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Viksit Bharat @2047

Governance Transformed

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Chapter 7. Infrastructure Development: Bridging the Critical Gaps

Dr. Venkatesh Sathyanarayana¹⁷ and K. Jayakishan¹⁸

Introduction

Good-quality infrastructure leads to sustained demand for better services, and this has been a cornerstone for India's rapid growth of projects, particularly in the last two decades. To respond to this demand and to provide a boost to the economy, central and state governments have been taking several initiatives to give an impetus to the infrastructure sector in India. According to an IBEF ¹⁹ blog titled "Growth of infrastructure sector: A potential boost to the Indian economy,"²⁰ India is expected to grow at a compounded annual growth rate (CAGR) of 8.2% by 2027. Government of India (GoI) has set for itself a goal to become a developed nation by 2047.

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¹⁹ India Brand Equity Foundation (IBEF) is a trust set up by the Department of Commerce, Ministry of Commerce and Industry, Government of India, to promote and create international awareness of business opportunities to overseas investors.

²⁰ See <https://www.ibef.org/blogs/growth-of-infrastructure-sector-a-potential-boost-to-the-indian-economy>

Going forward there needs to be a clear framework to understand the infrastructure needs that may occur on account of increasing population, more and more people in the working age group²¹ contributing to the economic growth of the country, and therefore adequate steps need to be taken to augment infrastructure in the country for provision of better public services to the people (DEA). Increased public investments as envisaged in the infrastructure sector during the Amrit Kaal²² would enable increased crowd-in of private investments (LAARRDIS, 2023).

Department of Economic Affairs (DEA), Government of India, has been notifying the harmonised list of infrastructure sub-sectors²³ from time to time (DEA, 2012). In the updated harmonised master list in the year 2022, 37 infrastructure sub-sectors are notified²⁴ in five different categories²⁵ (DEA, 2022). In this chapter, the growth of a select infrastructure sub-sectors since India's independence in 1947 is mapped. These are transportation (highways, railways, ports, and airports), energy, and telecommunication, and these account for nearly 70% of the National Infrastructure Pipeline (NIP). The various initiatives taken by the central government in the development of important policies and regulations, key schemes announced, and resultant benefits accrued in the infrastructure space are presented. Examples of a few significant projects in these sectors are discussed. The objective is to examine the historical

²¹ According to the National Infrastructure Pipeline (NIP), the working age population of India is likely to grow 1.2 times more in the period 2015–2030.

²² The period between the 75th year of Indian independence and the 100th year: 2022 to 2047.

²³ Notification F. No. 13/6/2009-INF dated March 27, 2012, issued by the Department of Economic Affairs (Infrastructure Section), Ministry of Finance, Government of India.

²⁴ Notification F. No. 13/1/2017-INF dated October 11, 2022, issued by the Department of Economic Affairs (Policy and Planning Unit, IPP Division), Ministry of Finance, Government of India.

²⁵ (a) Transport and logistics, (b) energy, (c) water and sanitation, (d) communication, and (e) social and commercial infrastructure.

progress in the development of infrastructure in India, identify the challenges and gaps, and recommend what steps need to be taken by the stakeholders to achieve the objectives of Vision India@2047.

Overview: Status of Infrastructure

1947–1950

During the early period post-independence in 1947, the country went through different cycles of infrastructure development on account of several reasons. In the First Five Year Plan (1951–1956), the main intent was to increase agricultural production, develop transport, and improve communications. Due to the partition of the country, it was felt that by focusing on these initiatives, the great imbalance in the economic conditions would be ironed out. In the 100 years prior to 1951, the administrators of the country laid increased emphasis on building railway assets for administrative and strategic reasons; therefore, in this period the construction of roads and waterways had been largely neglected. Another reason for un-balanced development in the transport sector was the functional division between different types of transport between the central government and the state governments (Planning Commission, 1951).

1951–1961

During 1951–1956, a sizeable amount—nearly 25% of the total planned outlay (₹388.12 crores)—was set apart for transport and communication (Planning Commission, 1951). From this, three-fourths was for railways (₹200 crores), keeping in view the special needs of this sector, and also due to the additional strain

placed on the railways during that period on account of partition of the country. Airports at Bombay (Santacruz), Calcutta (Dum Dum), Delhi (Palam), and an airfield at Madras for operations on the Malaya–Indonesia–Australia route were developed during the Second Five Year Plan (1956–1961). Later, during 1958–1961, the country witnessed a stark reduction in investments in infrastructure assets due to the foreign exchange crisis (DEA, 2024).

1962–1970

In the next couple of years, by 1964, infrastructure spending gradually increased; however, on account of the Chinese aggression (1962), death of the then Prime Minister Jawaharlal Nehru (1964), and the subsequent war with Pakistan (1965), which was followed by drought conditions across the country (1967–1968) and the war for the liberation of Bangladesh (1971), the infrastructure spending across the country took a substantial hit over this prolonged period (DEA, 2024).

1970–1980

Again, during the 1970s, when infrastructure spending was seen to be increasing, there was another setback in terms of oil shock which had an adverse impact of a dramatic increase in oil prices in the period 1973–1974 (Siddayao, 1987). In 1975–1976, there was a political crisis leading to imposition of emergency, and this further slowed down investments in infrastructure (IDFC Ltd, 2012).

1980–1990

October 1984 saw the assassination of Prime Minister Indira Gandhi. The period 1985–1990 (Seventh Five Year Plan) saw that

food grain production had accelerated, and there were increased employment opportunities as well as a general rise in productivity. A growth rate of 6% was achieved against the targeted 5% during 1985–1990. Also, during this period, the highest infrastructure investments post-independence were seen, peaking at 5.7% of GDP by the year 1991. In May 1991, the former Prime Minister Rajiv Gandhi was assassinated, and this was followed by a financial crisis because of the suspension of the loan programme to India by the International Monetary Fund (IMF). The World Bank also discontinued its assistance (IDFC Ltd, 2012).

Post-economic Liberalisation (1991–2024)

In the annual plans of 1990–1991 and 1991–1992, Dr. Manmohan Singh, then Finance Minister, launched India's free market reforms, and this period was the beginning of privatisation and liberalisation. The Eighth Five Year Plan (1992–1997) was the period of strengthening infrastructure. The Ninth Five Year Plan (1997–2002) noted that the country's transport systems such as railways, roads, ports, and airports, were facing capacity constraints, and therefore, there was a significant loss of opportunities which would lead to economic distress. The Ninth Five Year Plan (1997–2002) also noted that the implementation of the Minimum Needs Programme²⁶ was poorly done where the "earthen tracks and gravel roads" were not adhering to the "technical norms of compaction, drainage and geometrics" (IDFC Ltd, 2012).

By 2010–2011, the pace of development of infrastructure projects in the country reduced significantly, especially the

²⁶ Started during the Fifth Five Year Plan in 1974, it was proposed that all villages with a population of 1,500 and 50% of villages with a population between 1,000 and 1,500 would be linked with all-weather roads.

projects taken up under PPP (public-private partnership) arrangements, on account of problems in land acquisition, environmental and other clearances, and delays in decision-making which led to the declaration of large-scale non-performing assets by the banks. During 2004–2014, while the government took up a large number of PPP projects, many of them failed to take off (Aiyar, 2016). The 12th Five Year Plan (2012–2017) focused on health, education, skill development, environment and natural resources, and infrastructure development. In the Union Budget of 2018–2019, it was estimated by the Finance Minister that infrastructure investments exceeding an amount of ₹50 lakh crores are required to increase the GDP growth of the country for roads, airports, railways, ports, and inland waterways. Therefore, the budgetary allocation was increased to ₹5.97 lakh crore in 2018–2019 against an expenditure of ₹4.94 lakh crores in 2017–2018 (PIB, 2018).

The central government launched the National Infrastructure Pipeline (NIP) in 2019 for the development of infrastructure projects across sectors like energy, roads, railways, and urban development projects to the extent of ₹111 lakh crores. The centre government and states are to have nearly equal contribution (39% and 40%), and it was expected that the private sector contribution will be a 21% share. It is expected that through the NIP, an amount of US\$1.4 trillion will be spent on infrastructure projects in five years (NIP, 2019). In the Union Budget 2023–2024, the outlay towards capital investment is increased by 33% to ₹10 lakh crores, which is 3.3% of the GDP and nearly three times the budgetary outlay during 2019–2020. A new institution known as the “Infrastructure Finance Secretariat” was set up during 2023–2024 to accelerate private investments in the railways, roads, urban infrastructure, and power sectors (Infrastructure Finance Secretariat, 2023-24).

Newer Programmes and Initiatives

The central government has taken several steps to improve infrastructure. Projects were developed at a rapid pace, with public sector capital investment increasing from ₹5.6 lakh crores in 2014–2015 to ₹18.6 lakh crores in 2023–2024 according to budget estimates. This is a 3.3-fold increase. There has been a significant increase in infrastructure development, such as adding to the length of roads and highways, expressways, freight corridors, airports, metro rail, trans-sea link projects, and digital infrastructure. Newer programmes for the improving air connectivity, both nationally and internationally, were launched, viz., the UDAN scheme for developing new airports and air routes, Bharat Mala for roads and highways, and Sagarmala for the improvement of port infrastructure. In the railway sector, efforts are being made to increase electrification and upgrade railway infrastructure (DEA, 2024). The Prime Minister's Gati Shakti National Master Plan, a digital platform launched in October 2021 intends to bring together 16 ministries on a single platform for integrated planning and coordinated implementation of infrastructure projects in the country.

The Government of India has laid down a framework for monetisation of assets and, accordingly, a potential list of core assets belonging to various ministries and Central Public Sector Enterprises (CPSE) was prepared. The total value of the assets identified in August 2021 is about ₹6.0 lakh crores for the period financial year (FY) 2022–2025. These projects are spread across sectors like roads, railways, aviation, power, oil and gas, and warehousing. The NITI Aayog assisted various ministries in the transaction structuring, and the targeted amount of ₹80,000 crores was achieved in FY2022. A further pipeline of about ₹1.23 lakh crores is under various stages of processing (NITI Aayog, 2022-23).

Sector-Wise Developments

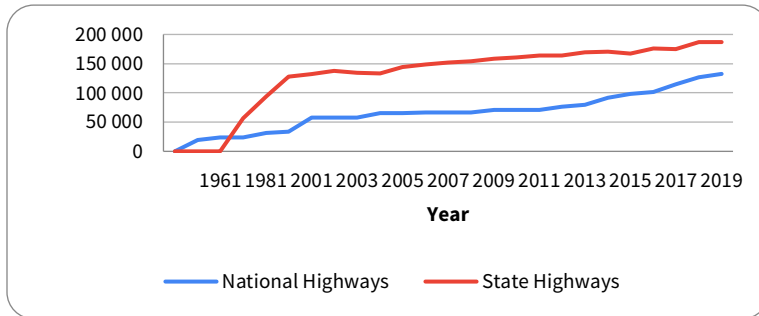
Transportation Sector: Road Infrastructure

Historical context

- National Highways. In the Fifth Five-Year Plan (1974–1978), the Indian national highway system was introduced. By the beginning of 1991, it was recognised that there was a severe budgetary constraint in building and maintaining national highways. Therefore, it was necessary to seek private sector participation in the construction and upgradation of select highways, especially the construction of four-lane highways and expressways so that they could be tolled.²⁷ The development of highways witnessed very slow progress in the first 50 years post-independence. Given that the national highway network was carrying nearly 65% of freight and 85% of passenger traffic despite being less than 2% of the total road network, it necessitated the adoption of a different approach to its development. It was in this background that the National Highway Authority of India (NHAI) was established in the year 1997 (Nallathiga, 2019), and, as expected, kick-started the development of the national highway network (see Figure 1). NHAI has ever since been taking up projects under EPC and under PPP models. National highway network has expanded by 60% from 91,287 km in 2014 to 146,145 km till 2023.

²⁷ Eighth Five Year Plan document, para 9.4.5.

Figure 1: Growth of National Highway and State Highway Road Network



- NHDP and Golden Quadrilateral. In 2001 after the launch of the National Highway Development Programme (NHDP), there was a major thrust to highway development in the country, especially after the announcement of the Golden Quadrilateral (GQ)²⁸ and the North-South-East-West Corridor (NSEW).²⁹ Subsequently, NHDP was taken up in Phases III to VII, essentially to improve lane capacity by converting two-lane highways to four-lane and six-lane highways. Besides this, the development and maintenance of nearly 41,290 km of national highways was taken up under NHDP. The PPP mode was extensively used by NHAI, particularly in Phases III to VII of highway development. To give a boost to the development of projects under PPP frameworks, the Government of India in 2006 set up the PPPAC³⁰ for appraisal and speedy clearances. PPP cells were set up, and Model Concession Agreement (MCA) for the road sector was prepared in 1999. However, as the private sector participants had to face a variety of risks which they did not foresee, many of the initial projects failed, and several of them did not take off (Nallathiga, 2019).
- State Highways. The trend in the state highways was quite

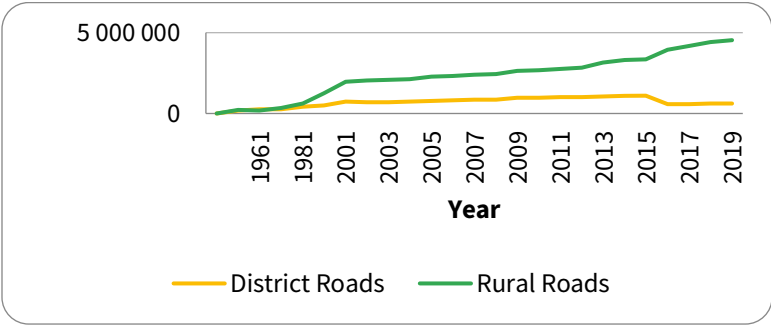
²⁸ This was later termed as NHDP Phase I.

²⁹ This was later termed as NHDP Phase II.

³⁰ Public-Private Partnership Appraisal Committee.

- different from the NHAI, with the state highway network witnessing a steep increase until 1991. However, the focus was primarily to enhance connectivity, and large parts of the network had a lane configuration of two-lane or lesser. Also, over a period of time, owing to a lack of focus on maintenance, the quality of the state highway network deteriorated drastically. In recent years, this trend has seen a reversal through a multi-pronged approach adopted by most states, and budgetary resources have been bolstered by multi-lateral development programmes and through PPPs.
- District and Rural Roads. State governments have control over Major District Roads (MDRs) which are developed through the State Public Works Departments (PWDs) and State Road Development Corporations (KPMG, 2019). In order to ensure rural connectivity to enable smooth movement of agriculture produce and accessibility to health, education, and other facilities to rural communities, the government launched the Pradhan Mantri Gram Sadak Yojana (PMGSY) in 2000. This programme also served as a rural employment scheme. Till February 2024, 763,277 km of rural roads have been developed/improved under the programme (NRIDA, n.d.). Figure 2 shows the growth of rural road network during 1961–2019 in comparison to district roads. A gradual increase in rural roads can be seen from the period 1981 onwards.

Figure 2: Growth of Rural Road Network



Future Plans and Trends

In the future, with the development of significant lengths of national highways and the improvement of state highways, greater focus will be needed to sustainably maintain these roads in the long term; that is, to provide better-quality services to the users. Also, road safety and the adoption of IT-enabled services are likely to receive greater attention. The priorities are likely to be more towards the integration of multimodal transportation, lowering costs, finding newer sources of financing, and PPP establishing arrangements. The development of green infrastructure will also be a focus of the future. The key sector trends and future priorities are given in Table 1.

Table 1: Priorities in the Road Sector

<i>Key sector trends</i>					
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
Bharatmala Pariyojana & other projects	Ease and economy of traffic movement	Focus on road safety	Increased use of IT applications	Alternate sources of funding	Emphasis on green initiatives
<i>Priorities</i>					
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
Maintenance and capacity augmentation of huge road network	Focus on multimodal transport integration	Increase priority on road safety	Adoption of more IT enabled solutions	Bettering costs, exploring new fund sources and new PPP models	Adoption of environment friendly green transport solutions

Source: Roads and highways sector: Current trends and future roadmap (KPMG, 2019).

- **Monetisation of Road Assets:** In order to mobilise revenues for ploughing back into further development of the highway

network, the NHAI has adopted the Toll Operate Transfer (TOT) model to monetise its road assets. The TOT model, which grants the right to collect toll by the private sector, was launched in 2018 and has yielded ₹26,366 crores through the monetisation of road assets to date. The model is now also being adopted by various state governments.

- Development of Economic Corridors. Another trend is the development of economic corridors that combine the development of highways/expressways with the planned development of industrial and economic nodes alongside. Some recent examples/announcements of such development are:

1. Ganga and Yamuna Expressways in UP
2. Mumbai-Nagpur Samruddhi Expressway in Maharashtra
3. Delhi-Vadodara Expressway
4. Hyderabad-Visakhapatnam Economic Corridor
5. Nagpur-Vijayawada Economic Corridor
6. Chennai-Bengaluru-Mysuru Expressway

Transportation Sector: Railways

Historical Context

In 1950–1951, India's railways covered 53,596 km which had increased to 61,661 km by 1984–1985, with electrification rising from 388 km to 6,440 km.³¹ The Seventh Five Year Plan (1985–1990) increased train traffic by 8%. The plan showed that 25% of rails needed renewal since many lines were old. The Government of India introduced several technological and

³¹ Eighth Five Year Plan document, para 9.1.8.

institutional changes to improve railways during the period from 1950 to 1990. A few of them are given in Table 2.

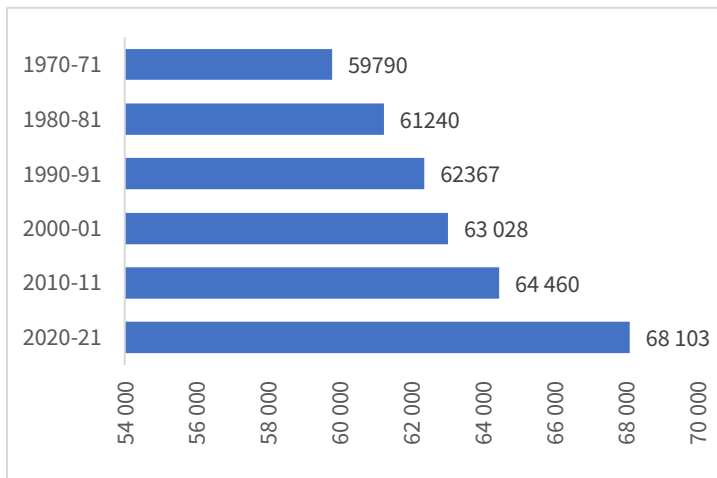
Table 2: Key Developments During 1950–1992

<i>Period</i>	<i>Date/year</i>	<i>Technological and institutional changes</i>
1950–55	January 27, 1950	Chittaranjan Locomotive Works (CLW) is inaugurated, and Assam Rail Link is opened to passenger traffic
	April 14, 1952	The Eastern and North Eastern Railways are formed
	1955	Integral Coach Factory at Perambur in Tamil Nadu is inaugurated South Eastern Railway is formed
1956–61	1956	First fully air-conditioned train, popularly known as the AC Express is introduced between Howrah and Delhi
	1957	Indian Railways decides to adopt 25 KV AC system for electrification. The Research Designs and Standards Organization (RDSO), the Indian Railway Institute for Signal Engineering and Telecommunication (IRISET), and Railway Protection Force (RPF) are established
	January 15, 1958	The Northeast Frontier Railway is formed by splitting the North Eastern Railway
	1961	CLW starts manufacturing electric locomotives and the Diesel Locomotive Works is set up at Varanasi, Uttar Pradesh
1962–67	1964	CLW builds its first locomotive WAG-1
	1965	Fast Freight services or the “Super Express” is introduced on several routes
	1966	The first container service in India starts between Bombay and Ahmedabad and the South Central Railway is formed
1968–73	March 3, 1969	Rajdhani Express, the first high-speed all-AC train, runs between Howrah and New Delhi

	1971	Indian Railways formulates its gauge conversion policy
	1971	The Farakka Railway Bridge and the Pathankot–Jammu Tawi section is opened
	1972	Construction of Calcutta Metro begins
	1973	CLW stops production of steam locomotives
1974–80	1974	Rail India Technical and Economic Services (RITES) is incorporated as a public limited company
	1979	Central Organisation for Railways Electrification (CORE) is formed
	1983	To promote tourism, a tourist train called the Great Indian Rover to sacred Buddhist sites is launched
	1984	Railway Reform Committee recommends creation of four new railway zones
1985–88	1985	A pilot project for computerisation of Passenger Reservation System through the Integrated Multi-train Passenger Reservation System (IMPRESS) has been introduced in New Delhi
	1986	Rail Coach Factory is established in Kapurthala, Punjab
	1988	Container Corporation of India Ltd. (CONCOR) is created
1989–92	1989	Work on Konkan Railway begins
	1989	The Railways Act, 1989, comes into effect replacing the Railways Act, 1890
	1991	India shifts to a new industrial policy, a move towards liberalising the economy through private participation
	1992	The Indian Railways adopts the Uni-Gauge Policy

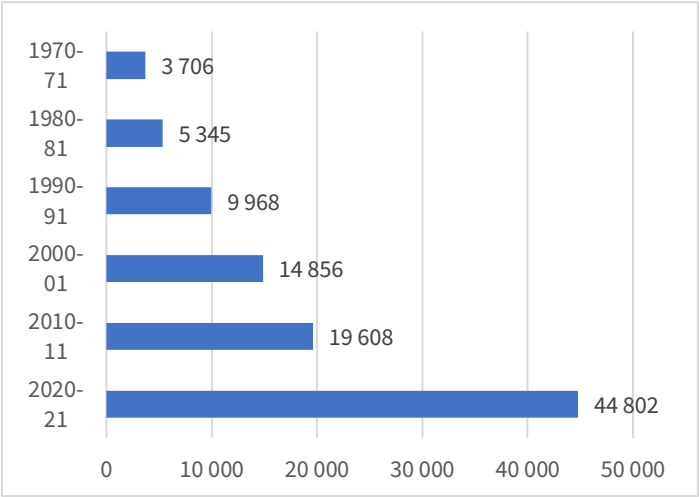
Source: Relevant extract from the book Indian Railways: A visual journey (Ramaraao Annavarapu et. al., 2020) (compiled by authors).

Figure 3: Increase in Route Length (km)



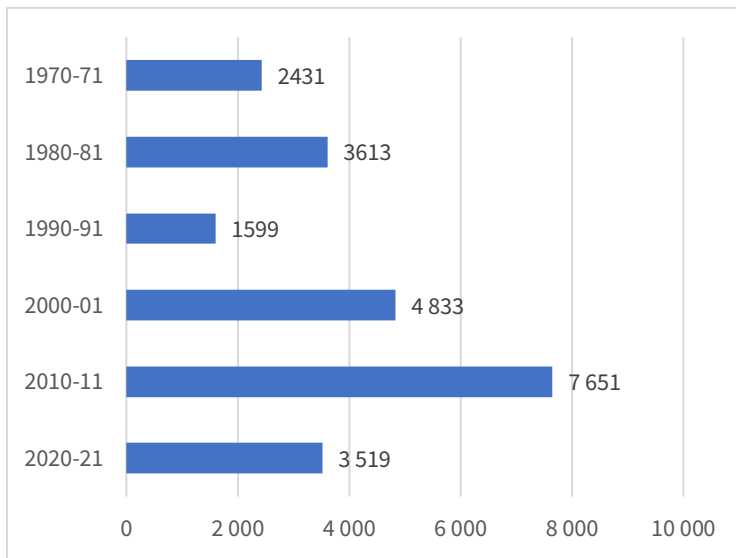
Due to the government's efforts to improve passenger and freight rail connectivity, India's railway lines expanded from 98,546 km in 1970–1971 to 1,26,611 km in 2020–2021. The route length, the distance trains travel, increased slightly from 59,790 km to 68,103 km (Figure 3), reflecting a concentration on capacity along the new lines. Railway electrification, from 3,706 km to 44,802 km, was a major feat (Figure 4). Indian Railways transformed with initiatives such as the Uni-Gauge Policy and Mission Electrification, which increased the operating efficiency, sustainability, and reduced carbon emissions.

Figure 4: Electrified Route Length (km)



Indian Railways launched major initiatives to revamp its system and prepare for the future in both freight and passenger services. A landmark achievement was the commissioning of the 760 km Konkan Railway broad-gauge line in January 1998. However, the Ninth Five Year Plan (1997–2002) highlighted a decline in railway freight traffic from 89% in 1951 to 40% in 1995. The Plan emphasised the need for better, more reliable services and competitive freight rates to reclaim bulk traffic that once relied on rail transport. The decadal trends of passenger traffic during 1970–1971 to 2020–2021 are shown in Figure 5.

Figure 5: Passenger Traffic (in Millions)



Recent Developments

In 2006, the Indian government established the Dedicated Freight Corridor Corporation of India Ltd. (DFCCIL) to develop specialised freight corridors nationwide. This initiative aims to ease the burden on the busy Delhi–Mumbai and Delhi–Kolkata lines, which have seen a surge in cargo movement due to booming international trade and domestic transport. Apart from the above corridors, the DFCCIL also plans to implement dedicated freight corridors along other high-density routes (estimated to be about 7,201 km). Of these, East to West corridor between Kolkata and Mumbai will be 2,328 km and North to South between Delhi and Chennai will be 2,327 km. Along the east coast the corridor between Kharagpur and Vijayawada will be 1,115 km, and the South–West, Chennai–Goa, corridor is also being considered (Ramarao Annavarapu et. al., 2020). Dedicated freight corridors (DFCs), with projects such as the Eastern and Western DFCs, with the objective to create specialised freight

corridors, was intended to reduce congestion and increase efficiency.

In 2016, the Government of India launched the National High Speed Rail Corporation Ltd. (NHSRCL) to develop high-speed rail corridors. The flagship project, the Mumbai–Ahmedabad High-Speed Rail Corridor, promises faster, more efficient travel between these major cities. To further enhance passenger experience, the Vande Bharat Express trains were introduced in 2019, offering safer, quicker, and more comfortable journeys. As of January 2024, there are 82 Vande Bharat trains operating across the country over 10,891 km route of the Golden Quadrilateral and Diagonal Routes (Ministry of Railways, 2024). Indian Railways has introduced Kavach, an advanced automatic train protection system developed in collaboration with the Indian industry by the Research Design and Standards Organisation (RDSO), aimed at enhancing rail safety and prevention of collision (Ministry of Railways, 2022). The station redevelopment programme aims to modernise key railway stations, enhancing passenger amenities. Under the Amrit Bharat Station Scheme, 1,309 stations are slated for revitalisation, focusing on accessibility, waiting areas, restroom facilities, life and escalator installations, cleanliness, and local product kiosks like “One Station One Product” (Statis, 2024).

Transportation Sector: Ports and Maritime Infrastructure

Validation of the development of a country or region can be ascertained through the index of infrastructure facilities available and/or the occurrence of infrastructure developments therein. The port sector in India embraces a vital section of infrastructure that may be considered a gateway to integration with the global economic system. With a massive coastline of 7,517 km and a peninsular setting, Indian ports are strategically positioned for collaboration with other global economies. In

terms of nomenclature, the ports in India are classified as major and non-major ports, with the former falling under the administrative control of the Government of India and later under the purview of respective State Maritime Board.

Out of the 12 major ports in India at present, only six existed in the year 1947 at the time of independence. The other six were established later during the 1970s. During the initial years post-independence, all the major ports in the country were not making profits and were being self-financed with their own funds. They did not have enough reserves at their disposal to improve and modernise the port facilities. There was a significant capacity constraint in the 1970s in the matter of handling bulk cargo, iron ore, petroleum, oil, and lubricants. Also, there were deficiencies in capacity for the handling of fertiliser and general cargo frequently in most of the major ports during this period (IDFC Ltd, 2012). During 1982–1983, the country moved towards the improvement of major ports like Calcutta (Kolkata), Cochin (Kochi), Madras (Chennai), Kandla, Bombay (Mumbai), and others to increase their capacity and efficiency. Additional general cargo berths were constructed at Kandla, Mormugao, New Mangalore, Madras, Tuticorin, Visakhapatnam, and Paradip. Additional POL (petroleum, oil, and lubricants) handling facilities were built at Cochin, Kandla, and Visakhapatnam, and a full-fledged container terminal was built at Madras (Ministry of Finance, 1982).

From the late 1980s, Indian government's focus shifted from the development of major ports to non-major ports. States were encouraged to develop their own port infrastructure in order to reduce congestion at major ports and promote decentralised regional economic growth. Aiding this, the economic liberalisation in the 1990s led to greater private sector participation in port development, and non-major ports started receiving investments for modernisation and expansion. The volume of cargo handled in the country (Figure 6) experienced a CAGR of 1.08 in last 10 years, supported by handling through 12 major ports and 229 non-major ports, aided by the significant

addition of 30 non-major ports gradually in the referred decade. In parallel, the average turnaround time per ship has reduced from 4.2 days to 2.9 days (Figure 7). These significant advancements can be credited to major investments and changes implemented in the sector.

Figure 6: Total Cargo Handled (in Million Tonnes)

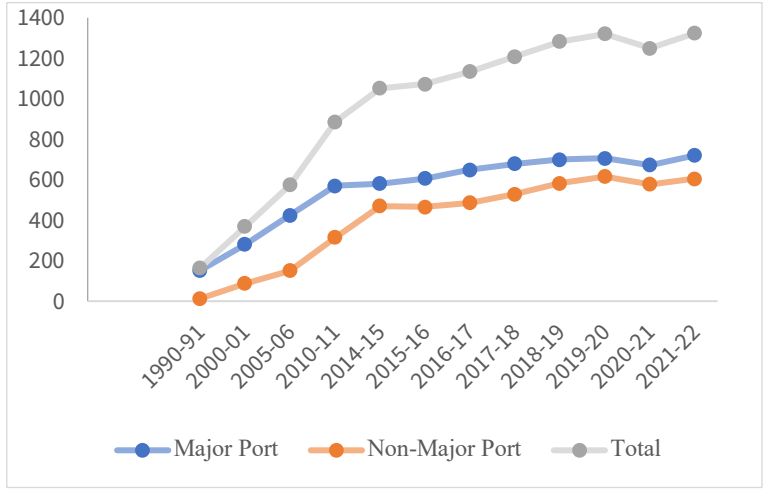
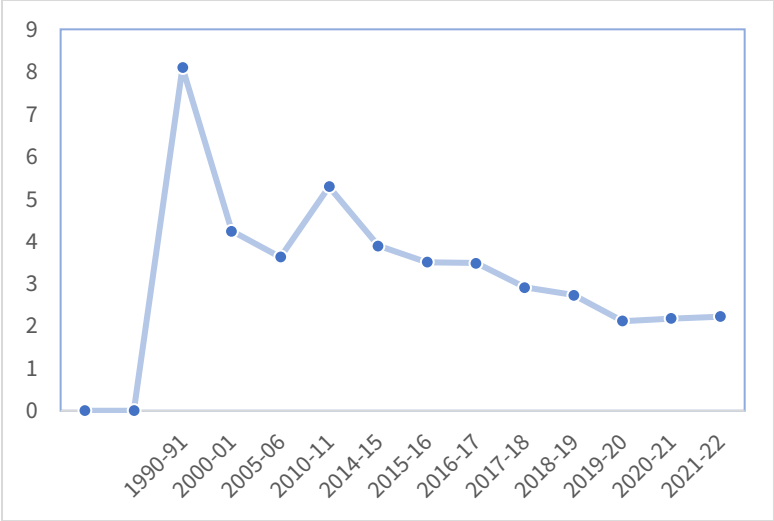


Figure 7: Average Turn Round Time (Days)



The Indian government, through various initiatives like the National Maritime Development Programme (NMDP) and the Sagarmala Programme, has been focusing on upgrading port infrastructure, including non-major ports. These projects aim to enhance connectivity, increase capacity, and improve operational efficiency.

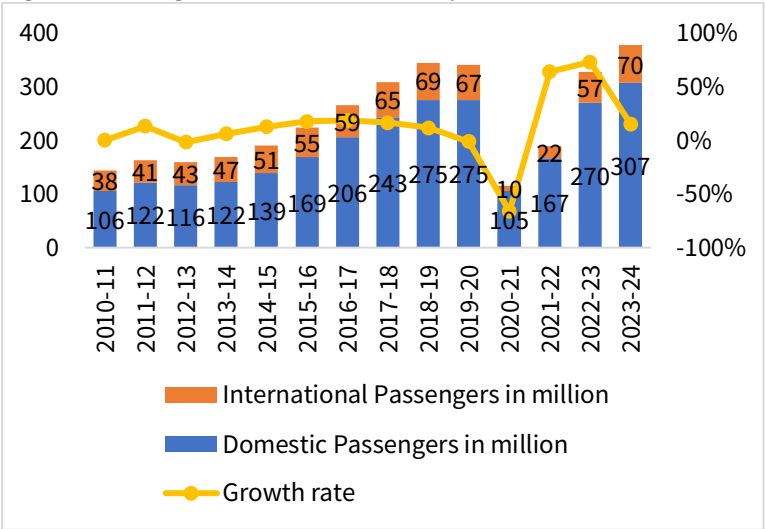
Several Indian states, recognising the economic potential of their coastal regions, have undertaken ambitious port development projects. States like Gujarat, Andhra Pradesh, and Tamil Nadu have developed robust port infrastructure, making non-major ports significant contributors to the maritime economy. Inland waterways development in India presents a transformative opportunity to create an efficient, cost-effective, and sustainable transportation network. By addressing infrastructure gaps, navigational challenges, and environmental concerns, India can fully leverage its vast network of rivers and canals to support economic growth and regional development. The Government of India has taken up the development of inland waterways to improve hinterland connectivity and complement coastal shipping. The Inland Waterways Authority of India (IWAI), established in 1986, is the nodal agency under the Union Ministry of Ports, Shipping and Waterways, mandated to develop and regulate National Waterways (NWs) in India. The navigable waterway in India is about 14,500 km, and a significant amount of cargo and passengers are presently transported through a fuel-efficient and environment-friendly mode of transport. IWAI has taken a quantum leap from just 5 national waterways to 111 NWs in the last 10 years (IWAI, n.d.).

The Ministry of Shipping has compiled more than 300 initiatives to develop India's ports, shipping, and waterways. The "Amrit Kaal 2047" envisions a comprehensive transformation of India's ports, making them pivotal to the nation's economic growth and strategic capabilities by modernising infrastructure, integrating advanced technologies, enhancing connectivity, and promoting sustainable practices (Vision@2047, 2023).

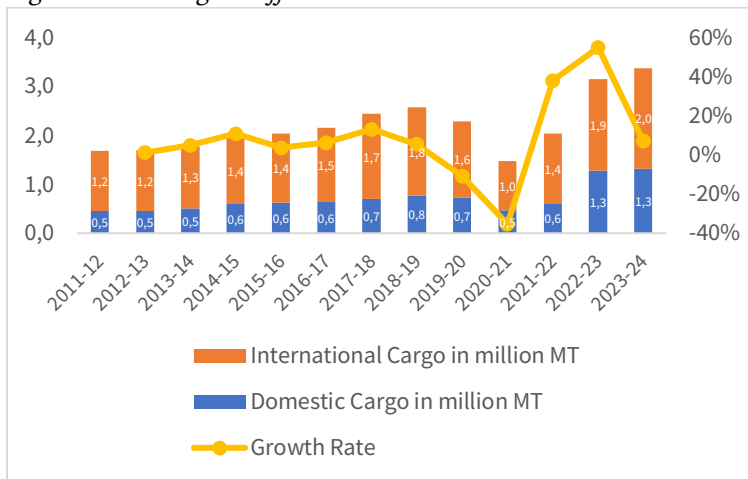
Transportation Sector: Airports

During the period of 20 years from 1990–1991 to 2010–2011, the performance of the domestic air traffic grew at an annual average rate of 10.4%, while in the case of international passenger traffic, it grew at 9.4%. Total passenger traffic during this period grew at an annual average rate of 9.9% (NTPDC, 2012).

Figure 8: Average Turn Round Time (Days)



Figures 8 and 9 show the passenger and air cargo traffic in India have been gradually increasing except for a dip during 2020–2021 and 2021–2022 due to COVID-19. The growth in passenger air traffic has inched back to the pre-COVID levels for the year 2023. Air cargo traffic, over the last 12 years, reached its highest level in 2023–2024. With economic recovery and growth rate coupled with macroeconomic stability in the country, the aviation sector is bound to achieve leaps in the coming years. This is witnessed by the various actions and events that have been taking place in the sector as a whole.

Figure 9: Air Cargo Traffic in India

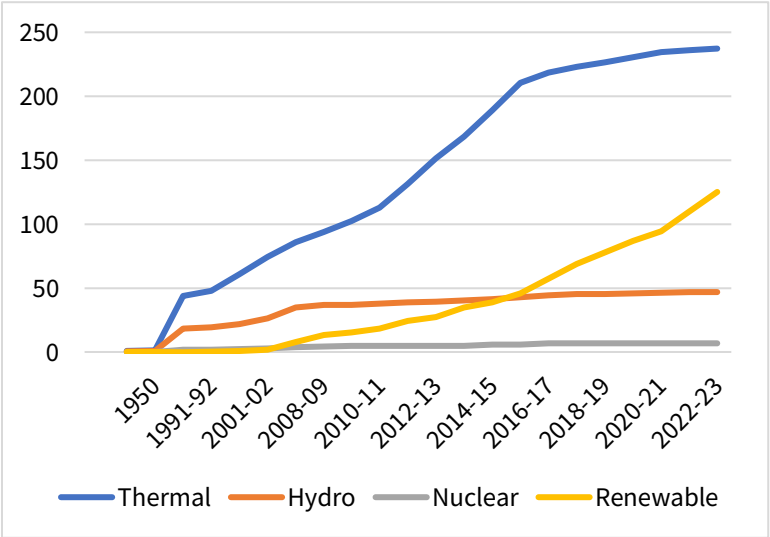
From the connectivity perspective, the Regional Connectivity Scheme (RCS UDAN) launched in 2016 has been a game changer, where the idle airports have been put into use and also in unlocking the underlying flying potential by establishing connectivity to Tier 2 and Tier 3 cities (MoCA, 2022). The number of airports is set to increase to 220 from the current 149 by 2025, to build infrastructure capacity to support towards realising the vision of achieving US\$20 trillion economy by 2047. This also increases the investment outlay in the sector and tapping of private investments to address the gaps in financing the capital expenditure by concessioning the feasible airports. Under NIP, capital expenditure of more than ₹98,000 crore is likely to be incurred between 2019 and 2025, where Airports Authority of India to incur about ₹25,000 crore and remaining to be borne by private developers under PPP mode. Under the PM Gati Shakti vision, it is proposed that 16 new airports will be built in five states.³² Under the NextGen Airports for Bharat (NABH), the government plans to take up expansion of airport

³² Chhattisgarh, Madhya Pradesh, Maharashtra, Rajasthan, and Uttar Pradesh.

capacity of more than five times in the next 10 to 15 years which will facilitate handling of billions of trips each year. The MRO (maintenance, repair, and operations) industry is expected to grow from US\$800 million in 2018 to over US\$2.4 billion in 2028, and investments worth US\$25 billion would be made in the civil aviation sector by 2027 (IBEF, 2024).

Energy Sector

Figure 10: Installed Generation Capacity (GW)

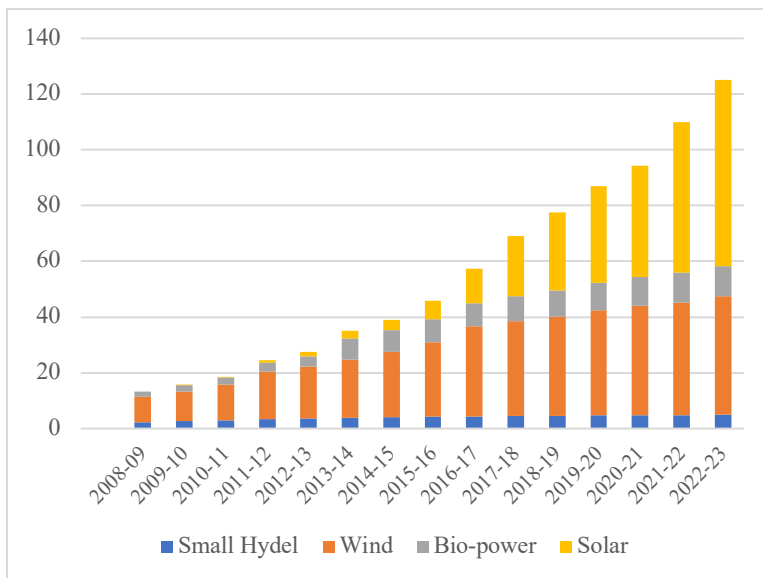


Public sector agencies have been dominant in the Indian energy sector since independence. The construction of thermal plants was a significant step in power generation to meet the growing demand for electricity. Several hydroelectric projects were initiated to harness the potential of rivers and generate clean energy. India also invested in nuclear power plants to diversify its energy source.

In the power sector, as of March 31, 1997, nearly 95% of the total installed capacity of 85,919 MW (Figure 10) consisted of a

mix of fuel types: being thermal, hydro, and nuclear capacities which accounted for 72%, 25%, and 3%, respectively. During 1996–1997, the total power generation in the country was about 394 BU (IDFC Ltd). Electricity production from renewable sources, excluding hydroelectric, was 0.5% of total in the year 2000 which increased to 5.4% in the year 2015. In the year 2000, only about 60.3% of India's population had access to electricity which, by the year 2021, has increased to about 99.6% (World Bank, n.d.). The power generation capacity in India as of March 2019 was 356 GW, with the central government having a share of 24%, states 30%, and private sector 46%. In terms of fuel mix, thermal power (64%) accounts for the largest share, which is followed by renewable energy sources (22%), hydel power (13%), and nuclear power (1%).

Figure 11: Growth of Renewable Energy (GW)

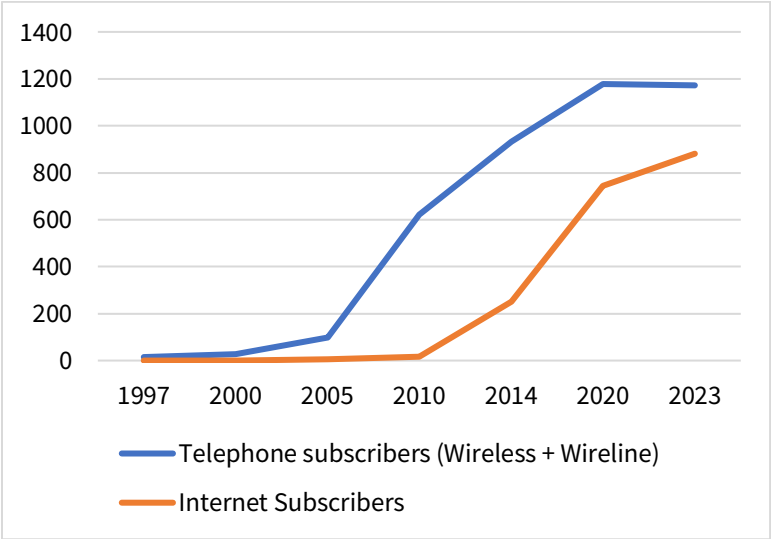


India has set an ambitious target for renewable energy by including 175 GW by 2022 and 450 GW by 2030. Key sources of

renewable energy include hydel, wind, biopower, and solar (Figure 11). The Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) focuses on rural electrification. The Integrated Power Development Scheme (IPDS) aims to strengthen urban power infrastructure (NIP, 2019). In January 2024, the Ministry of New and Renewable Energy (MNRE) launched a new solar power scheme for providing solar power to tribal households in India. The implementation guidelines for this scheme targeted Particularly Vulnerable Tribal Groups (PVTG) under the Pradhan Mantri Janjati Adivasi Nyaya Maha Abhiyan (PM-JANMAN) programme and aims to electrify 0.1 million un-electrified households across 18 states in PVTG areas. These households are identified by the Ministry of Tribal Affairs to provide off-grid solar systems and solar lighting in multi-purpose centres where the supply of electricity through the grid is techno-economically not feasible (Sudip Mahapatra et. al., 2024).

Telecommunication Sector

Figure 12: Growth of Telephony and Internet Users in India



Until the year 1984, the telecom sector was entirely government-owned. During this period, the sector was plagued by under-investment, leading to archaic equipment and systems, impeding the growth of the sector. In the middle of the 1980s, this sector was included as part of the “Technology Missions.” It was envisaged that the Technology Mission would develop specific programmes that are “welfare-oriented” which would be implemented at the national level (Rekha Jain, 2001). In 1987, the Centre for Development of Telematics was established, which is said to have revolutionised the telecommunications sector in India. Significant investments by the public sector were made in the telecom sector in computers, satellites, etc., which brought down the cost of long-haul telecommunications (IDFC Ltd, 2012). The National Council of Applied Economic Research in its report Telecom sector in India: A decadal profile has observed that the telecom services have significantly grown from 0.96% of GDP in 2000–2001 to 3.78% in 2009–2010 (Figure 12). From the years 2001 to 2011, the number of telephone subscribers grew at a CAGR of 35%, in comparison to the 1980s and the 1990s at 9% and 22%, respectively. Mobile phone and internet users also increased during this period (NCAER, 2012). Individuals using the internet as a percentage of the population which was 0% in 1990 has increased to 46.3% in 2021. It was 7.5% in the year 2010 (World Bank, n.d.).

The BharatNet Project, which is expected to connect nearly 250,000 Gram Panchayats in the country with broadband connectivity, will provide access to applications such as e-health, e-education, and e-governance in rural and remote locations in India. As of January 2024, nearly 210,100 Gram Panchayats have been made service ready (DoT, n.d.). India also has one of the lowest telecom usage costs in the world, both in terms of voice and data. It is estimated that this will not only increase the penetration of mobile phones in the country but also add 500 million new internet users, thus helping to create opportunities for businesses in food delivery, e-commerce, etc.

It is envisaged that the 5G technology will give a thrust to Indian economy by US\$450 billion between 2023 and 2040 (Invest India, 2022).

Current Gaps and Challenges

Good governance in building infrastructure is an important aspect of the implementation of large-scale projects and programmes for attracting investment. There are, however, several gaps and challenges that need to be addressed at the earliest. A few of them are described as follows:

1. **Land Acquisition and Rehabilitation:** The usual problems during acquisition are delays due to the rehabilitation and resettlement of persons, obtaining clearances for forest, wildlife, and environment, shifting of utilities, etc. As has been the experience, especially in the highways sector, delays in acquiring land in the past have impacted highway development significantly (Ibanez, 2003). Balancing development needs with the rights of people who are affected by the project is a delicate task and it has to be dealt with care. Timely acquisition for the project and proper rehabilitation with adequate compensation for displaced persons is a critical aspect (MOSPI, 2023).
2. **Permits and Clearances:** Timely permissions and clearances for the projects are an important element for the completion of construction. Streamlining the regulatory and clearance process is an important aspect and needs to be addressed.
3. **Implementation and Maintenance of Projects:** This requires skilled personnel, management expertise, and decision-making in a timely manner. Delays due to construction issues, disruptions in the supply chain of raw materials and other components for construction, and unexpected disruptions need to be handled in an efficient manner. Inadequate maintenance may lead to early deterioration of constructed assets.

4. **Political Will and Coordination:** Close coordination between the central and state governments, local bodies, and other relevant stakeholders is an important aspect, and if the projects are not monitored properly, they are likely to fail.
5. **Financing of Projects:** Funding for large-scale projects is difficult, as insufficient allocation of public finances and private investment can impede progress. Balancing fiscal responsibility with the development goals of the government is a challenge.
6. **Cybersecurity:** Of late, with the advent of advanced technologies like artificial intelligence (AI), blockchain, and machine learning, it is important to ensure non-interference in the operations of project assets within airports, ports, railways, etc., from cyberthreats.
7. **Legal Frameworks and Contract Management:** During construction, issues of interpretation of contract conditions, litigation, and force majeure conditions like COVID-19 and heavy rainfall/floods are also seen. A robust dispute resolution mechanism is crucial.

Table 3 shows infrastructure shortfall in select sectors.

Table 3: Sectoral Shortfall

Sectors	Description
Roads	– Out of 100,000 km of National Highways (NH) which constitutes nearly 2% of the country's road network accounts for 40% of traffic, and these roads are highly used. – NHs are the best in the country of all the roads. However, only 24% of NH is four lane or more, 52% is two lane, and 24% is single lane. It means significant congestion and time and fuel wastage.
Railways	Saturated routes and slow average speeds. In a few routes like Delhi–Mumbai and Delhi–Kolkata, the capacity utilisation is over 150%, leading to congestion and slow average speeds.
Ports	Sector is afflicted with inadequate berths, railroad connectivity, and shallow draught.
Airports	Inadequate capacity of runways, aircraft handling, and terminal buildings.
Power	Peaking power deficit: 3.2% Energy shortage: 2.3% Aggregate technical and commercial losses (AT&C) losses: 25% Transmission and distribution losses: 21%
Telecom	Delayed clearances and approvals. Significant number of compliances required. Sector is capital-intensive, hence making available adequate financing for R&D, incubation centres, incentives for creation of infrastructure/manufacturing facilities, etc. is critical for clearing roadblocks.

Source: (Kumar V Pratap & Rajesh Chakrabarti, 2017)); (TRAI, 2022) (compiled by authors).

Regulatory and Institutional Development

Recognising the importance of meeting the growing demands of infrastructure service provision to the people, the central government, since independence, has been evolving newer legislations to establish institutions, set standards and enable improved standards for each sector from time to time. Rather than deeply analysing the entire gamut of the legislative process in the infrastructure sectors, the ecosystem of a few of the applicable legislations and their main objectives are set out in Table 4.

Table 4: Evolution of Key Sectoral Legislations

<i>Year</i>	<i>Legislation</i>	<i>Main objectives</i>
1908	The Indian Ports Act	To consolidate enactments relating to ports and port charges
1956	The National Highways Act	Declare certain highways as national highways and matters connected therewith
1963	The Major Port Trusts Act	Constitution of port authorities for certain major ports and vesting its administration, control, and management of such ports
1988	The National Highways Authority of India Act	Constitution of NHAI to develop, maintain, and manage the national highways
1989	The Railways Act	Provisions related to railway zones, construction, and maintenance of works, and passenger and employee services
1994	The Airports Authority of India Act	Constitution of Airport Authority of India for airport development, planning, construction, etc.

1997	The Telecom Regulatory Authority of India Act	To regulate telecommunication services, adjudicate disputes, dispose appeals, and protect the interest of service providers and consumers
2001	The Energy Conservation Act	For efficient use of energy and its conservation
2003	Electricity Act	To consolidate laws relating to generation, transmission, distribution, trading, and use of electricity
2008	The Airports Economic Regulatory Authority of India Act	To determine tariff for aeronautical services, determine development fee, monitor performance standards, etc.

Source: (NIC) (compiled by authors).

In 1994, the central government set up an expert group on Commercialisation of Infrastructure Projects under the chairmanship of Rakesh Mohan. The Committee submitted its report *The India infrastructure report: Policy imperatives for growth and welfare* in the year 1996. The Committee undertook a detailed study of several sectors, including power, telecommunications, roads, and ports. Amongst other aspects, the Committee provided policy directions to activate the long-term debt market for infrastructure investments. Infrastructure Development Finance Company Ltd. (IDFC) was established in the year 1997 with the objective to build the nation (IDFC Ltd, n.d.). In 2006, the India Infrastructure Finance Company Ltd. (IIFCL) was set up by Government of India with an intention to increase private sector participation in the development of infrastructure projects.

Conclusion and Recommendations

There is a need to increase public investment on the one side with the allocation of increased budgetary resources for infrastructure, importantly in sectors such as transportation and renewable energy. It is crucial to create an environment with an adequate incentive mechanism for increased private sector investments and PPPs. This could be achieved through extending tax benefits, viability gap funding, and compensating the private sector to address unexpected risks in a project. On the one side, governments need to speed up the preparation of a shelf of projects and keep building a robust project pipeline, and, on the other, steps may be taken to encourage innovative financing mechanism such as infrastructure bonds, Green Fund, Blue Fund, REITs (real estate investment trusts), InvITs (infrastructure investment trusts), etc. The Government should continue to leverage funding from institutions such as the World Bank, Asian Development Bank (ADB), Asian Infrastructure Investment Bank (AIIB), etc. Innovative means of construction and advanced technologies by using smart tools and digital tools will be important in the future as this will enhance efficiency and reduce costs. An integrated approach to infrastructure planning that considers the inter-dependencies between sectors such as highways, rail, airports, ports, and waterways is essential for the seamless movement of goods and people. It is necessary to design infrastructure to be resilient to climate impacts such as extreme weather events, flooding, forest fires, rising sea levels etc. Active stakeholder engagement and ensuring inclusive development is critical in the future. The other aspects are considering adopting best practices by studying the successful models of implemented projects and taking up new pilots to test new approaches and technologies before they are scaled up. Conducting audits and evaluations of the projects that are implemented will also help in learning from mistakes. To protect project assets from cyberthreats, it is important in the future to prepare adequate policies and

regulations for the upgradation and maintenance of software and hardware in a programmatic way. It is also necessary to adequately train the project personnel to keep them updated on the technological advancements in AI, blockchain, and machine learning so as to prevent cyberthreats to the built assets.

In summation, the Government of India and state governments have, over the years since independence, been making extensive efforts to bridge the infrastructure gap through the development of policies, regulations, strengthening of institutional structures, as well as establishing newer institutions. In the National Highway sector, the rapid pace of development of better-quality roads, increasing the number of lanes, and building expressways etc., have helped facilitate faster movement of passengers and goods in the country. Maintenance of existing assets and de-congestion of heavy traffic roads is a critical factor that requires increased attention in the future. Road safety is another issue that needs to be dealt with appropriately. Greater focus on the development of railways from the early period after independence has helped the sector grow with the expansion of railway lines, moving from steam engines to diesel/electric locomotives, and especially in the last decade with the introduction of dedicated freight corridors and speedier trains like the Vande Bharat. In the future, there is a need to swiftly move towards modernisation of rolling stock, including safety and capacity expansion, to meet the growing demand. The focus of the central government on improving port facilities at the 12 major ports, increased hinterland connectivity, and the states' enhanced attention to the development of more than 200 minor ports with specific programmes like the Sagarmala has increased the effectiveness of port facilities in the country. However, much needs to be done to address the capacity constraints at ports, increasing draught to allow larger vessels to enter the ports, and improve connectivity to important trading centres within the country. In the airport sector, the maintenance of existing infrastructure and the building of

newer airports for increased trade and economic growth become critical. Skill development of pilots, engineers for repairs and maintenance, cargo handling, and others concerned is important for the enhanced growth of the sector. Similarly, in the energy sector, India needs to increase its generation capacity, improve distribution networks, and promote renewable energy sources. Access to electricity, especially in rural areas, remains a challenge. Timely financing of identified projects is another important factor which would ameliorate delays in construction and cost overruns. Lastly, streamlining clearances and approvals for the projects by reducing bureaucratic hurdles is an essential element to be considered for the future.

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