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HIGH-SPEED RAIL AS A NEW MODE OF INTERCITY PASSENGER TRANSPORTATION

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Abstract

High-speed rail is a new mode of intercity passenger transportation. The article reviews the history of the United States' (US) HSR development and makes a comparison with peer countries' HSR development. With the rapid progress of HSR and the successful competition with cars and air travel between medium and long distances (150 and 1,200 km), HSR has an increasing role in intercity travel worldwide. Decision makers, transportation planners, system designers, and operators as well as political leaders need to understand HSR's operational boundaries for intercity travel to determine which HSR will outperform the others and under which conditions. The analysis uses a simple time–distance factor to clarify the dominance. To confirm the validity of HSR in intercity passenger rail services, a comparison with the external competition of car and air travel is necessary. Meanwhile, an internal examination of operational performance considering sophisticated variables is imperative. The dissection, based on numerous HSR projects, selects four interrelated trade-off elements: the passenger access time and travel time associated with the total on-line travel time, the area coverage associated with the station density, the station density associated with speed, and the transit unit (TU) size, frequency, and loading factor associated with the independent line capacity. After examining the interrelations and trade-offs, a practical case study presents one of the major US economic corridors—the Northeast Corridor. The case study explores the geospatial metadata and concludes that three major system efficiency challenges exist; therefore, it provides corresponding engineering measures to convert an independent dead-end terminal into an integrated through-running station, which are the priority for converting Amtrak, the US national rail service, into an accelerated HSR service. It is time to renew the government's interest in paying systematic attention to the comprehensive effect of HSR.

Keywords: high-speed rail, regional connectivity, comprehensive effect, system performance, operational measure

JEL Classification: L92, R41, R53

Contents

1. AN OVERVIEW OF HIGH-SPEED RAIL IN THE UNITED STATES

The United States once had one of the world's best passenger rail systems, but today it lags far behind its peer industrialized and advanced countries in developing HSR. When Amtrak, the US's national rail system, was founded in 1971 (Amtrak 2017), it would have been logical for the federal government to develop and operate as a high-speed intercity rail system, since the system connects many major metropolises, as well as providing substantial financing for major improvements and modernization of its obsolete services. However, these have never occurred. The federal and state funding assistance programs have been low and inadequate compared with the investments made by Asian and European nations with a similar standard (Amtrak 2018; European Court of Auditors (ECA) 2018). Since America's modest investments have been unpredictable, Amtrak has had to fight for survival in each budgetary year (Congressional Research Services (CRS) 2013, 2017, 2018; US Department of Transportation (DOT) 2011, 2018). How can an agency plan a major upgrade when it has unpredictable financing and when several presidents have even threatened to cut its subsidy?

Such seasonal allocation forced Amtrak to maximize its revenue as a priority rather than maximizing the ridership and economic and comprehensive effects. Amtrak became a transportation system mostly for businesspersons and high-income travelers instead of a public transportation system, as found throughout most of the world, which serves all categories of people, from students and workers to tourists and retired persons as well as executives. As an example, fares from Philadelphia to New York, about 150 km apart, vary from $58 to $275 (Schabas 2012); as a result, many travelers are shifting to cars and buses (Amtrak 2010, 2012, 2017, 2018).

High-speed rail (HSR) is a prime candidate for the busiest corridors across high-population metropolises. More than 25 countries have built HSR systems, and they have been very successful in upgrading intercity travel. In worldwide cities' competition for economic growth, business friendliness, national events to boost visibility, and tourist attraction (Le Maout 2012), US cities are far behind their peers with respect to intercity mobility. A recent international example was the 2018 FIFA World Cup. The Sapsan HSR has been indispensable for intercity travelers between Moscow and St Petersburg and between Moscow and Nizhniy Novgorod since 2009. The Sapsan HSR is building another line between Moscow and Kazan with a total length of 770 km, which will shorten the travel time from 14 hrs to 3.5 hrs (Sapsan 2018). Most large cities have several intercity passenger railway stations. Moscow has nine, London nine, Paris five, and Tokyo more than a dozen. The airports in Beijing, Frankfurt, London, Moscow, Munich, Tokyo, Zurich, and many other cities also have direct rail transit lines. The city of Moscow has a 30-minute headway of Aeroexpress train travel regularly throughout the day from Sheremetyevo International Airport (SVO) to the integrated Belorusskiy railway station, where passengers can transfer to the Moscow Metro system to enter the central city. The newly opened Moscow Central Circle (MCC) enables passengers who live in the suburbs to transfer at the integrated Okruzhnaya Station without entering the central city (Vashchukov et al. 2018). The price of the Aeroexpress ticket from SVO airport to Belorusskiy station was ₽500 rubles (equivalent to about USD$7.5 using the September 2018 exchange rate) (Aeroexpress 2018), which is more affordable and offers better comfort and more regular services than Amtrak. In contrast, US cities, such as Chicago, New York, Philadelphia, and most other cities, have only one Amtrak station and another in the suburbs (Baltimore, Boston, and Washington).

Cities around the globe are either in the transition stage of repositioning their long-term competitiveness or in the development stage of scalable metropolitan planning or simultaneously undertaking the transformative process of tackling both. The cities of Atlanta, Baltimore, Chicago, Cleveland, Denver, Miami, Minneapolis, Oakland, Philadelphia, Phoenix, Portland, San Francisco, Seattle, and St. Louis have recently built LRT, metro, and regional rail lines, but New York has only recently opened rail transfer lines to JFK and Liberty Airports and has none to La Guardia. Los Angeles, Houston, Orlando, and Pittsburgh have no rail access to their airports yet. Regarding overall passenger rail, both the HSR development and the political willingness to scale the network are far behind those of global cities. In the case of the Russian Federation, the central diameter is currently under construction in Moscow, with a total of 54 km in length and 31 new stations. On completion, the length of the network will double to a total of 1,050 km. Although it is a case of urban transit, the Moscow central diameter (MCC) project reveals the government's ambition and determination to develop an integrated rail service (Vashchukov et al. 2018).

2. HISTORY AND PERFORMANCE COMPARISON BETWEEN CONVENTIONAL RAIL, HIGH-SPEED RAIL, AND AIR TRANSPORT

HSR is a new transportation mode suitable for intercity travel with greater advantages on medium-haul distances from 150 to 800 km and long-haul or long distances over 800 km. In the American society, until the 1950s, private cars were used extensively within US cities, but they were inefficient for trips of several hundred miles because of the low average speeds, particularly through urban and en-routes. When the US Interstate Highway System was built in 1956–72, the average car travel speeds increased on the highway to become uninterrupted at 80–120 km/h (Federal Highway Administration (FHWA) 2018). The auto-highway became a different mode of transport, with its domain extending to a longer distance, even coast to coast, starting to overlap with rail and air in the competition. A similar change occurred in overseas travel. Until 1960, propeller planes offered US–Europe travel in tiring 18–22-hour journeys strapped into seats. Steamships took 5–6 days to cross the Atlantic, but they offered much more comfortable travel. As jet planes were introduced around 1960, the trip times reduced to 7–9 hours. With upgraded airplane propulsion, the new mode of jet planes took over most of the long-distance trips from ships (except tourist cruise ships) and some overland passengers from railroads, buses, and automobiles. In the 1960s, conventional passenger trains operated at 60–100 km/h, and in some countries the maximum speeds were reaching 150 km/h. The first HSR line, Shinkansen, built in 1964 between Tokyo and Osaka, had a speed of 210 km/h. France's line was faster in 1981 at 270 km/h. In the following decades, Spain; Germany; the Republic of Korea; Taipei,China; and other economies operated trains at speeds of 300–360 km/h. The world record maximum speed achieved on a special track in France was 575 km/h (Le Maout 2012).

The progress in rail technology resulted in the development of a new mode—HSR. When conventional trains traveled at 60–100 km/h, they could not compete with car travel on freeways or with airplanes on distances over 150 km. Now, as the speed exceeds 300 km/h, HSR is 2–5 times faster than cars, and it competes with airlines in the total travel time, shorter access times, and much higher comfort levels up to distances of about 1,200 km. HSR is the only all-electric mode of intercity travel—a goal of energy saving and climate protection that all other modes are pursuing at a much slower pace of transformation. All-electric propulsion makes HSR a new intercity transportation system compared with both conventional rail, which in North America was mostly diesel powered, and the air and highway modes (National Cooperative Rail Research Program (NCRRP) 2015).

The distance–time–speed diagrams in Figures 1 and 2 show the relationship of speeds between the three high-speed modes—conventional rail (CR), air, and HSR—with overlapping domains in the medium- and long-haul range of 150–1,200 km.

Figure 1 shows a comparison of the total travel time by CR and air modes. For each mode, the figure shows the approaching and departure times along the abscissa and then adds on-line travel as the line with the average travel speed as its slope. The equilibrium point (E) represents the distance below which CR is faster and above which air is faster (Vuchic 2018).

Figure 1: Comparison of Conventional Rail and Air Travel by Total Travel Time 1960–2018

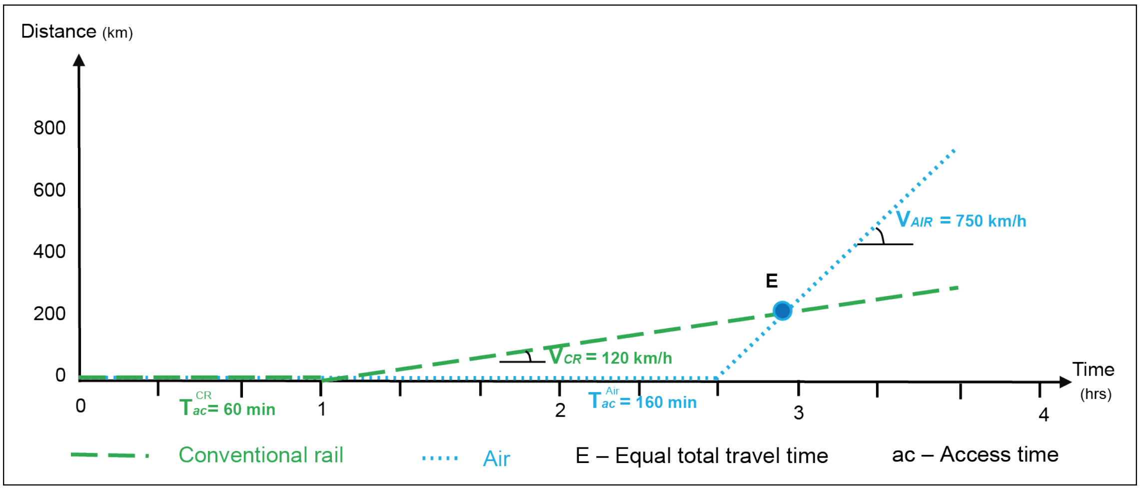


Figure 2 shows that the introduction of HSR increased the rail domain compared with air, using the common values from Table 1 for the two cases. Case 1 shows the travel time and speed of CR and jet planes about 1960, resulting in an equilibrium point at about 250. Case 2 shows the comparison of the travel time of HSR and air in 2018. The diagram shows that two major differences arose between 1960 and 2018 as the technology advanced:

I. The access times for rail did not change relative to CR, but the average speed increased drastically from 120 for CR to 300 km/h for HSR.

II. The average air travel speed did not change significantly, but the access time to the airport increased by at least 40 minutes, from 160 to 200 minutes, due to longer check-in times, security procedures, and delays in take-off and landing.

These two changes resulted in an increase in the equilibrium point (E) from 250 to nearly 1,200 km. Many countries' HSR services have corroborated this. For example, the travel time on the 1,200 km Beijing–Shanghai line (built in 3.5 years!) reduced from 11 hours on CR to 4.5 hrs on the HSR line.

Figure 2: Comparison of the Travel Time of CR and Air in 1960 and HSR and Air in 2018

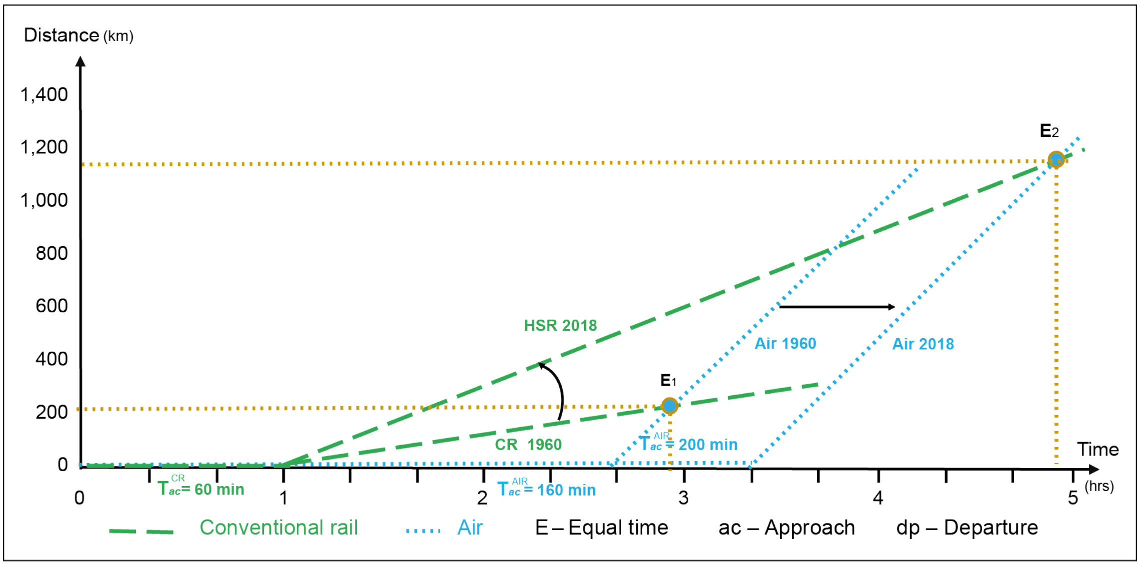


Table 1: Travel Time of the CR, HSR, and Air Modes in 1960 and 2018

	1960		2018	
	CR	**Air**	**HSR**	**Air**
T_{ap} [min]	40	120	40	160
T_{dp} [min]	20	40	20	40
T_{ac} [min]	60	160	60	200
V_{max} [km/h]	150	900	350	900
V_{av} [km/h]	120	750	300	750

While the minimum total travel time is an important factor influencing the choice between HSR and air, several elements also influence passengers' selection, such as:

- Access to terminals: rail stations are typically in a city center, accessible via many transit lines or walking. Airports are farther away and depend on access mostly by private cars. Many cities are now improving the access by bus or rail transit.
- Passenger comfort and environment: HSR cars offer increasingly comfortable seats and allow passengers to walk to bars for food and beverages, some joint tables, and a view of the surroundings during travel. Airplanes offer strapped, increasingly tight seats and often dark cabins (Narayanan and Batta 2003).
- Pricing: HSR travel often offers a less expensive rate than the combination of airfare, surcharge, and airport amenity fee.
- The weighted travel time elements vary between HSR and air: most travelers consider waiting and other in-terminal times to be much more objective than the time spent traveling in a vehicle.
- Ancillary business activities: besides the technical superiority of railway services, some railway stations include coffee shops, restaurants, and even duty-free ships (Trainsrussia 2006).

All these elements have led HSR to become more competitive with air travel. The discussion about mode choice, system comparison, and effective changes, a necessity to apprehend the major operating HSR elements and trade-offs, would lead to an objective assessment of its comprehensive effect.

3. OPERATIONAL DISSECTION AND PERFORMANCE MEASURE OF HSR

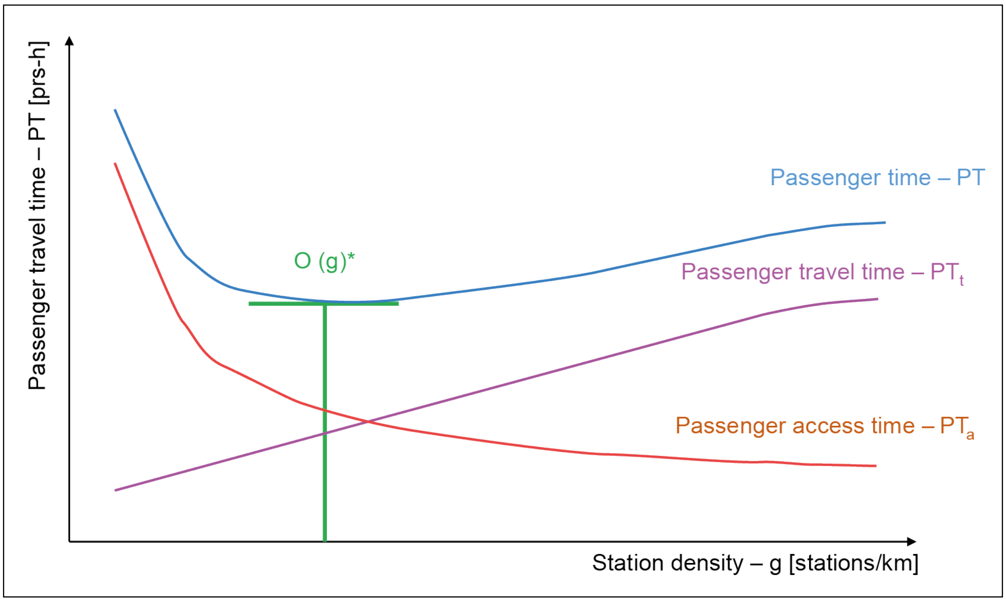
HSR network design requires meticulous technical planning and decision making regarding major elements (HNTB 2012; Asian Development Bank (ADB) 2016, 2018; American Public Transport Association (APTA) 2017; Jacobs 2018). These elements have a sophisticated interrelation. Negligence would lead to a series of operating nightmares; therefore, the study selects four distinct elements. They are the passenger access time and travel time associated with the total on-line travel time, the area coverage associated with the station density, the station density associated with the speed, and the transit unit (TU) size, frequency, and loading factor associated with the independent line capacity. Studying the severity and sophistication of such interrelated complexity offers a thorough procedure for decision making regarding the planning, design, and operation of an HSR line and its comprehensive effect.

3.1 Passenger Access and Travel Time

The travel time of passengers on a transit line, the passenger time (PT), consists of two main concepts: the access to/from the stations, including the waiting time (PT_a), and the on-line travel time (PT_t), as Figure 3 shows.

$$PT = PT_a + PT_t \tag{1}$$

Figure 3: Passenger Travel Time as a Function of Station Density



The number and location of stations along a line influence both the access and the travel time. Analyses of the number of stations on a line with a given distance often use the station density (g), defined as stations per km, or the inverse of the average station spacing. For example, if the average spacing is 0.8 km, the station density is $g = 1/0.8 = 1.25$ station/km.

Considering the passenger travel time, it is necessary to base the station density on the optimum value trade-off between access (PT_a) and travel time (PT_t).

1. An increase in the station density (g) results in a decrease in the average distance and access time to the station (PT_a).
2. An increase in the station density (g) on the line results in an increase in the passenger travel time (PT_t).

When the station spacing becomes too short for trains to reach their maximum speed, an additional delay happens so that the marginal increase in travel time begins to decline. The total passenger travel time curve, PT, shows the optimal station density—O (g)*. If the passenger distribution along a line is uniform, it is possible to determine the optimal station density through the trade-off. If the passenger distribution is non-uniform, such distribution influences the optimal station locations and results in variable spacing (Vuchic 1985 2005).

3.2 Area Coverage

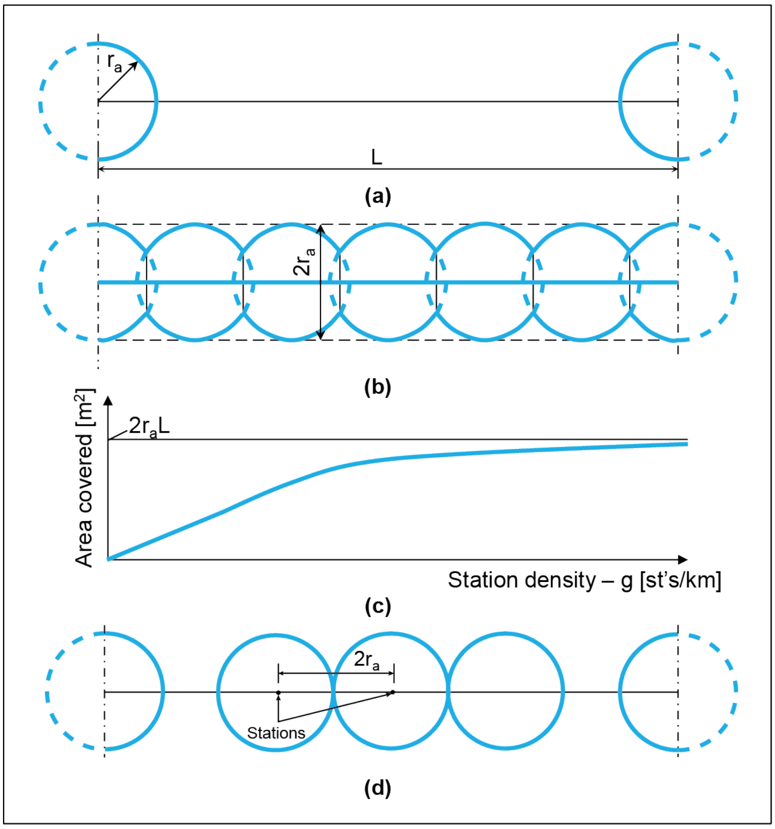
The area coverage, defined as the percentage of the total area within 5 min/400 m (primary) and 10 min/800 m (secondary) walking distance of transit stations, represents the basic element of transit system accessibility. Maximizing the area coverage is one of the important priorities in network planning and design, because the system usage depends on both the technical operations and the ability to attract passengers. The area coverage is a direct result of the station density. For simplicity, the study makes two very liberal assumptions:

1. A station can be placed at any location along a line.
2. There is ubiquitous access; that is, people can access any station in a straight line. This makes the area coverage of a station a circular surface with a radius of the maximum walking distance (r_a).

If a line segment with length L has only two stations, the area coverage is limited to two circles around them with radii equal to r_a, as Figure 4a shows. Each additional station increases the area coverage by another $\mathbf{2r_a} \times \pi$ area until these areas touch and then begin to overlap (Figure 4b). The increase in coverage begins to diminish if the station-to-station distance begins to overlap too much. The theoretical maximum coverage of a line, $\mathbf{2r_a} \times L$ (Figure 4c), would be achieved by a continuous station (Figure 4d) (Vuchic 1976, 2005).

In short, the planning of stations faces a fundamental dilemma: closer stations (with short spacing between them) result in better area coverage and easier access for a larger number of potential passengers. However, short station spacings cause a lower operating speed and possibly a larger vehicle size as well as higher construction and station maintenance costs. Longer station spacings result in the opposite situation: high speed and better operation but a line that passes through areas without serving them, since there are no stations. A portion of potential passengers is then lost (Vuchic and Newell 1968).

Figure 4: Station Area Coverage by Density



3.3 Station Density and Speed

The operation and passenger attraction of HSR has high elasticity between the number of stations, the speed, and the disutility. As Figure 5 shows, when the station density g [st's/km] is low (say, only two terminal stations for a single line), the travel speed can be very fast, but the total disutility is also very high, mainly due to the many unserved areas (resulting in low ridership). As the station density increases, the speed will become lower and then the railway will serve more passengers, although the overall travel time will increase. This will also result in a lower cost per passenger.

Figure 6 shows the distribution of Q stations in a single line (from the left) and the speed (from the right). HSR lines mostly operate under the lower disutility scenario, and the distribution between stations and speed will be at the equilibrium point E: q_g, the number of stations, and q_{vc}, the operating speed. This situation exists in the real world, where there is an HSR system with an average speed of 350 km/hr and another conventional rail (CR) system with an average speed of 120 km/hr. If one could make an impact on the other, for example, Δq shows the number of travelers deciding to travel on a single line; when the number of stations decreases, its operating speed can increase. Therefore, the travelers on the line would benefit, so identifying the station density and speed leads to a system optimum—minimum total disutility.

Figure 5: Travel Disutility by Station Density and Speed

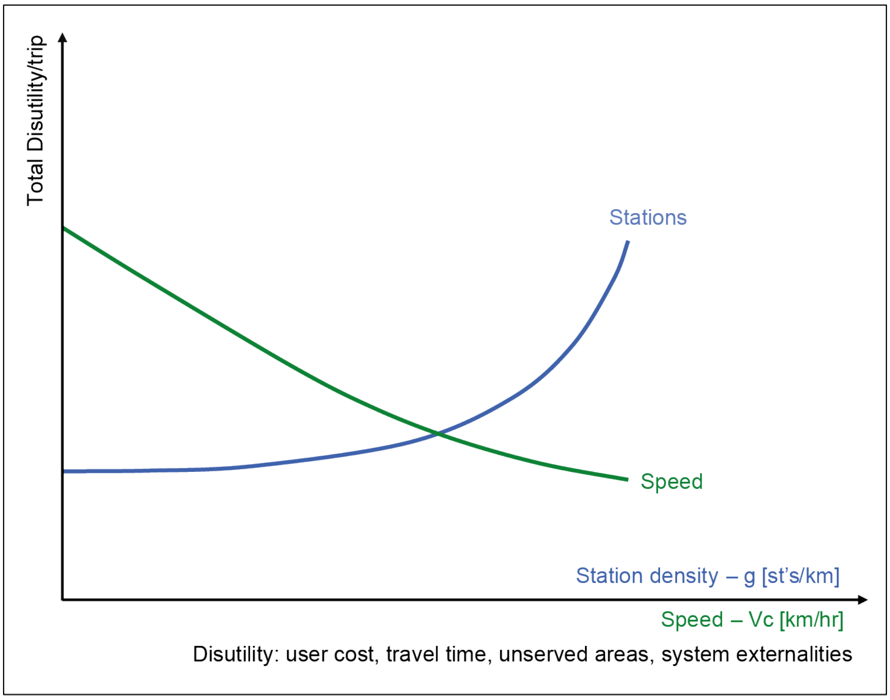
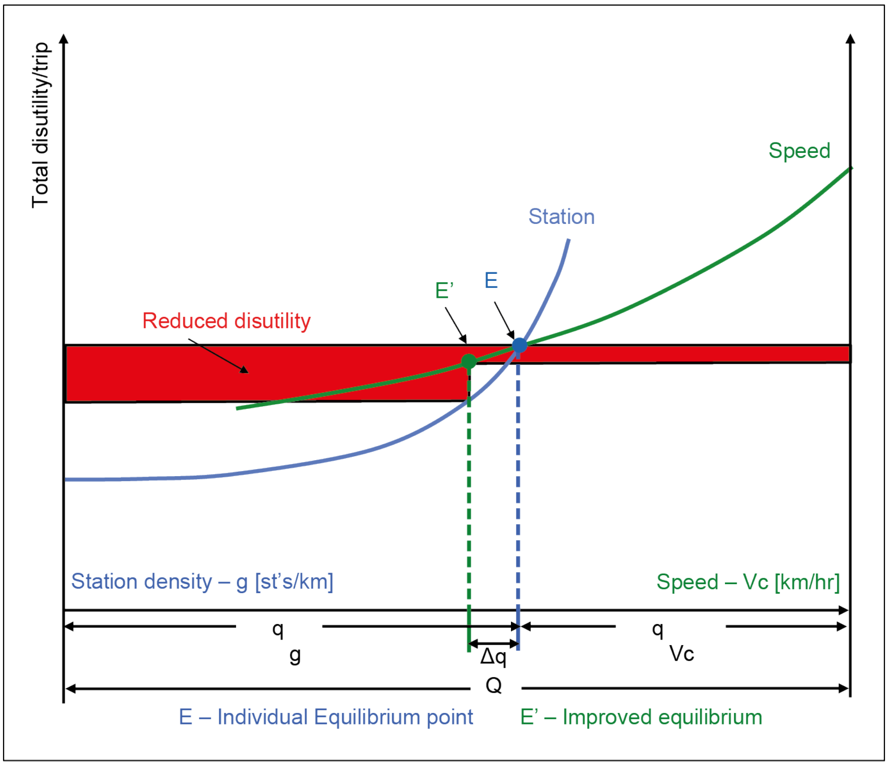


Figure 6: Travel Distribution between Station Density and Speed



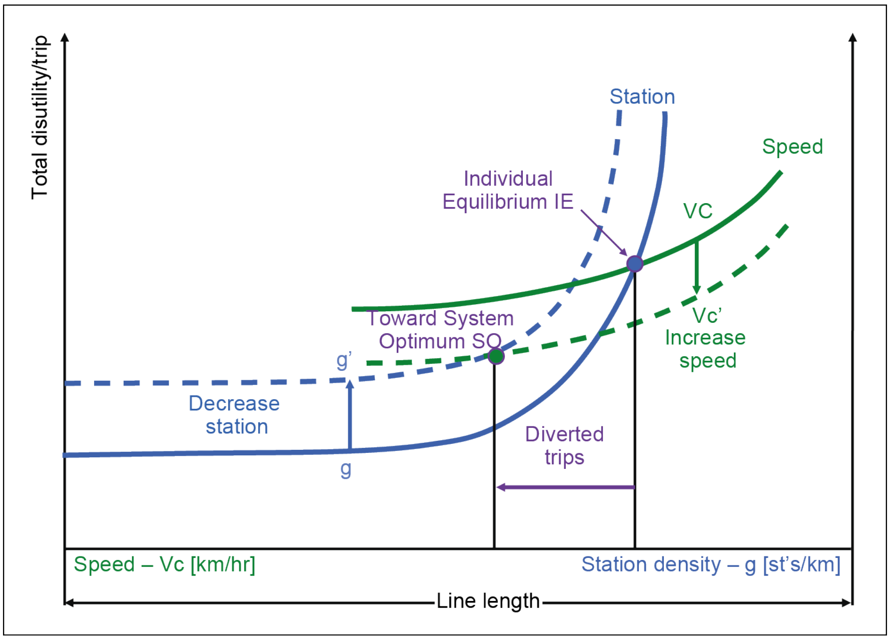
HSR challenges the existing modes of transportation and creates a new mode to shorten the intercity passenger commuting time massively. One must understand this relationship between the station density and speed and the application of two design principles and the corresponding operating strategy to plan for a “flexible” HSR system. The term “flexible” in transportation system planning always comes with trade-offs (Vuchic 1971). As mentioned above, the trade-offs are between the passenger access time and the passenger travel time, the area coverage, and the station density and speed. Thus, if pursuing the maximum speed of this new mode of transportation (only if the line reaches its offered capacity), one should understand the importance of the two interchangeable principles:

Method I: Increase the speed

Method II: Decrease the station density

Figure 7 shows how these two sets of measures result in a shift of the equilibrium point from the individual equilibrium point (IE) toward the system optimum (SO) point: to increase the speed, move the V_C curve down to V_C’, whereas the station density moves the g curve up to g’. The result is a shift from operating more stations to operating fewer stations so that trains can travel at a higher speed, known as skip-stop and express services; this moves from the initial IE toward the SO due to the individual decisions of travelers and operators, and it remains stable thereafter. The diagram shows the total disutility of travel in both modes, which was initially at the IE level and has reduced to the SO level.

Figure 7: Operation Strategy for Shifting the Individual Equilibrium to the System Optimum



The corresponding measures of station spacing on any section along a line should be the ratio of the number of passengers with origins and destinations along the ridership distribution vs. the number of passengers on the trains passing through the same section who prefer to skip the stop due to time loss. The greater this ratio, the more stations the line should establish. On the other hand, when the volume of through passengers dominates the volume of local passengers, the station spacing should be long. In brief, the station density (g) varies with the distribution of the passenger demand along the line (Vuchic and Newell 1968; Vuchic 1969, 2005; US DOT 2011).

3.4 Guidance for the TU Size, Frequency, and Load

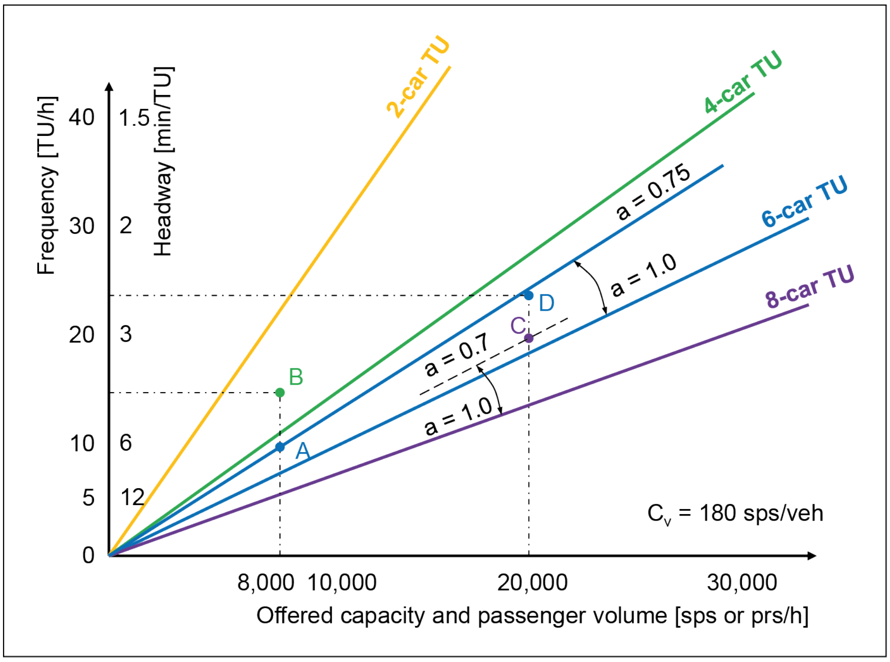
The system capacity has a comprehensive effect on an HSR network. The examination of the system capacity requires an in-depth analysis of engineering elements. Equation 2 enables the selection of the optimal combination of transit unit (TU) size (n), operating speed (C_v), service frequency (f), headway (h), and load factor (α) for any scheduling period of the day. The diagram is based on the equation:

$$C = n \text{ x } C_v \text{ x } \alpha \text{ x } f \qquad (2)$$

Figure 8 shows four different trains comprising TU sizes of two, four, six, and eight cars and the line capacity with operations at different frequency/headway and load factor α. Each slope line shows the values for a given TU size at full occupancy, α = 1. The blue-dashed line shows the capacities offered by six-car TUs with α = 0.75.

Assume that the offered capacity is 180 seats per vehicle. During the mid-day period, P_{max} – 8,000 prs/hr, the reasonable choices would be to operate six-car TUs at h = 6 min with α = 0.75—point A on the diagram—or four-car TUs at h = 4 min with α = 0.75—point B. Suppose that the peak period has P_{max} = 22,000 prs/hr; then the choices may be to operate eight-car TUs at h = 3 min and α = 0.70—point C—or six-car TUs at 2.5 min and α = 0.77—point D (Vuchic 2005). The selection of TU size has an impact on the system capacity, fleet, and schedule management.

Figure 8: Transit Unit Capacity and Headway on Schedule Design



4. A CASE STUDY: NEW YORK PENNSYLVANIA STATION: EXISTING CHALLENGES AND CORRESPONDING ENGINEERING MEASURES

In a comparison of the US cities and major corridors with the passenger rail services in peer locations—Paris, Munich, Moscow, or Madrid, not to mention Tokyo and Beijing—their rail services are incomparably better than Amtrak's, even those between Washington and Boston. Amtrak offers services that are slower (Acela trains are an exception), less frequent, less reliable, less comfortable, and involve tedious boarding and alighting. Amtrak's tickets are grossly overpriced not because of its services but because of the lack of a consistent funding stream from the government (Burns 2012). Such a fact forces intercity travelers to choose low-cost buses and cheap domestic airlines. Highway and airline lobbyists and special interest groups are still challenging the role and necessity of Amtrak in the US intercity travelers' market by asking how other corridors besides the Northeast Corridor (NEC) in North America could benefit from the construction of HSR. In fact, ambition and political willingness never create the right conditions for Amtrak and other HSR networks in the US (Federal Railroad Administration (FRA) 1997; Regional Planning Association (RPA) 2011). For example, Florida was ready to build an HSR but Governor Bush vetoed it. Later, Governor Rick Scott refused federal funds as part of Obama's American Recovery and Reinvestment Act (ARRA). Since then, the operation of HSR in Florida has commenced, with further expansion and higher speeds planned. Major planning efforts are taking place in Texas, Midwest, Toronto–Montreal, Seattle–Portland, and others. The leader among these efforts is California. With a steadily growing population, it is leading the way by constructing HSR connecting most cities between San Diego and Sacramento (Vuchic 1985, 2018; Washington State Department of Transportation (WSDOT) 2017).

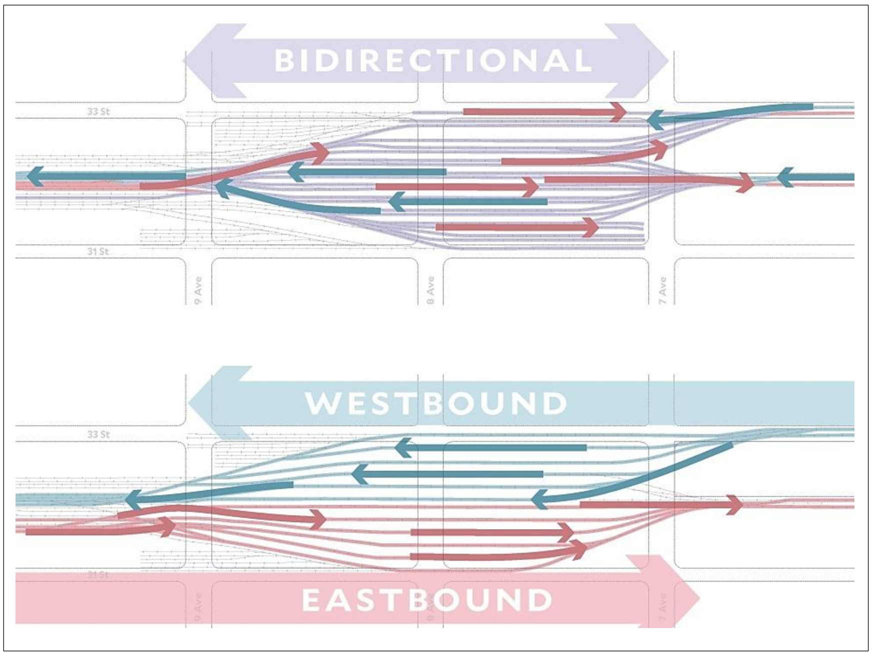
The Northeast Corridor (NEC) is unique due to its geographic, economic, and population conditions and the fact that it has good services from Amtrak and several regional rail networks (LIRR, Metro North, SEPTA, and others). Therefore, the study naturally focuses on Pennsylvania Station, a choking point in New York's regional connectivity. To solve the problem, the city would require transformative action to rethink its urban strategies: to connect the disconnected parts and increase the efficiency gain from an integrated network (Sayer 2016).

To quantify HSR's comprehensive and spillover effects, an exploration of the geospatial metadata on the population distribution, O-D survey, transit connectivity, land use pattern, and prediction scenarios of future urban growth demands complex network modeling. The selected case study focused on the tristate region (New York, New Jersey, Connecticut) due to the accessibility of publicly available data. Instead of boiling the metadata, the study presented a specialized detail. The detail brought a practical application to Amtrak to transform a semi-HSR system into an actual HSR system. The construction phasing plan mapped a series of schematic station designs for platform expansion, track reengineering, and network realignment at the currently underperforming Pennsylvania Station. This section dissects three major challenges and provides corresponding engineering measures to convert an independent dead-end terminal into an integrated through-running station, which are the totality of an initial step to convert Amtrak into an accelerated HSR service (Rethink Studio 2017a).

4.1 Low Network Capacity vs. Flexible Track Alignment for Higher Operation

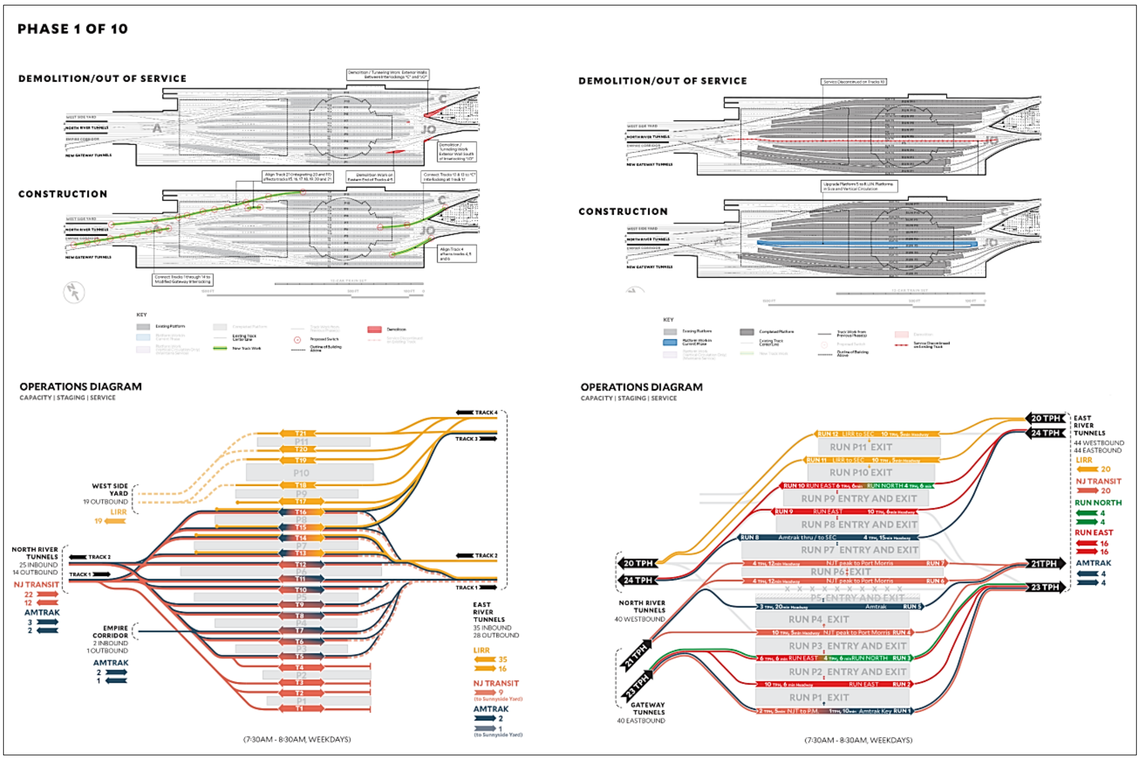
First, the current tracks at Pennsylvania Station are operating at maximum network capacity. It is impossible for the inflexible alignments to accommodate extra services or any incidental changes. Following trains (FTs) have to wait in tunnels for 15 minutes as leading trains (LTs) exit the station. The station is operating as a terminal rather than as a through station. Trains must cross each other as they enter and leave the station, as Figure 9 (left) shows. The countermeasure of through-running avoids congestion by scheduling eastbound traffic on southern tracks and westbound traffic on northern tracks, as Figure 9 (right) shows. Each train would enter the station, prepare for passengers boarding and alighting, and continue without ever crossing the incoming and outgoing traffic (Rethink Studio 2017b).

Figure 9: NY Pennsylvania Station Dead-End Conflict (Left) vs. Through-Running Flow (Right)



To enable the steady flow of through-running operation, the study comprehensively examined a feasibility study of the phasing plan incorporating track reengineering, network realignment, and minimization of construction and demolition for normal operation. It identified a total of 10 phases to convert the existing independent dead-end terminal into an integrated through-running station (Figure 10 left). Each phase has a counter operating strategy to follow (Figure 10 right). The phase plan balances the construction and demolition timelines without disrupting the normal commuting services (Rethink Studio 2017b).

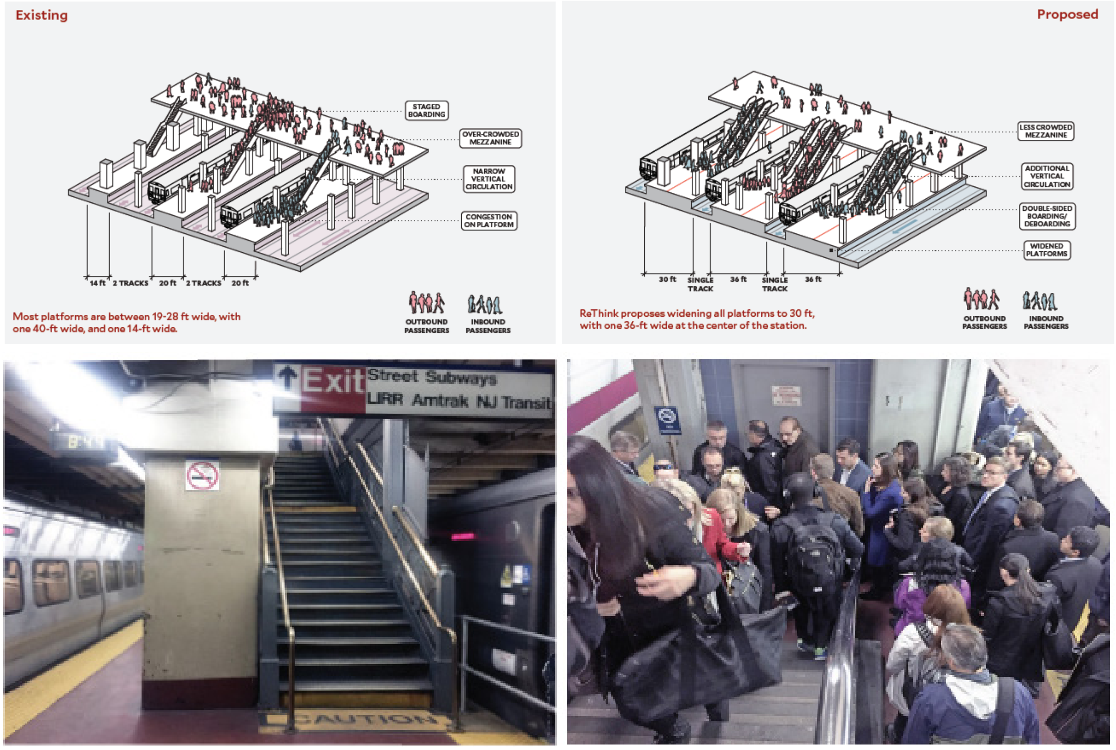
Figure 10: Selected Schematic Designs for Track Reengineering, Network Realignment (Left), and Counter Operation Strategy (Right) within the Penn Station Construction Phasing Plan



4.2 Limited Passenger Circulation vs. Platform Expansion to Expedite the Boarding and Alighting Process

Second, narrow platforms present a safety issue. Staged boarding mitigates overcrowding on platforms, forcing outbound passengers to wait on the mezzanine level until all the passengers on the leading train have alighted. Limited vertical circulation (stairs and escalators) produces chaotic passenger flows and rushed transfers, especially for New Jersey Transit (NJT) passengers (Figure 11 upper-left and lower two). Without even discussing the possibility of protective screen door installation, overcrowding drastically reduces the system reliability. In contrast, a through-running station would allow single-track configuration to widen the platform and additional space for vertical circulation (Figure 11 upper-right). Such an engineering effort would offer greater safety and increase passengers' boarding and alighting process at the platform and mezzanine levels (Rethink Studio 2017c).

Figure 11: Penn Station Existing Platform Condition (Upper-Left and Lower Two) vs. Engineering Improvement of Vertical Circulation (Upper-Right)



Most platforms are between 19-28 ft wide, with one 40-ft wide, and one 14-ft wide.

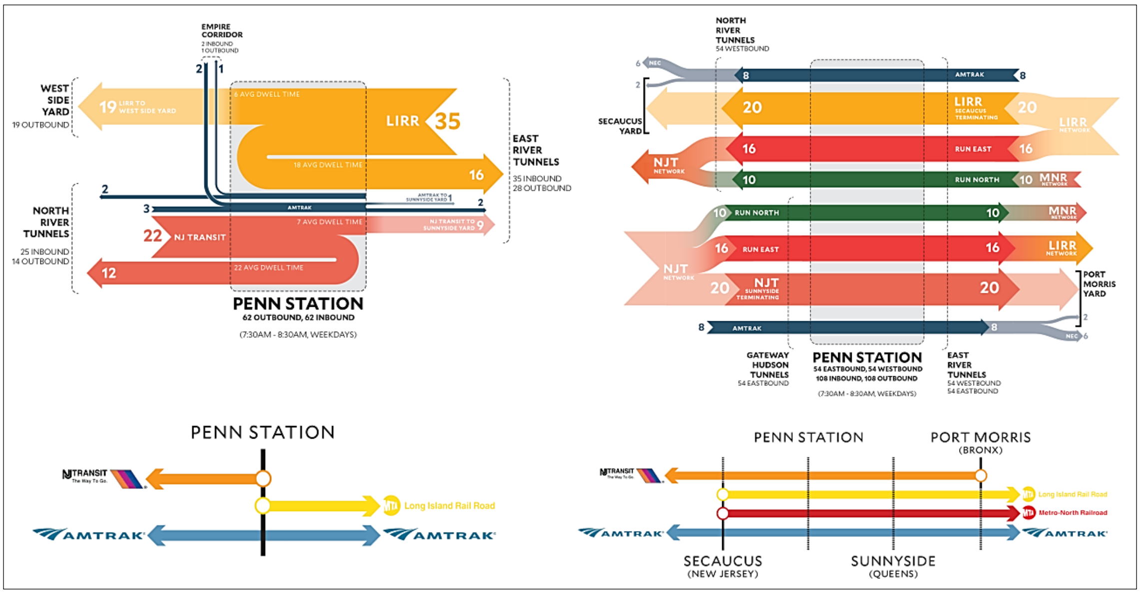
ReThink proposes widening all platforms to 30 ft, with one 36-ft wide at the center of the station.

4.3 Disconnected Network Services vs. a Unified Network to Increase Regional Connectivity

Third, the New York regional rail services are disconnected. Different land masses (Manhattan, New Jersey, the Bronx, and Long Island) have different transit agencies. Passengers who would like to travel between New Jersey and Long Island must experience Penn Station's narrow platforms and unreliable boarding and alighting process. Those who would like to transfer from Penn Station to Grand Central must use the MTA subway. To enable Penn Station's through-running's capability, the adjustment of terminal functionalities includes the relocation of railyards, the reduction of long dwelling times at platforms, and the execution of the two abovementioned measures (4.1 and 4.2). Instead of operating a single nucleus terminal in the center of downtown Manhattan, the plan is to distribute the ridership by leveraging the gravity of satellite cities and incubating the growth in Port Morris, Bronx, and Secaucus, which will become multimodal transit hubs (Leland 2016).

Although Amtrak connects major cities in the Northeast Corridor, effort must be put into unifying New York's regional rail services. The construction phasing plan provides a schematic adjustment for platform expansion, track reengineering, and network realignment at the currently underperforming Penn Station to enable the through-running services to become a cohesive regional network. In Figure 12, the system throughputs and service density have increased and the regional connectivity and fleet utilization performance have improved (Rethink Studio 2017c).

Figure 12: Comparative Analyses of Dead-End (Left) vs. Through-Running (Right) Network Capacity at the New York Pennsylvania Station

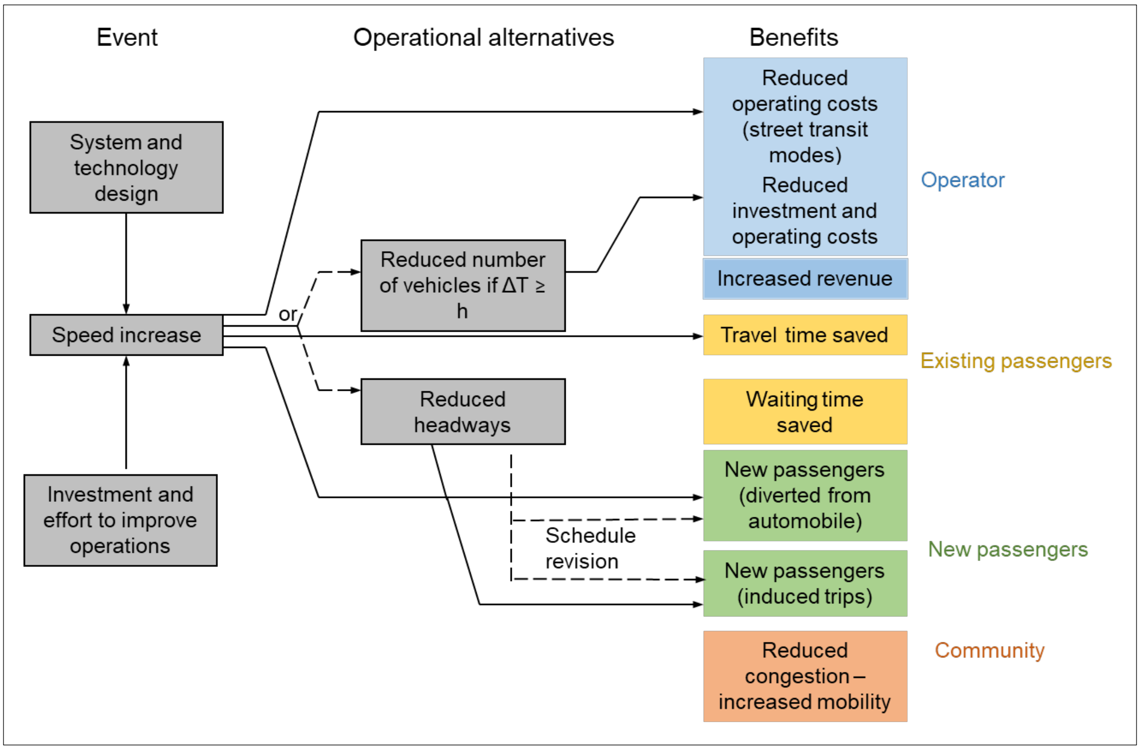


5. CONCLUSION

In the United States, unlike the People's Republic of China, the Russian Federation, Japan, and European countries, the development of HSR encounters administrative contradictions and managerial barriers; however, a relentless effort must be devoted to understanding the technicality of planning, designing, and operating HSR and its comprehensive effect on the long-term economic growth of metropolitan areas as well as the network efficiency for economic value contribution. The development needs to happen while avoiding mutually conflicting policies to achieve an intermodal balanced transportation system. The article reviewed the history of the US's HSR development and made a comparison with that in peer countries. Then, the analyses compared medium and long-distance intercity passenger modes of car, air travel, conventional rail, and HSR regarding the total travel time and speed within the given time frame (1960 to 2018). Following the discussion of which mode would outperform another under which conditions, the study presented a well-thought out dissection of sophisticated interrelations among selective variables. Figure 13 evaluates the gain of a speed increase for four beneficiaries.

Many global cities are either in the transition stage of repositioning cities' long-term competitiveness or in the development stage of large-scale metropolitan planning. Common actions are observable in these two settings: the outstanding commitments to the modernization of efficient urban and intercity rail systems and the transformative mindset for the recapitalization of a city's assets, both developable and underutilized lands, within the Central Business District (CBD) and surroundings. The Northeast Corridor accounted for 23.6% of the US's national GDP in 2017 (Amtrak 2017; BEA 2018). The economic contribution reflects its importance to the country. Naturally, studying and upgrading this corridor has become a critical task. In the case of New York Pennsylvania Station, reengineering efforts to convert an independent dead-end terminal into an integrated through-running station will result in a more efficient regional unified network. Three incremental steps will start modernizing the inflexible Penn Station track geometry, overcrowded platforms, and uncoordinated regional and intercity passenger rail services. A plan always comes with a purpose. A broad vision of the city's transportation relationships and the creation of regional unified networks are interdependent on countries' long-term competitiveness.

Figure 13: Evaluation of the Speed Increase



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