ADBI Working Paper Series

SPEED AND SOCIOECONOMIC DEVELOPMENT: INFLUENCE OF INDIAN RAILWAYS

Neelakantan Ravi

No. 952
May 2019

Asian Development Bank Institute

Neelakantan Ravi is advisor and adjunct faculty at the Centre for Public Policy of the Indian Institute of Management in Bangalore, India.

Suggested citation:

Ravi, N. 2019. Speed and Socioeconomic Development: Influence of Indian Railways. ADBI Working Paper 952. Tokyo: Asian Development Bank Institute. Available: https://www.adb.org/publications/speed-and-socioeconomic-development-influence-indian-railways

Please contact the authors for information about this paper.

Email: ravin@iimb.ac.in

Asian Development Bank Institute
Kasumigaseki Building, 8th Floor
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

Abstract

Indian Railways is a little over a century and a half old. Its development over the decades has been gradual. It has been and continues to be the "lifeline for the socioeconomic growth of India," by connecting human settlements across the country and simultaneously transporting various resources to centers of production and markets. Nationalized in 1951, Indian Railways is among the largest rail networks in Asia and the world's second largest network operated under a single management. We will feature its growth over the past 7 decades. Indian Railways has always aimed to provide safety during travel. The rate of its development as a service organization has been modest, with two forces, one originating from political considerations balanced by another based on engineering competence. High-speed rail travel emerged in Indian Railways in 1969, when the first high-speed limited-stop train service was introduced between New Delhi and Kolkata. We will trace the origins of high-speed travel on Indian Railways and attempt to show how it has indeed helped passengers reach their destinations in less time. Any direct correlation between high-speed train travel and the growth of the economy, the effect on the environment and society, while significant over the long term, would be difficult to estimate empirically.

We will show, in terms of policy flow and implications, how Indian railways has been unwavering in providing sustenance for economic growth. One common theme in these decades has been the inexorable drive to acquire and develop technology to ensure faster, inexpensive, and safer travel for all users. The increase in speed of travel has been steady, progressive, and not an attempt at creating records. Over the years, high-speed trains have enabled better quality of life for professionals in India, especially in the age of globalization. However, the effect of this has been generally restricted to medium distance and suburban travel. In this scenario, we will detail the steps that have to be taken by the provider and the user for making future high-speed rail travel profitable, productive, comfortable, and dependable.

Keywords: high-speed rail, Indian Railways, socioeconomic development, train, travel

JEL Classification: O2, O53, R480

Contents

INTRODUCTION TO INDIAN RAILWAYS

Indian Railways, over the last 160 years, has brought about deep and irreversible change across India, hauling it along towards modernity, one step at a time. It has been a journey that has kept abreast of the available technologies in rail transport, while incorporating these into the Indian railway system based on affordability, its domestic capacity to indigenize these technologies and thereby enhance performance. A crucial contribution of Indian Railways has been connecting and networking communities and markets. However, the basic approach of considering the Indian railways as their “socioeconomic lifeline” has seldom changed. Whether in terms of travel comfort or speed or safety, the all-round growth of the railways in India has been guided by a steady hand, across decades, keeping in mind the requirements of feisty travelers and freight tonnage while fostering safety.

> “Given the strategic role played by railways in the transportation space, rail transportation has been one of the three areas reserved for the public sector in successive industrial policies of the country (the others being atomic energy and defense)” (National Transport Development Policy Committee 2013).

Indian Railways (IR) is managed directly by the Ministry of Railways, Government of India, which owns and operates most of India’s rail transport. IR had a total route network of 67,368 km in 2016–17; it operates more than 22,300 trains daily (13,098 passenger plus 9202 freight trains). IR has 278,000 wagons, 69,322 coaches, and 11,461 locomotives. Over 23 million passengers travel by train daily in India. The passenger traffic stood at 8.3 billion in FY18 and is expected to increase to 15.18 billion by FY20. In FY51 the passenger traffic was 1.3 billion. Around 1.2 billion tonnes of freight was transported via trains in FY18 and 2.2 billion tonnes is expected in FY20. In FY51 the freight carried was 73.2 million tonnes. This includes a huge variety of goods such as mineral ores, iron, steel, fertilizers, petrochemicals, and agricultural produce (India Brand Equity 2018).

GROWTH OF RAILWAYS THROUGH FIVE-YEAR PLANS

India’s economy was actively driven by five-year plans (FYPs) for the 5 decades after independence in 1947. The objectives and targets of IR were always reflected in the plan document, usually in a separate chapter dealing with railways. The concerned chapters of the plan periods were examined and checked for any reference to high-speed rail travel. However, no FYP document until the 11th five-year plan mentioned high-speed train travel with any degree of emphasis. Table 1 gives some details of objectives and developments under the various plans. The first five-year plan was launched in 1951 and the 10th in 2002.

Table 1: Major Objectives Designated for Railways Development Under Each Five-year Plan in India

Time Period	Name of Plan	Major Objectives	Miscellaneous Developments
1951–1956	First Five-Year Plan	Track Renewals	
1956–1961	Second Five-Year Plan	Continue track renewals, install better signaling technology, and enhance line capacity	Examine and permit higher speeds on main trunk routes such as Mathura–Baroda, Wardha–Bezwada, and Delhi–Kalka
1961–1966	Third Five-Year Plan	Complete track renewal programs along with rail and sleeper renewals	
1966–1969	Annual Plans	No specific mention	
1969–1974	Fourth Five-Year Plan	Run higher-speed trains on long-distance routes where overcrowding is high	On 3 March 1969, the first Rajdhani Express, a high-speed nonstop service, started between Delhi and Howrah (i.e., Kolkata). On 17 May 1972, the second Rajdhani Express, another high-speed nonstop service, started between Delhi and Bombay
1974–1978	Fifth Five-Year Plan	Electrification of tracks, acquisition of more powerful locomotives, and efficient freight movement	On 7 August 1976, the Tamil Nadu Express, a superfast train, started service between Delhi and Madras (i.e., Chennai)
1978–1980	Annual Plans	No specific mention	
1980–1985	Sixth Five-Year Plan	Assessment of quality and quantum of railway assets; their efficiency/performance	Overall evaluation was that all assets were being utilized optimally
1985–1990	Seventh Five-Year Plan	Electrification of high-density routes; upgradation of such networks for speedier trains by seeking more funding for new projects	Indian Railway Finance Corporation (IRFC) set up in 1987 as the financing arm, borrowed from the market for projects, owing to reduced budgetary support. Introduction of the high-speed Shatabdi Express between Delhi and Agra in November 1988
1991–1992	Annual Plans	No specific mention	
1992–1997	Eighth Five-Year Plan	Enhance reliability and quality of service through modernization programs, energy conservation, ensuring greater safety, pursue financial viability	
1997–2002	Ninth Five-Year Plan	Initiate measures to regain railways' role as the principal transport mode for passengers and especially freight	
2002–2007	Tenth Five-Year Plan	Focus on increasing capacity on the Golden Quadrilateral; tackle problems arising out of old technologies; measures to tackle prevalence of slow train speeds	
2007–2012	Eleventh Five-Year Plan	Building of dedicated freight corridors on the Delhi–Mumbai and Delhi–Kolkata routes	Introduce high-speed train (with max. speeds of 150 km/h) between more city pairs, like Delhi–Agra

Source: Planning Commission of India (2018).

Table 2 below gives details of the original and present state of India's first three superfast trains, providing a clue to the way in which the engineering objective of safe high-speed travel gets compromised by sociopolitical compulsions. This is revealed by the initial and present number of halts and the speed. We thus find that the seventies were the first years when relatively high-speed trains were introduced between the four major cities in India.

Table 2: Comparison of India's First Three Long-distance Superfast Trains

Train Number	12302	12952	12622
Train Name	New Delhi Howrah Rajdhani Express	New Delhi Bombay Rajdhani Express	New Delhi Madras Tamil Nadu Express
Date of Introduction	3 March 1969	17 May 1972	8 August 1976
Original Time Taken, Distance and Speed	17 hours 1,450 km 85 kmph	19 hours 1,385 km 72 kmph	29.5 hours 2,188 km 75 kmph
Time Taken and Speed Today	17 hours 85 kmph	16 hours 90 kmph	33 hours 66 kmph
Original Halts	NONE: [Only 4 technical halts]	1 Passenger Halt and 1 Technical Halt	5 Passenger Halts
Passenger Halts Today	7	6	10

Source: Compiled from the Indian Railway Catering and Tourism Corporation, www.irctc.co.in; the India Rail Info Website, www.indiarailinfo.com; the Indian Railways Fan Club Website, www.irfca.co.in; and Information on Superfast Rail Services in India http://www.nationalrailplan.in (accessed 8 October 2018).

On the 200 km Delhi–Agra route, a high-speed train (the Shatabdi Express) with a maximum speed of 150 km per hour was introduced in November 1988; it was proposed that similar trains be introduced between selected city pairs. Currently, there are about 25 pairs of such trains running in various regions across India connecting important cities connected with business, tourism, and pilgrimage.

It was in the 12th FYP (2012–17) document (Planning Commission of India 2012) that "Developing High-Speed Rail Corridors and Upgradation of Speeds" was dwelt upon in some detail. For instance, the Ministry of Railways had selected the following six corridors for conducting pre-feasibility studies for the development of high-speed rail corridors:

1. Delhi–Chandigarh–Amritsar (450 km)
2. Pune–Mumbai–Ahmedabad (650 km)
3. Hyderabad–Dornakal–Vijayawada–Chennai (664 km)
4. Chennai–Bangalore–Coimbatore–Ernakulam–Thiruvananthapuram (849 km)
5. Howrah–Haldia (135 km)
6. Delhi–Agra–Lucknow–Varanasi–Patna (991 km)

The FYP document aimed to undertake at least two detailed project reports and develop one corridor of about 500 km for construction. The Ahmedabad–Mumbai HSR project is the first one taken up for construction. The viability of each corridor identified for a pre-feasibility study under examination by consultants is at different stages of progress. The present status vis-à-vis the various corridors is given in the following Table 3.

Table 3: Status of Various Corridors Selected for Conducting Pre-feasibility Studies

High-Speed Rail Corridors – Studies/Status			
Sl. No.	**Route Description**	**Study Status**	**Agency**
Diamond Quadrilateral Routes			
1	Delhi–Mumbai	Feasibility study in progress	Consortium of Third Railway Survey and Design Institute Group Corporation (People's Republic of China) and Lahmeyer International (India) Pt. Ltd, India
2	Mumbai–Chennai	Feasibility study in progress	SYSTRA – RITES – E&Y Consortium
3	Chennai–Kolkata	Yet to be taken up	
4	Delhi–Kolkata	Feasibility study in progress	Consortium of M/s INECO (SPAIN) – M/s TYPSA – M/s Intercontinental Consultants and Technocrats Private Limited, India
5	Delhi–Chennai	Delhi–Nagpur section of this corridor is being taken up as Phase I under government to government cooperation	Planning study report for this high-speed rail corridor by China Railway SIYUAN Survey and Design Group Co. Ltd has been completed. Project feasibility study is yet to be taken up by SIYUAN
6	Mumbai–Kolkata	Mumbai–Nagpur section of this corridor is being taken up as Phase I under government to government cooperation	ADIF, Spain and INECO, Spain
Other Important Corridors			
7	Mumbai–Ahmedabad	Project under implementation	National High-Speed Rail Corporation Ltd (NHRCL), under Japanese financing
8	Delhi–Chandigarh–Amritsar	Pre-feasibility study completed	SYSTRA – RITES Consortium
9	Howrah–Haldia	Pre-feasibility study	INECO, Spain
10	Delhi–Patna	Pre-feasibility study	Mott McDonald, India
11	Thiruvananthapuram–Mangalore	DPR completed	DMRC, India
12	Hyderabad–Dornakal–Vijayawada–Chennai	Pre-feasibility study	Parsons Brinckerhoff India Pvt. Ltd
13	Chennai–Bengaluru–Coimbatore–Ernakulum	Pre-feasibility study	Consortium of JARTS (Japan Railway Technical Service) and Oriental Consultants

Source: Information drawn from respective chapters dealing with Indian Railways in all the five-year plan documents. www.planningcommission.nic.in (accessed 15 August 2018).

As if it were a run-up to the introduction of HSR in India, in the midst of the 12th FYP, IR applied for a safety certification to run a new semi-HSR service between Delhi and Agra, a distance of 200 km. "Called the Gatimaan Express, the service was expected to run at top speeds of 160 kmph. Though scheduled to be launched in 2015, safety requirements of the Commission of Railway Safety (CRS) caused delays. Originally planned to cover the stretch in 90 minutes, the trial run on 22 March 2016 took 113 minutes, just four minutes faster than the time taken by the Shatabdi Express" (Dastidar 2016).

After 30 years of research and development in railway technologies, with a focus on high-speed travel, the Gatimaan Express posted only a very modest achievement. This indicated that the existing network can only support so much speed and no more. The need of the hour had to be a totally new system with a clear break from the past. The HSR system is that clear break in technology and is waiting to be embraced.

The 12th FYP document also proposed the setting up of an autonomous National High-Speed Rail Authority (NHSRA), through a bill in Parliament for the implementation of high-speed rail corridor projects by Indian Railways. This authority was to be entrusted with the work of planning, standard setting, and implementing and monitoring these projects. However, the actual establishment of the HSRA was slightly altered in procedure. The High-Speed Rail Corporation of India Limited was incorporated as a subsidiary of Rail Vikas Nigam Limited (RVNL) on 25 July 2012 and was launched on 29 October 2013 in New Delhi.[1]

It was in the midst of these circumstances that in February 2010, nearly 2 decades after the start of the economic liberalization process in India, the Government of India set up the National Transport Development Policy Committee as a high-level committee. The final report, submitted in 2013, was titled India Transport Report: Moving India to 2032 and had many recommendations for Indian Railways (National Transport Development Policy Committee 2013). Among them were the following:

For long-term sustainability, railways have to be run as a business on sound commercial principles. However, the several social/national responsibilities of IR prevent it from operating on a purely commercial basis. While IR has to fulfill both roles, it is essential that the commercial and social roles are kept distinct and separate.

The lack of clarity between its public-service obligations and commercial objectives affects several other operational practices/systems of IR, such as investment planning, project execution, costing and tariff practices, the accounting system, etc., making it even more difficult to reconcile these roles. This, and the need to implement India's first HSR project, resulted in the establishment of the NHSRA/HRSCIL.

In order to meet the ambitious goals set for 2032, the major issues confronting the network were classified under the following broad headings:

- Capacity constraints;
- Lack of clarity on social and commercial objectives;
- Safety;
- Inadequate research and development;
- Optimization of land use;
- Energy conservation; and
- Organizational and human resource issues.

[1] The RVNL is a special-purpose vehicle created to undertake project development and mobilization of financial resources, and implement projects pertaining to strengthening the Golden Quadrilateral and port connectivity. The Company was incorporated in New Delhi as a public limited company on 24 January 2003 as "Rail Vikas Nigam Limited." It is an organization associated with Indian Railways among whose tasks is to build engineering works required by Indian Railways.

HIGH-SPEED RAIL: BASICS AND BACKGROUND

According to the International Union of Railways (UIC), the definition of HSR states that it is a grounded, guided, and low-grip transport system; it could be considered to be a railway subsystem. The most important change comes from the speed. As travel times had to be reduced for commercial purposes, speed emerged as the main factor. HSR meant a jump in commercial speed and this is why the UIC considers a commercial speed of 250 km/h to be the principal criterion for the definition of HSR (UIC 2018).

INDIAN RAILWAYS ENTERS THE 21ST CENTURY

Keeping the above definition in mind, it would be useful to examine the evolution of the Indian approach. From time to time various white papers and other important documents have been released by Indian Railways, listing contemporary objectives. For the purposes of this paper, those released over the last decade are considered.

One of the principal documents was titled: **Indian Railways Vision 2020 was presented to the Indian Parliament on 20 December 2009** (Ministry of Railways 2009). It focused on four strategic national goals, namely:

- Inclusive development, both geographically and socially;
- Strengthening national integration;
- Large-scale generation of productive employment;
- Environmental sustainability.

The document touched upon all aspects of India's development of its railways. These covered, among others, the areas of high-speed travel, capacity augmentation, passenger services, safety, freight movement, technology upgradation including enhanced telecommunications, investment goals, public-private partnership etc. It was also emphasized that Indian Railways would remain under government control for the foreseeable future.

Some specific points in the vision document include:

- **For enhancing capacity**, doubling or quadrupling of selected lines and complete segregation of passenger and freight lines on high-density routes. With this, more than 30,000 km of route would be of double/multiple lines of which more than 6,000 km would be a quadrupled line with segregation of lines. This would include the main routes from Delhi to the three other major metropolises, viz., Kolkata, Mumbai, and Chennai, with the building of dedicated freight corridors.
- The **speed of freight trains** on Indian Railways, which had stagnated at around 25 km/h, would be raised to a maximum of 60 to 70 km/h. Passenger services that are slow by international standards would see an increase in their maximum permissible speed of 130 km/h (for Rajdhani/Shatabdi trains) and 110 km/h (for other mail/express trains) to between 160 and 200 km/h, respectively. As regards high-speed rail travel, the vision document aimed to raise the speed of regular passenger trains to between 160 and 200 km/h on the segregated routes.

However, the Vision 2020 document (Ministry of Railways 2009) also laid down the objective to implement “at least 4 high-speed rail projects to provide bullet train services running at between 250 and 300 km/h.” Specifically, six corridors were listed, namely:

(i) Delhi–Chandigarh–Amritsar

(ii) Pune–Mumbai–Ahmedabad

(iii) Hyderabad–Dornakal–Vijayawada–Chennai

(iv) Howrah–Haldia

(v) Chennai–Bangalore–Coimbatore–Ernakulam

(vi) Delhi–Agra–Lucknow–Varanasi–Patna

The white paper observed that these could be built as elevated corridors in keeping with the pattern of habitation and the constraint of land in India. The railways will use the public–private partnership (PPP) mode for investment and execution and draw on frontier technologies incorporating the highest standards of safety and service quality.

Part of the vision document deals with the suburban segment. It needs to be mentioned here that even though HSR networks connect the city centers, the importance of suburban rail in the system framework cannot be overlooked. These would provide further efficient connection to specific destinations within the urban/suburban areas.

The vision document refers to “partnership with state authorities for development of suburban rail systems.” In the same context, it also clarifies an aim for railways to integrate the metro rail and suburban rail systems under a single management in partnership with the respective state/city authorities. This would be one area for deeper study in the realm of public policy.

As soon as a new government came to power in the middle of 2014, a new white paper on Indian Railways subtitled “Lifeline of the nation” was released in February 2015 (Indian Railways 2015). The thrust was to convert Indian Railways into being *“… the backbone of India's economic development,”* as the Prime Minister put it at the time of the release of the document.

In the words of the then Railway Minister, “the objective of this paper is to show the challenges that the organization is facing today. It also shows that Indian Railways is perched on a precipice but is capable of flying off and attaining great heights. The organization, especially its staff, has inherent strength and I am confident that a clear direction, targeted investments, and well-defined priorities can make the organization grow by leaps and bounds.”

There is a clear reference to the High-Speed Trains project under the FDI chapter and the Ahmedabad–Mumbai HSR is also referred to under the projects identified for domestic/foreign direct investments in railways. The document is more focused on the overall development of the railways sector with special emphasis on the finances required and on the pattern of public-private partnership required to meet the objectives of the contents of the white paper.

In the following year, on 8 December 2016, the incumbent Minister of Railways launched the website: National Rail Plan, 2030 (NRP 2030).[2] The objective is to "develop the National Rail Plan (NRP 2030) in consultation with all the stakeholders including state governments, public representatives, and other relevant central ministries" and thereby provide the long-term perspective. NRP 2030 will endeavor to harmonize and integrate the rail network with other modes of transport and create synergy for achieving a seamless multimodal transportation network across the country. A visit to the website reveals that under the heading "Existing and Planned Rail Network" there is a detailed reference both to the high-speed rail corridors and dedicated freight corridors.

At this point it can be concluded that the HSR idea is now firmly embedded in the policy framework of the entire government apparatus, including, possibly, across the political spectrum.

At present, the Ahmedabad–Mumbai HSR project (AM-HSR) is in the initial stages of implementation with major financing from the Japan International Cooperation Agency (JICA). The total cost of the project is Rs1.08 trillion (approximately $13.6 billion). Of this amount, Rs88,000 crores (approximately $12 billion) is in the form of a loan from the JICA, with the remainder being funded by the Indian Ministry of Railways and the state governments of Gujarat and Maharashtra.

Since early October 2018, the implementation of the project has been running into problems over land acquisition and compensation (Indian Express 2018). An estimated 312 villages in Gujarat and Maharashtra will have to give up land for the AM-HSR project. Additionally, 7,974 plots belonging to the forest department and railways will have to be acquired in the two states. The progress on these fronts is currently less than 50% of the target. If there were to be litigation then there would be further delays.

In addition, issues like the diversion of 80 hectares of forest land, the cutting of 80,000 trees to enable track construction, endangering environmentally sensitive zones in the coastal areas, and disturbing bird migration patterns in proximate water bodies etc. are also emerging into focus, and can cause project delays.

The AM-HSR, with its proposed capacity of 730 passengers per trip, is expected to travel at speeds between 320 and 350 km/h, thereby reducing the travel time between Ahmedabad and Mumbai to three and a half hours or less from the current eight hours. It is hoped that it will divert passengers from among those who are currently using other modes. Some figures are given in Table 4 (Indian Express 2018).

Table 4: Travel Time and Fare Range Comparison of Transport Modes between Mumbai and Ahmedabad

Mode	Time Taken	Fare (Range)
Air	60 Minutes	Rs1,500 to Rs5,000
Bus	540 Minutes	Rs600 to Rs1,200
Train	340 to 380 Minutes	Rs1,500 to Rs2,500
Bullet Train	120 to 180 Minutes *(Proposed)*	Rs2,500 to Rs3,000 *(Proposed)*

Source: www.irctc.co.in, www.indiarailinfo.com, and www.irfca.co.in (accessed 15, 22, 29 September 2018 and 13 and 20 October 2018).

[2] This unique website, accessible at http://www.nationalrailplan.in, has been developed for all stakeholders to give their inputs for a purposeful study to enable long-term growth of Indian Railways in a comprehensive manner.

The AM-HSR project is planned to be completed by August 2022. However, protests from tribespeople and farmers have halted or delayed geotechnical investigations, hydrological surveys, and utility mapping procedures. Two organizations, namely *Bhumi Adhikar Andolan* and *Shoshit Jan Andolan*, have approached the National Human Rights Commission demanding an investigation into the “illegal” detention of activists during protests earlier in 2018.

SPILLOVER EFFECTS FOR INDIA’S CONDITIONS

Against this background, it would be pertinent to examine the steps that need to be taken for the **spillover effects from HSR** to be beneficial across the socioeconomic spectrum. As the Indian HSR project gathers speed, as a first step, a guide to the use of high-tech facilities and other HSR assets so created should be issued and given the widest form of publicity.

There would be three categories of persons who need to be trained: the operations personnel on board the HSR and their corresponding crew on the ground; then there would be the service personnel on board the HSR with support personnel on the ground; and the third main group would be the users. Without doubt, the training of operations personnel would have to be done exclusively by the parent organization with help from Japanese trainers.

However, a special effort should be made in training not only the users, who will come from different social and economic backgrounds, but also service providers inside the train, who will also have originated from varied social backgrounds. For example, well before the HSR service commences, training modules on how to board and disembark, how to use the special features of the HSR etc. are among the elements that would have to be covered extensively in the user manual and the training module. In fact, a massive public awareness campaign should be launched through all forms of media by 2020, so that when the actual service commences, the users and the providers of the HSR service are on a par with regard to the appropriate use of the HSR assets, in the optimal manner.

An additional area of focus could be the extensive use of icons for rail track signs and symbols for the HSR project at the various stops on a given route. Simultaneously, the use of applicable icons in the non-HSR portions of Indian Railways can also be promoted. Most of the symbols used currently by IR owe their origins to days prior to the computerization of activities in India’s railway operations. A separate module for both categories should be designed to ensure consistency and ease of recognition.

Japan Railways is well known for the high standard of its service personnel, especially the cleaning staff, who complete their task in a bullet train in around seven minutes or so during a turnaround. To achieve comparable levels of productivity for Indian personnel, appropriate guidance and, where needed, special training modules would have to be designed. Further, the technology that goes with the provision of the service or maintenance would have to be specially designed to suit Indian climatic as well as community conditions.

For instance, Japanese engineering-based activities are supported solidly by the practice of preventive maintenance. It has to be ensured that when such activities for the HSR in India are designed, the cost of operation should remain within limits. In this context, it is also necessary to focus on aspects like redundancy, which Japanese technology is famous for, especially for high-value assets. Admittedly, redundancy in engineering systems enhances reliability but this should not increase the costs of implementation of the Indian HSR to uncontrollable levels.

It needs to be remembered that levels of compliance between Japanese and Indian personnel (both user and service) vary significantly. If the HSR assets created at enormous cost are to last for a long time, then it is necessary that appropriate care is given to these assets right from the beginning. This should therefore include specially trained people who are appointed for that task.

One of the important tasks for public policy specialists would be to look at various alternatives that correctly balance (a) the overall costs of construction, (b) the maintenance cost of the assets thus created, and (c) the overarching need to make HSR services available at an affordable cost to the user over the long term.

Indians, like people from other countries, love to travel during holidays, especially by train. Undoubtedly, this would ensure higher occupancy rates. Even though travel habits have changed over the years, certain aspects of behavior that arise from Indians traveling in groups differ widely from the Japanese practice and routine. This may require a modified design for the movement of both passengers and their baggage inside the HSR carriages. From seat design to racks for baggage, a new approach may be called for. Yet again, there would be a challenge to design a system that caters to the distinctive demands of the service provider and the user in the Indian context. A thorough examination of all facets followed by an extensive exchange of views on this would be an absolute necessity if the high-value HSR is to ensure exceptional levels of service at high speeds!

Currently, of the following six corridors under consideration, four are in peninsular India. A crucial question arises. Should one wait for the Ahmedabad–Mumbai HSR project to be completed before taking up the other projects in the list? In the context of proposed high-speed corridors, the table below lists the current time taken to cover the existing distance by train and the time that is likely to be taken if HSR is introduced between the concerned destinations.

Table 5: Comparison of the Current Journey Time to the Assumed Values for HSR Corridors in India (IRCTC 2018)

Route	Present Distance	Current Time by the Fastest Train	Proposed HSR Distance	Likely Journey Time (Assumed Values)
Ahmedabad–Mumbai	491 km	430 mins	534 km	120 to 180 mins
Bangalore–Chennai	362 km	300 mins	340 km	90 to 120 mins
Chennai–Hyderabad	715 km	760 mins	664 km	150 to 220 mins
Chennai–Bangalore–Ernakulam	Not Applicable	Not Applicable	649 km	150 to 220 mins
Delhi–Jaipur–Ajmer–Jodhpur	553 km	610 mins	591 km	130 to 190 mins
Delhi–Patna	983 km	700 mins	991 km	220 to 330 mins

Source: Data downloaded from Raghuram and Udaykumar (2016).

It needs to be noted here that the first AM-HSR is being constructed in an area that has very high levels of economic development going back well over a century. However, are there other routes? The next most talked-about route is the Bangalore–Chennai corridor (BC-cord) as part of the proposed Chennai–Ernakulam/Trivandrum HSR corridor.

A desk study was done to compare the present capacity available on the BC-cord through all modes so that a suitable conclusion can be arrived at with regard to capacity and pricing for a possible HSR on the BC-cord. A calculation of the number of seats available in air-conditioned comfort across modes was compiled and comparative data derived from a hypothetical journey from Bangalore to Chennai by various modes, for a hypothetical journey on 17 October 2018, appears in Table 6 below.

Table 6: Travel Time and Fare Range Comparison of Transport Modes from Bangalore to Chennai

Mode	Time Taken	Fare (Range)
Air (4,400 Seats daily)	60 minutes	Rs2,500 – 10,700
Bus (3,400 Seats daily)	360 minutes	Rs650 –1,800
Train (2,400 Seats daily)	300 to 360 minutes	Rs550 – 1,500
Bullet Train (??? Seats daily)	90 minutes (nonstop)	???

Source: http://www.nationalrailplan.in (accessed 8 October 2018).

AREAS LIKELY TO BE INFLUENCED BY HSR

The introduction of HSR in India is certain to stimulate active interest, both commercial and technological, in the area of transportation in general and in railways in particular. India is among the latest entrants in the HSR segment. Countries like Japan, Germany, France, Spain, and the People’s Republic of China (PRC) have already established the norm for their respective systems.

The 2013 report of the National Transport Development Policy Committee (*NTDPC*), dealing with the railway sector, states the following regarding HSR projects: *A review of the most important projects carried out today around the globe highlights that the potential demand for services must be particularly high in order to make investment in them socially profitable and that these projects must target the corridors linking densely populated metropolitan areas, suffering from severe road congestion, and having deficient air links.*

A closer examination of the statement reveals the crucial phrase “socially profitable.” This is one of the most important parameters whenever any high-cost infrastructure project is considered in India. The viability has to meet not only the private cost-benefit analysis but also the social cost-benefit analysis norms prevalent at any given point in time. If the latter yardstick were used for assessing the proposed HSR project in India, there would be many weaknesses that may well negate the idea.

The present decision of the governments of Japan and India to go ahead with the construction of the HSR would appear to be driven by the futuristic vision of the respective leaders. They look at the project as bringing the two countries closer together economically, commercially, and technologically for the foreseeable future.

What effect the HSR will have on Indian Railways is difficult to predict. However, in a large and highly populated country like India, the effects are likely to emerge over a period of time. One thing, however, is certain – that the introduction of the new technology of high-speed transport is certain to have a decisive effect on the existing system. Transportation at higher speeds and economic productivity are directly linked. If a given task can be completed in less time, productivity goes up automatically. In Japan, as people shifted from ordinary trains to the Shinkansen, productivity levels increased and the economy benefited. Since the corridors identified in Table 5 are mostly business, commerce, and industry oriented, the possibility that a similar productivity increase can be observed in the Indian context too, by the middle of this century, is high. This could also form the basis for a deeper, analytical study in the realm of public policy.

SPILLOVER EFFECTS

HSR, apart from providing a reliable, fast, and timely service, helps in **two** other ways. It has the capacity to divert and absorb traffic from the air mode and the automobile (bus and cars) mode and also have an effect on **reducing the carbon footprint** over a period of time. The other is the **demonstration effect** that the HSR can have on other transportation modes in India. HSR may well replicate the effect that the automobile sector and the highways sector have had on road transportation in India in the 21st century.

According to the European Energy Agency, the following are the CO_2 emissions per passenger kilometer for various modes of transport (Table 7):

Table 7: Carbon Dioxide Emissions per Passenger Kilometer for Various Modes as per European Energy Agency

Transport Mode	Passenger Average	Emissions ($g\text{-}CO_2$/km*pax)
Train	156	14
Small car	4	42
Big car	4	55
Bus	12.7	68
Motorbike	1.2	72
Small car	1.5	104
Big car	1.5	158
Plane	88	285
Ship	–	245

Source: Figures obtained from www.eea.europa.eu/transport on 23 October 2018.

A UIC study on HSR in France and the PRC (UIC 2016) concluded that the carbon footprint of HSR can be up to 14 times less carbon-intensive than car travel and up to 15 times less than aviation travel, even when measured over the full life cycles of planning, construction, and operation of the different transport modes. This is even more important where there are predictions of changes to the technology of all transport modes, such as cars, and even airplanes, powered by electricity.

In the case of India, the potential for renewable sources for electricity production, especially wind and solar energy, can really help in this regard. Further, in a country like India, where there is always a perennial shortage in the supply of railway accommodation, any new high-speed alternative will always be fully subscribed. Given Indians' innate urge to travel for business and pleasure, a modal shift is bound to occur, thereby reducing the carbon footprint even further. Since an average high-speed train is expected to carry about 700 to 800 passengers, the carbon footprint will certainly grow smaller in the long run.

An average high-speed train emits no direct CO_2. Emission depends on the mode of electricity generation used to run the train. Keeping the above in mind, a calculation was made of the possible levels of emissions of CO_2 in the BC-cord based on actual seats available. The results are based on the desk study conducted on the number of seats available in each mode for the BC-cord, and depending on the load factor for a given mode, the amount of emissions is compared.

Table 8: Carbon Dioxide Emission Estimations for Bangalore–Chennai Corridor

Transport Mode	Total No. of Seats A/C	Capacity Utilization Approx.	Passengers Traveling	Distance	Emissions (gCO2/km*pax)	Total Emissions	Total Emissions (In Tonnes)
Air	4,400	70%	3,080	350	285	307,230,000	307 Tonnes
Bus	3,400	90%	3,060	350	68	72,828,000	72.9 Tonnes
Rail	2,800	80%	2,240	350	14	10,976,000	10.9 Tonnes
HSR	5,600	90%	5,040	350	6[a]	10,584,000	5.3 Tonnes

[a] UIC Carbon Footprint of Railway Infrastructure: Comparing existing methodologies for typical corridor recommendation to harmonized approach. UIC. https://uic.org/IMG/pdf/carbon_footprint_of_railway_infrastructure.pdf.

A LESSON FROM THE RECENT PAST

To a large extent, the paradigm shifts in road transport in India arose as a result of the construction of the Golden Quadrilateral highway project. It came into prominence after a decisive leap in technology achieved through foreign investment in the manufacture of cars and commercial vehicles. The innumerable number of models of cars and buses available in India, particularly over the last decade, has made road travel very comfortable. There is no denying the fact that it was the government that built the roads on which these vehicles travel. However, the choice available to the user from a private car to the most comfortable air-conditioned bus has changed the culture of road travel in the country. Today, the three models of cars and three major models of trucks that defined the Indian motoring landscape in the 20th century have disappeared.

Owing to the better quality of roads, constructed around the turn of the century, and the availability of luxury buses, long-distance travel has blossomed in India in a big way over the last decade and a half. In this case, however, it was the private bus operators who took the lead in acquiring modern buses and providing very comfortable services connecting major cities in various regions of India. This, in turn, compelled the various state-run road transport corporations to buy the same luxury buses, just to be able to compete. Long- and medium-distance travel (up to 600 km) has now resulted in a Pareto equilibrium in bus road travel in many parts of the country.

It is very likely that the HSR will compel Indian Railways, possibly through the demonstration effect, to change its method of functioning and operations to help give greater comfort to passengers, enhance timely departures and arrivals, and thereby post higher revenues along with greater efficiency. Two activities are already underway: the construction of dedicated freight corridors and the expansion of carrying capacity by doubling or quadrupling the number of railway lines on high-density routes. This will reduce congestion and also help the non-HSR sector to improve its average speeds, thereby enabling a reduction in travel time across long distances.

Depending on the capacity of a given HSR, there would certainly be a shift away from the road to HSR, thereby freeing up both the road and a part of the existing railway system. This would, in turn, reduce congestion across the board. This freeing up of space will not only help the achievement of higher speeds for passenger trains on normal tracks but also help freight trains move faster.

COMPETITION FROM CYBERSPACE?

From another angle, let us take just two corridors: one between Chennai and Bangalore and the second between Chennai and Hyderabad. Travel by HSR in the |two sectors mentioned above is possible in about 90 minutes and 180 minutes, respectively. All the peninsular cities/city pairs in the table above are heavily commerce and business oriented. Thus, the customer base for an HSR service is significantly large. Their ability to pay more for a better and faster service is also a favorable factor. The assistance that such a facility will render to the business community will be immense – especially to those who need to physically travel to the termini or to the intermediate stops. Further, a trip in the above pairs can be completed by businesspersons in the space of one working day. Such time savings will certainly lead to greater efficiencies.

At the same time, just as the mobile phone revolution has comprehensively connected India by speech as well as images, the appeal and pull of high-speed travel will be such that it will have to compete with the modern technology of instant voice/image communication embellished by other facilities offered by high-speed Internet. An average businessperson, taking care of a small/medium-sized enterprise, would normally tend to save time and costs. Thus, unless travel by HSR becomes an inevitability or is a source of pleasure, that segment of the market may use it more for the latter than the former. Therefore, HSR will face competition from the facilities offered by high-speed connectivity by cyberspace both at the individual and at the industrial level, unless trips are taken purely for pleasure. Simultaneously, however, varying with the distances involved, HSR may encourage that segment of the population that can afford to travel short distances to try and take an HSR alternative just for the sake of it.

Here, it would be appropriate to quote from an article from the *Free Press Journal* dated 1 June 2018 about the oldest high-speed journey train, called the *Deccan Queen*, which has run between Pune and Mumbai for nearly 90 years.

On 1 June 1930 (88 years ago), the Indian passenger train *Deccan Queen Express* started its service between Mumbai and Pune. It was started as a weekend train during the British rule and was a medium for rich people from Bombay (now Mumbai) to attend horse racing at Pune racecourse. The train started its initial services on weekends but was soon converted to a daily service running from Bombay Victoria Terminus (now Chhatrapati Shivaji Maharaj Terminus (CSMT)) to Pune Junction.

Deccan Queen is one of the longest-running train services of Indian Railways to never run on steam power. It has been running using electric locomotives from the start and also used a diesel locomotive in case of original locomotive failure. It was the first train to have a "ladies only" coach and among the first to feature a diner. It was also one of India's first vestibule trains.

Currently, *Deccan Queen* is the fastest train service linking CSMT in Mumbai and Pune station. It has an average operating speed of 58 km/hr and a top speed of 105 km/hr. The train leaves Pune Junction every day at 7:15 a.m. and reaches CSMT at 10:25 a.m. The train departs from CSMT every day at 5:10 p.m. and reaches Pune Junction at 8:25 p.m. There are hundreds of Pune residents who take this train to Mumbai on a daily basis for work and return the same day. This is also what the HSR service hopes to achieve in India, but in the 21st century. There are bound to be lessons from this train's operations for the HSR planners in catering to the commuters who would travel for work daily for a few hundred kilometers and return home the same day.

It would be useful to do a detailed study on a public policy canvas about those routes that could face competition from cyberspace, as technology increases the speed of data transmission almost by the day. In the same context of advances in technology, studies could be undertaken by the NITI Aayog (successor to the Planning Commission) on identifying sources of funding and how to create new assets in the HSR universe. This should include studies by Indian Railways on the introduction of new technologies and how these can be indigenized over a period of time. They should also conduct studies on how traffic patterns can be improved and economy of operations can be made more cost-optimal. The Ministry of Finance, which has now included the railway budget within its own ambit, should enable public policy studies on pricing of services and sources for funding, especially for asset maintenance and renewal.

No discussion on HSR today can be complete without a mention of the achievements that the PRC has posted in this sector. The PRC today has the world's longest HSR network. Long-distance travel of more than 2,000 km is now operational there. This includes the journey between Beijing and Hong Kong, China, which began its commercial operations on 23 September 2018. It takes about 9 hours to cover the distance of 2,300 km between the two cities. The line is the world's longest high-speed rail route and cuts travel time by more than half.

A similar route in India could link the capital Delhi with major southern cities like Chennai, Bangalore, Hyderabad, and Trivandrum during the course of a day or through comfortable overnight journeys. Even if it is in the realm of imagination, India needs to think ahead in terms of how the reliability and speed of the trains in our country can better serve the socioeconomic objectives of India in general, and her railways in particular. There is a need to dream big and dream right!

REFERENCES

Dastidar, A., 2016. India’s ‘fastest train’ beats first Shatabdi by all of two minutes. https://indianexpress.com/article/india/india-news-india/indias-fastest-train-shatabdi-express-gatimaan-express/ (accessed 25 October 2018).

High Speed Rail. 2018. https://uic.org/highspeed (accessed 8 October 2018).

India Brand Equity Foundation. 2018. India Brand Equity Sectoral Report on Indian Railways. www.ibef.org.

Indian Express Centre. Can't delegate land acquisition power to state government for bullet train project: Farmers. http://www.newindianexpress.com/nation/2018/oct/16/centre-cant-delegate-land-acquisition-power-to-state-government-for-bullet-train-project-farmers-1885919.html.

Indian Railways. 2015. Lifeline of the Nation. White Paper released by India’s Railway Minister in February 2015. Accessed from the web on 19 September 2018.

Indian Railways. Five-Year Plans of India. www.planningcommission.nic.in (accessed 15 August 2018).

IRCTC Indian Railways Catering and Tourism Company. https://www.irctc.co.in, www.irctc.co.in, www.indiarailinfo.com, and www.irfca.co.in (accessed 8 October 2018).

National Rail Plan 2030 (NRP 2030) released on December 8, 2016 and accessed through website http://www.nationalrailplan.in.

New Delhi Government of India, Ministry of Railways. 2009. Indian Railways: Vision 2020. https://www.prsindia.org/uploads/media//Railways%20Vision%20Document%202020.pdf (accessed 19 September 2018).

New Delhi Planning Commission of India. 2013. National Transport Development Policy CommitteeReport, Part 1.

Planning Commission of India 12th Five-Year Plan. New Delhi Planning Commission of India 2012.

Raghuram, G. and Udayakumar, Prashanth D. 2016. "Dedicated High Speed Rail Network in India: Issues in Development," IIMA Working Papers WP2016-03-58, Indian Institute of Management Ahmedabad, Research and Publication Department.

UIC Carbon Footprint of Railway Infrastructure : Comparing existing methodologies for typical corridor recommendation to harmonized approach. UIC. https://uic.org/IMG/pdf/carbon_footprint_of_railway_infrastructure.pdf.