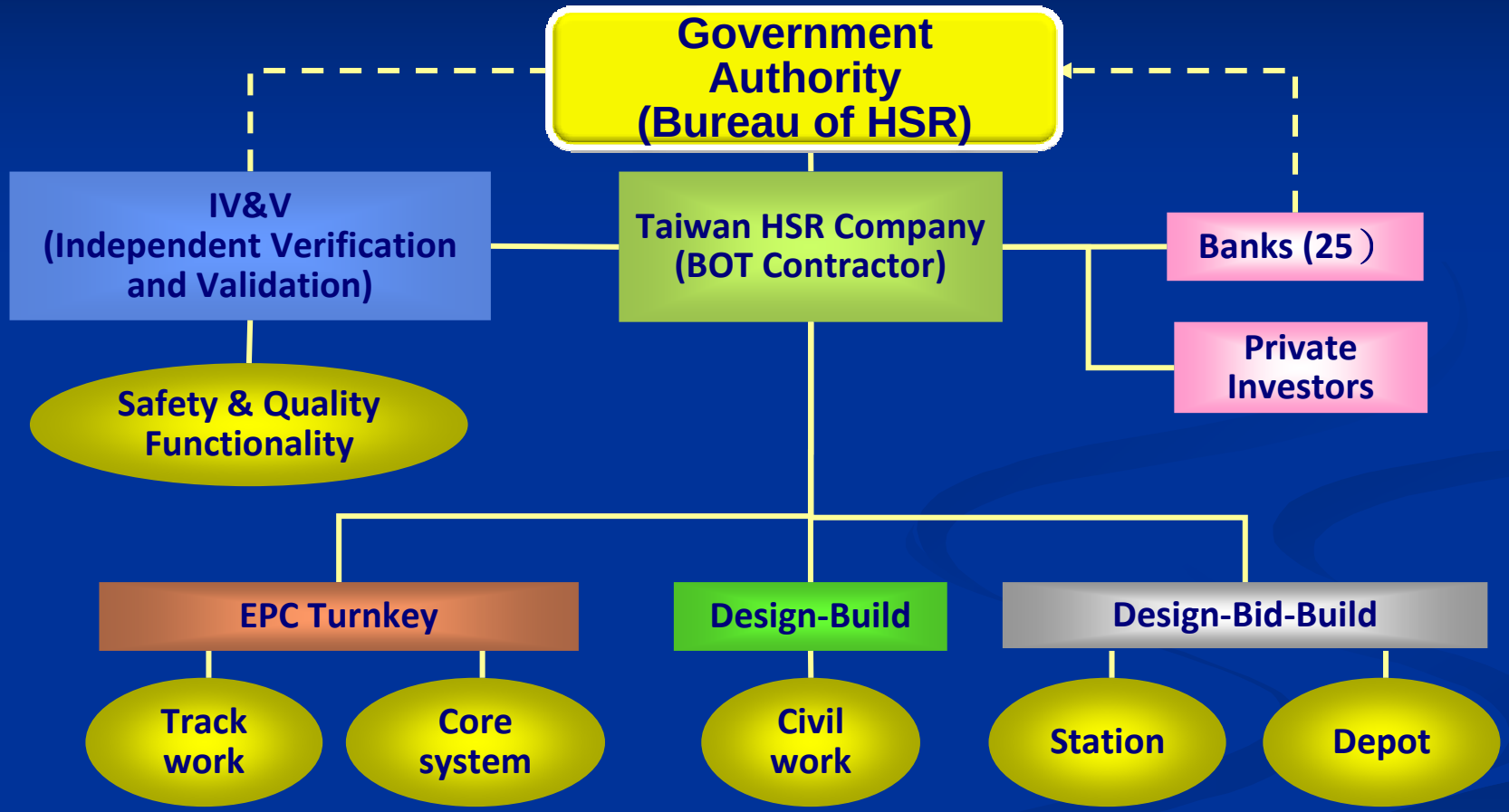
Total Costs: US$13.1B



Financing Sources: US$13.1B



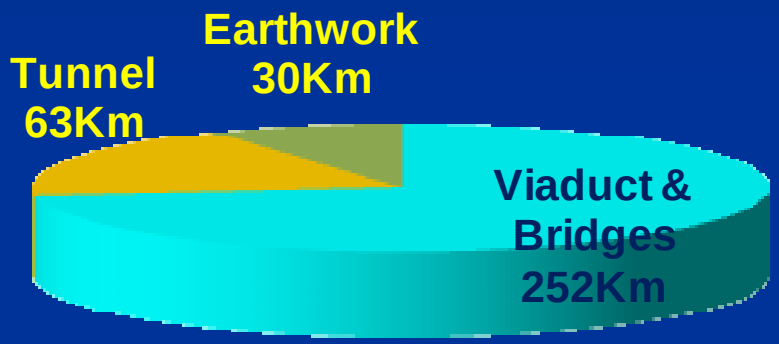
Taiwan HSR Project Organization

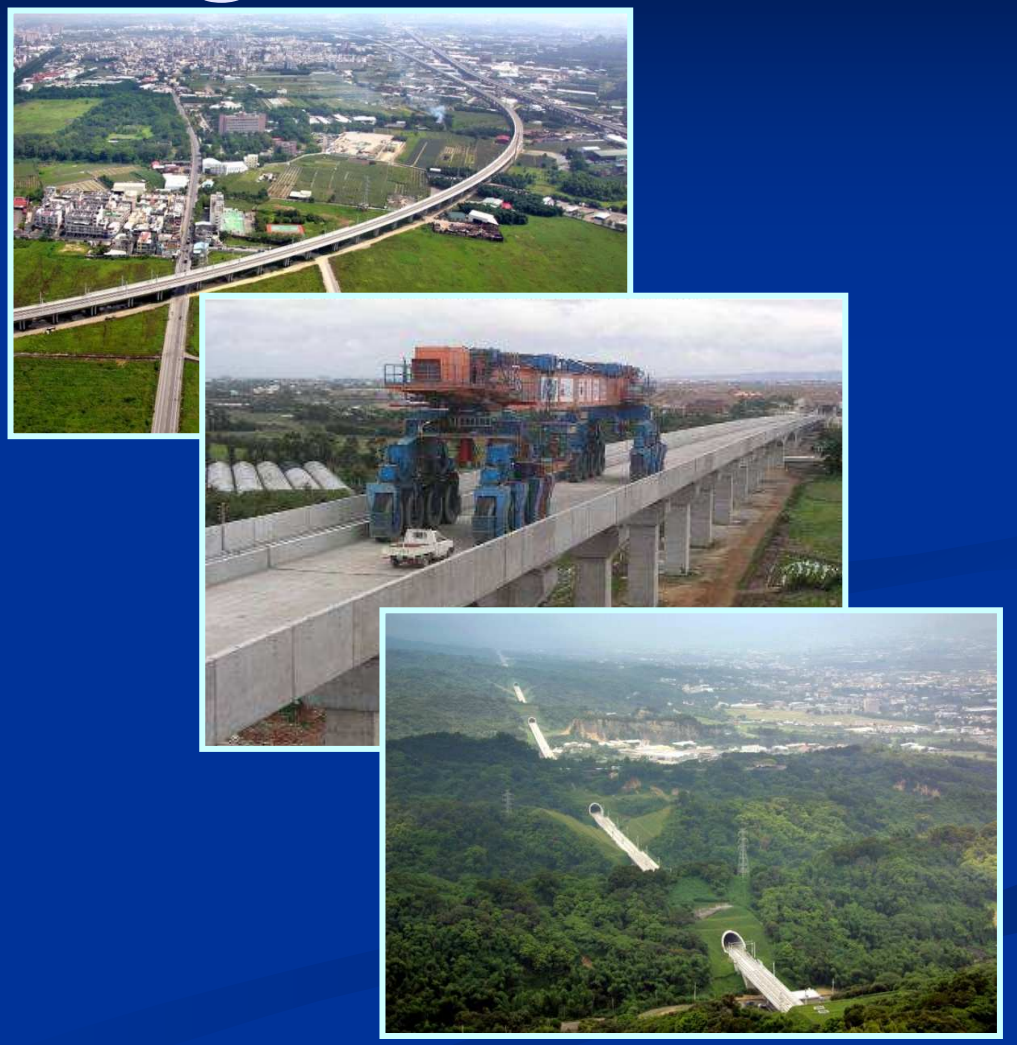


Land Acquisition

Civil Engineering Structures

Civil Engineering Structures
Total 345 Km





To mitigate the impacts of noise and visual intrusion, the project required the use of elevated structures in open areas and tunneling in urban sections.

Tunnel Construction

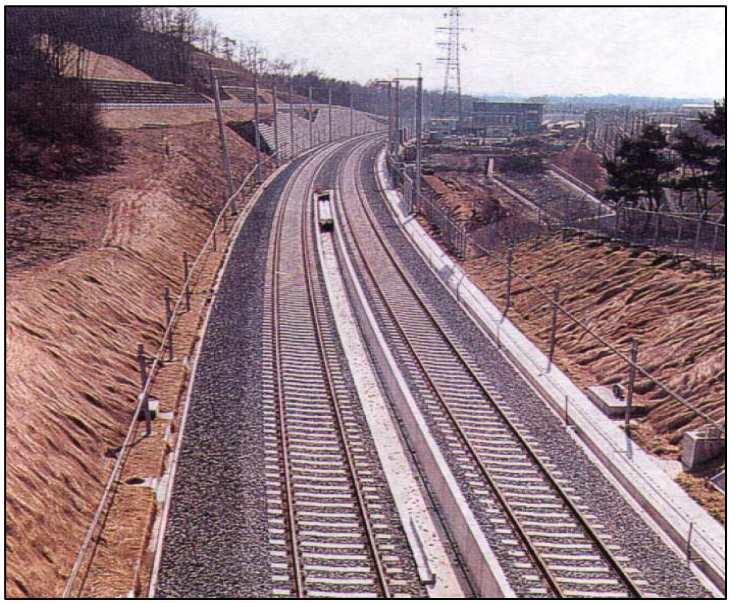
Length 321m

隧道口管幕施工(L=12公尺)

- Design Spec is based on the AASTHO Code of the USA

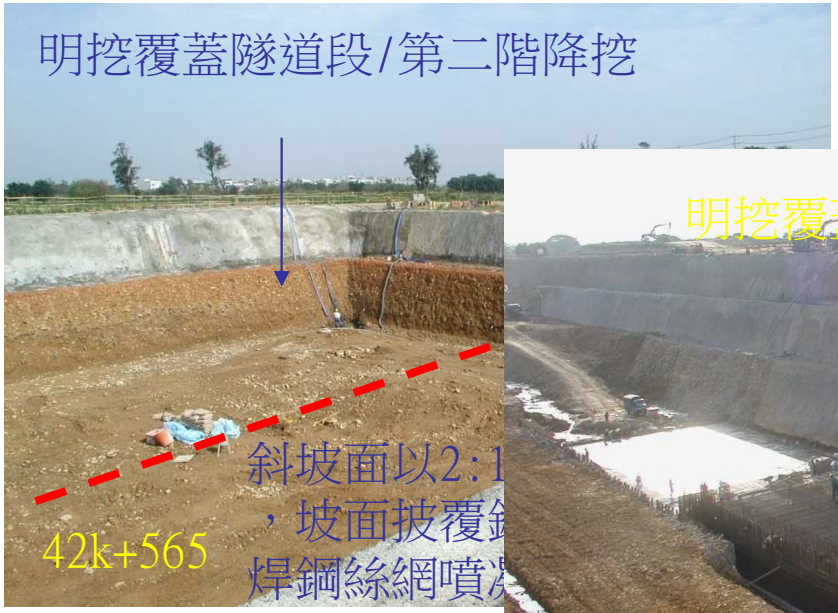
Track Works

- Standard Gauge 1,435mm
- Two tracks
- Mostly slab track
- Design-Build Turnkey



Station Construction

連續壁施工 --> 明挖



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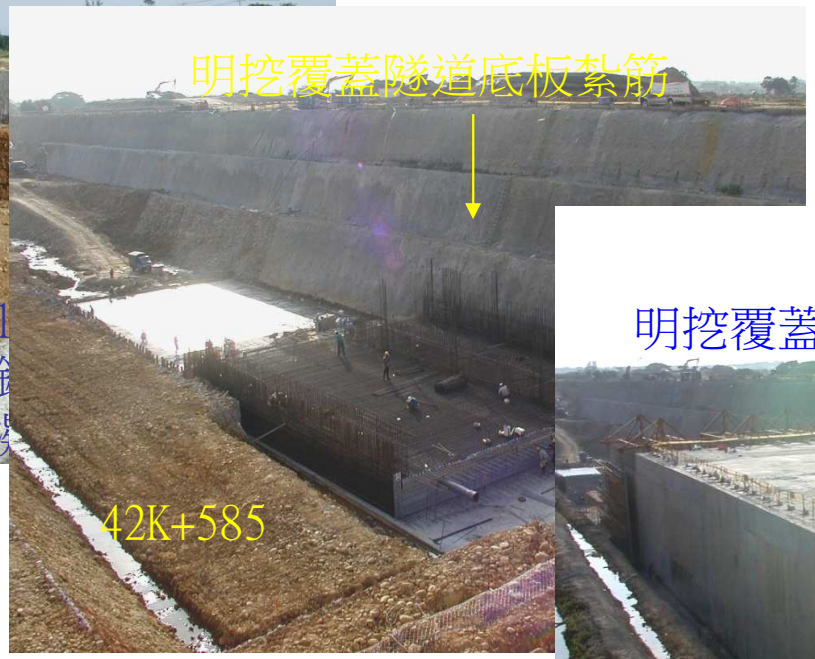

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HSR Hsinchu Station

Core System

Rolling Stocks

Business Class

Standard Class

27 M

25 M

L: 304 M

W: 3.38M

H: 3.65M

989 seats/train

Business Class: 66 seats

Standard Class: 923 seats

Taiwan HSR Project milestones

1990.07 Government authority Bureau of HSR established

1996.10 Government issued RFP of the HSR BOT Project

1998.07 THSRC awarded the BOT contract

1999.07 THSRC started construction contract solicitation

1990 1992 1994 1996 1998 2000 2002 2004 2006 2008

2004.06 The last civil work completed for track laying

2005.01 Trainset started dynamic test on the Test Line

2007.03 Revenue service started

Three Major Construction Stages

- Construction duration less than 9 years (July 1998 ~ Mar. 2007)
  - The 1st 3 years -- Planning, design, urban design, land acquisition, procurement, etc.
  - The 2nd 3 years – Construction of bridges, tunnels, earthwork, stations and depots
  - The 3rd 3 years—Track works, power supply, signaling, communication, train control system, system testing, verification, etc.

Conclusions 1

- High Speed Rail is comparatively safe, punctual, massive, weather-free, clean and energy saving.
- HPR sustains the economic growth
- High cost, short public fund, lengthy construction duration, complicate bureaucratic procedures for constructed projects faced by many governments

Conclusion 2

- Government has to maintain balance among overall social benefits, fairness of resource distribution, effectiveness of investment, and reasonable regulations in providing public infrastructure
- PPP thru BOT is an optional solution to bring in private capital & efficiency of entrepreneurship.

- 小華在作文簿上寫道：「我的家有爸爸媽媽和我三個人，每天早上一出門，我們三人就分道揚鑣，各奔前程，晚上又殊途同歸。

- 爸爸是建築師，每天在工地上比手劃腳；媽媽是售貨員，每天在商店招搖撞騙、來者不拒；我是學生，每天在教室眼瞎口呆、充耳不聞。

- 我的家三個成員臭氣相投，家中一團和氣。但我成績不好的時候，爸爸也同室操戈，心狠手辣地揍得我遍體鱗傷、五體投地，媽媽在一旁視若無睹或袖手旁觀，從來不曾見義勇為，有時甚且助紂為虐。」

- 老師問小明；你考試成績不好的話，你父母怎麼懲罰你？

- 80分以下女子單打...

- 70分以下男子單打...

- 60分以下男女混合雙打...

-

謝謝大家!

Thanks!