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Asian Development Bank Institute

[Briefing]: Sine Qua Non: High-speed Rail Forms and Roles in Intercity and Urban Areas

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Tokyo/Philadelphia-Teleconference March 17-18, 2020

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Outline

No.	Theme
1.	Abstract and Content
2.	Define Questions
3.	Network Planning and Design / Operation Strategy
4.	Case Studies: Mistakes and Lessons
5.	Next Step



Submission date: December 10th, 2019

Conference theme:

Call for Papers on Transport Infrastructure Development, Spillover Effects, and Quality of Life

Title:

Sine Qua Non: High-speed Rail Forms and Roles in Intercity and Urban Areas

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Abstract:

Dissecting many of the world's most prosperous cities, rail infrastructure serves as a strong element to bind the city's total transport network together. Rail lines and stations influence the city's form and functionality due to their permanence and considerable investment. With the global trend of urbanization, we are seeing construction of more high-speed rails (HSR, in the American term: high-speed intercity passenger rails) and urban transit systems. Digesting historical land use theories from distinguished experts and successful HSR operations from creditable agencies, a critical topic has not discussed yet. Opinions differ about geometric shape and operating strategies for HSR networks influence future patterns of city development and regional integration. The article evaluates different types of HSR network planning, design, and operations associated with their urban forms. First, the definition, geometric pattern, and corresponding characteristic of various type of lines represent the necessities to differentiate network functionalities in shaping various socioeconomic activities. Second, the reflection of international case studies distills insightful grappling of comparative analyses across independent lines vs. integrated network, trunk vs. branch lines operation, and adding new stations to the existing network vs. extending the line to new geographical areas. Third, the review of selected cities' transformational experience offers common mistakes and meaningful lessons to shape better project success. The practitioner-centric research offers a fine-grained dissection of the sophistication of HSR planning, design, and operations associated with city's form and functionality.

Keywords: High-speed Rail, Comparative Analyses, Network Efficiency and Functionality, Livable Cities

2. Define Questions

Infrastructure Investment Sine Qua Non!!!

1. HSR binds multiple cities along major corridors. Service efficiency relies on two decisive factors: network design and operation strategy.

Network Design: City's Formation Operation Strategy: City's Efficiency and Functionality



"The methodology/mechanism on how to extract the maximum synergy between network design and operation strategy"

2. The North America HSR and its concept may not be categorized as "the" HSR based on other countries' HSR standard.

American HSR does not carrying all the performance attribute (e.g., speed, exclusive use for ROW, etc.) of its peers



"American regional rail sometimes plays more role and functionality than the American HSR in defining and shaping the urban and intercity areas"

3. Could the North America HSR leverage track sharing activities with the regional rails in certain sections to increase service frequency and area coverage?



U.S. Rail Lines by Ownership



Comparative Analyses of HSR vs. Regional Rail

	Intercity High-Speed Rail (HSR)	Regional Rail
Distance (Total System)	Depends, ~ 150 – 500 km	Depends, $\sim \le 150 \text{ km}$
Service Characteristics	Headway 30 – 60 mins; Trains stop	Headway 10–15 mins; Larger
	at major CBD stations along the	number of stations within and
	corridor; the purpose is to connect	around CBDs; serving commuters
	cities.	within and around the cities.
Train Speed	Depends, ~ 180 – 200 kph	Depends, ~ 50 – 120 kph
Operating Model	Heavily subsidized by the Congress	Operated as a public service,
	to sustain the services (<u>U.S.</u>);	normally subsidized to maintain low
	Operated as a for-profit enterprise	fares and high frequency of service
	with market-based fares, multiple	
	classes of service and customer-	
	centric experience (Abroad)	
Ownership	Government agencies (U.S.);	Government agencies
	Private companies (Abroad).	

Examples of Intercity Rail Corridors and Market Shares (FY2018)

Intercity Rail	Distance (km)	Region	Operator	Market Share
Corridor				
Boston – New York	345	Eastern U.S.	Amtrak	15%
London – Paris	465	U.K./France	Eurostar	80%
Madrid – Seville	530	Spain	Renfe	51%
New York – Philadelphia	160	Eastern U.S.	Amtrak	29%
New York – Washington D.C.	385	Eastern U.S.	Amtrak	27%
Paris – Lyon	465	France	SNCF	72%
Rome – Milan	580	Italy	Italo	23%
Tokyo – Osaka	550	Japan	Japan Central Tokaido Shinkansen	72%

Source: Virgin Train USA. LLC, U.S. SEC Filing Document, Jan 30, 2019

3. Network Planning and Design [3.1 and 3.2] / Operation Strategy [3.3]

3.1 Independent vs. Integrated





II. Multiple Transfer Stations

- Independent line: each line operates by itself between two terminals;
- Integrated network: where lines overlap, have joint sections or branches.

Comparative Analyses

Integrated network compared to independent line advantages (+) and Disadvantages (-):

- + Provide more direct trips, reduce needs for transfers;
- + Shorten station dwell times due to fewer passengers boarding/alighting;
- + Allow scheduling that better matches volumes on individual network sections;
- + Rolling stock can be shifted among lines, increasing its utilization;
- + Integrated control center and maintenance facilities usually bring significant economies of scale;
- + Lines and their sections can be changed to respond to changes in demand patterns or operating conditions;
- More complicated to operate due to interactions among lines;
- Delays transfer among lines, reducing reliability.

3.2 Trunk and Branches



- Trunk line: overlapping sections are used by more than one line, usually in center cities;
- Branch line: separating from the trunk as single lines operate toward the suburbs.



Gyeongbu Trunk Line toward Seoul (Blue) and Suseo Branch Line toward Yongsan (Green) Source: Korean Trains

Area Coverage, Load Section, Capacity, and Passenger Profile: Trunk Line with Two Branches

Trunk compared with Branches have the following advantages (+) and Disadvantages (-):

- + No passenger transfers are required; thus, transfer stations are not required;
- + Less terminal time is involved (longer lines);
- + Lower average load factor because each full-size train runs the entire length of the line, while capacity of the branch (usually smaller size vehicle) can adjust to more volume than the trunk line carriers;
- Delays on the outer sections affect operation on the entire line;
- Scheduling is less flexible (feeders can operate with headways x2 and x3 times longer or shorter than the trunk).

Comparative Analyses

Branches have the following advantages (+) and Disadvantages (-):

- + Each vehicle type, length, schedule can be tailored to its optimal operating status with higher loading factors, smaller fleet size, and lower operating cost
- + Use of high-performance vehicles on the trunk provides superior services at lower operating cost than smaller vehicles from branches can provide;
- + Regular headways can be operated on the trunk and each branch;
- + More reliable services: delays are less likely to be transfer between trunk and branches;
- + Suburban terminals for trunks offer trunk/branch transfers and transfers among branches, providing greater network connectivity;
- When ridership is low on branch line, operating cost is high;
- When ridership is high enough, a feeder may worth to convert to a trunk. Then, it is required to develop new operating strategy.

3.3 Dead-end Terminal and Through-running Station



I. Separate Terminals with Radial Lines

II. Connected Terminals with Diametrical Lines

- Through-running station: allowing trains to pass through the station with a minimal headway (hs min);
- Dead-end station: Prohibiting trains to pass through, functioning as a terminal.

Decisive Factor



(a) Four sets of stop/station locations. Each set can serve one or more lines (Based on operation in Portland, Oregon)



(b) Stop/station with independent arrivals/departures with two sets of stopping locations (Based on operation in Athens, Greece)



(c) Stop/station with simultaneous parallel stopping at an island platform for bypassing of local by express trains

Examples of Station Design with Train Bypassing Capabilities

[The trade-off] between **fix tracks with lower investment but higher O&M cost** vs. **flexible tracks with higher investment but lower O&M cost** resulted in different frequency and capacity profiles.

Operation Benefits of Through-running Station



4. Case Studies

Philly Dead-end Terminal (Left) converted to Through-running Trunk Operation (Right)



Chicago Railway Six Entrances and Disconnected Dead-end Terminals in 1892 (Left) vs. Diametrical Through-running Trunk Routes in 1937 (Right)



Source: The Chicago City Club

Boston North South Rail Link Existing Dead-end (Left) vs. Proposed Through-running (Right)



Nork York Existing Dead-end Terminals vs. Single-Core (Left) vs. Futuristic Through-Running and Multi-Core (Right)





DECEMBER 26, 2019 Albany, NY

Governor Cuomo Unveils 13th Proposal of 2020 State of the State: Developing an Innovative Strategy to Build High Speed Rail in New York

Panel of Outside Experts to Re-examine and Reimagine Designs to Develop High Speed Rail on New York's Empire Corridor lines average 51 miles per hour, meaning it is often the slowest method available for New Yorkers.

Recommendations to implement high speed rail across the State, which have not changed much over the last two decades, have consistently estimated that projects would take decades and be unaffordable. This team of experts will review these past studies, and strategies that countries all over the world have used to build thousands of miles of high-speed rail, to ask every question and find the best way to build high-speed rail in New York.

No other state has demonstrated a stronger commitment to rebuilding its transportation infrastructure than New York under Governor Cuomo. The Governor's latest five-year, \$150 billion infrastructure plan builds upon his historic \$100 billion infrastructure initiative that concluded last year. The capital projects included in these plans rebuild transportation and

The capital projects included in these plans rebuild transportation and mass transit systems, construct safe and secure affordable housing, drive economic and community development, build new and better school buildings for 21st century learning, create new environmental and park facilities, support our sustainable energy future, and generate 675,000 new jobs and expand opportunity for all New Yorkers.

1/3

High speed rail is transforming economies around the world, we version that bringing this technology to our state is too expensive, too difficult and would take too long - that's not an acceptable attitude for New York," **Governor Cuomo said.** "When we developed our plan to repair the L Train Tunnel, the team of experts we assembled questioned every assumption and brought new creativity to a seemingly intractable problem. We not only found a way to repair the tunnel without shutting down service, we are doing it ahead of schedule. This kind of outside-the-box thinking will help us determine how we could deliver high speed rail for New York."

Most of the State's population lives a short distance from the Empire Corridor, which connects the State through New York City, Albany, and Buffalo. However, these

employment growth in 76 of the past 88 months.				
Contact the Governor's Press Office				
Contact us by phone:	Albany: (518) 474 - 8418			
	New York City: (212) 681 - 4640			
Contact us by email:	Press.Office@exec.ny.gov			

2/3



A New Approach



Virgin Train USA (form Brightline HSR) Route Map Phase 1 (Current) and Phase 2 (Planned)







SIEMENS

SKIDMORE, OWINGS & MERRILL LLP

SIEMENS A.G.

rockwellgroup

ROCKWELL ARCHITECTURE, PLANNING AND DESIGN, P.C.



ARCHER WESTERN, A MEMBER OF THE WALSH GROUP



90,000 RSF / OFFICE 35,000 RSF / RETAIL

PARKLINE LIVING

800 RESIDENCES

2 MIAMICENTRAL

190,000 RSF / OFFICE

MIAMICENTRAL RETAIL SPACE 130,000 SQ.FT.

Global Railway Review Ben Porritt Sept 5, 2018 Brightline: Redefining passenger train travel in America https://www.globalrailwayreview.com/article/73073/brightline-redefining-passenger-train-travel/

OFFICES, RESIDENCES AND HOTEL APPROX. 1.8 MILLION SQ.FT.

MIAMICENTRAL



Virgin Train USA Ownership Structure



Source: Virgin Train USA. LLC, U.S. SEC Filing Document, Jan 30, 2019

Tax-Exempt Private Activity Bonds

Type of Private Activity Bonds	Subject to Volume Cap?
Private activity bonds financing exempt facilities (Section 142):	
airports	No
docks and wharves	No
mass commuting facilities	Yes
facilities for the furnishing of water	Yes
sewage facilities	Yes
governmentally owned solid waste disposal facilities	No
privately owned solid waste disposal facilities	Yes
qualified residential rental projects	Yes
facilities for the local furnishing of electric energy or gas	Yes
Iocal district heating or cooling facilities	Yes
qualified hazardous waste facilities	Yes
governmentally owned high-speed intercity rail facilities	No
privately owned high-speed intercity rail facilities	Yes ¹
environmental enhancements of hydro-electric generating facilities	No
qualified public educational facilities	No
qualified green building and sustainable design projects	No
qualified highway or surface freight transfer facilities	No
qualified enterprise zone facilities	Yes
new empowerment zone facilities	No



Phase 1: \$4BN a volume cap of 25% of the bond

Decision Process: Adding a Station to An Existing Line



*Community effects (e.g., congestion, noise, air pollution, and energy consumption) are proportional to traffic volume

Proposed Strategy: Accelerated Operations associated with Track Flexibility



I. Express/local operation

Comparative Analyses of Skip-stop and Standard Operations



5. Next Step (If we can publicly disclose with an "agreement")



2. Visual representation of finding the optional station with different variables under different models



After deciding station density and speed, how would it affect ridership and revenue? Will operation flexibility (due to track alignment) attract more riders?