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RAILWAYS IN MOTION

VISION 2023
TO VIKSIT BHARAT 2047

INDIAN RAILWAYS IN MOTION – VISION 2030 TO VIKSIT BHARAT 2047

Indian Railways has prepared a National Rail Plan (NRP) for India – 2030. The Plan is to create a 'future ready' Railway system by 2030. The aim of NRP is to formulate strategies based on both operational capacities and commercial policy initiatives to increase modal share of the Railways in freight to 45%.

The National Rail Plan 2030

The NRP has been created with the following vision …. "**To enhance rail freight share … …to prepare a compressive strategy for the Rail Sector in the form of National Rail Plan for creation of adequate capacity by 2030 that will cater to the demand up to 2050 i.e. to develop capacity ahead of demand**" Keeping the vision in mind, the NRP is planned to meet the following objectives……

1. To assess Present & Future Modal Share of Railways

2. To examine Capacity Utilization of Existing Railways Assets

3. To provide a Long-Term Rail Development plan to meet demand for:

- Dedicated Freight Corridor
- High Speed Rail
- Doubling of lines
- Signalling
- Electrification of Entire Network
- 160 kmph Speed on Selected Corridors
- Passenger Stations
- Freight Terminals
- Rolling Stock

4. To identify Options, Evaluation and Prioritization of projects

5. Funding Requirements and Financing Strategies for identified projects

Key Objectives of
National Rail Plan 2030

The key objectives of the National Rail Plan are:-

- Formulate strategies **based on both operational capacities and commercial policy initiatives** to **increase modal share of the Railways in freight to 45%.**

- Reduce transit time of freight substantially by **increasing average speed of freight trains to 50Kmph**.

- As part of the National Rail Plan, Vision 2024 has been launched for accelerated implementation of certain critical projects by 2024 such as

    1. 100% electrification,
    2. multi-tracking of congested routes,
    3. upgradation of speed to 160 kmph on Delhi-Howrah and Delhi-Mumbai routes,
    4. upgradation of speed to 130kmph on all other Golden Quadrilateral-Golden Diagonal (GQ/GD) routes and elimination of all Level Crossings on all GQ/GD route.

- Identify new Dedicated Freight Corridors.

- Identify new High Speed Rail Corridors.

- Assess rolling stock requirement for passenger traffic as well as wagon requirement for freight.

- Assess Locomotive requirement to meet twin objectives of 100% electrification (Green Energy) and increasing freight modal share.

- Assess the total investment in capital that would be required along with a periodical break up.

- **Sustained involvement of the Private Sector** in areas like operations and ownership of rolling stock, development of freight and passenger terminals, development/operations of track infrastructure etc.

- 58 Super critical Projects of a total length of 3750 kms and 68 Critical Projects of a total length of 6913 kms, have been identified for completion by 2024.

Current Industry Scenario

Keeping in sync with the Mantra, "**Hungry For Cargo**", Indian Railways has made sustained efforts to improve the ease of doing business as well as improve the service delivery at competitive prices which has resulted in new traffic coming to railways from both conventional and non-conventional commodity streams. The customer centric approach and work of business development units backed up by agile policy making has helped the Railways breach the 1400 MT Freight Loading mark for first time ever in Financial Year-2021-22. Then in the following FY 2022-2023, Indian Railways registered highest ever Freight Loading of 1512 MT. Indian Railways recorded monthly freight loading of 135.46 MT in Jun 2024, an improvement of 10.07% over last year freight loading for the same period.

- The railway sector in India aims to contribute about 1.5% to the country's GDP by building infrastructure to support 45% of the modal freight share of the economy.

- Two Dedicated Freight Corridors (DFC), one on the Western route (Jawaharlal Nehru Port to Dadri) and another on the Eastern route (Ludhiana to Dankuni), have been fast-tracked.

- Railways have earned INR 14,798.11 Cr in Jun 2024 against INR 13,316.81 Cr over the last year from Freight loading.

- New Line/ Doubling/ Gauge Conversion: 5,243 km of conversion have been achieved during 2022-23 as against 2,909 km in 2021-22. The average daily track laying in FY23 comes out to be 14.4 km per day, which is the highest ever.

- As on date, 102 Vande Bharat train services are operating across the Indian Railways.

- Currently, a total of 2,359 trips of Kisan Rail trains have been operated on 167 routes, wherein nearly 7.9 Lakh Tonnes of consignments have been transported.

- 6,521 (98.8% of total stations) stations have been equipped with Electrical/Electronic Signalling Interlocking System up to 31.12.2023.

- Under the Union Budget 2024-25, Indian Railways has been allocated a highest ever capital outlay of INR 2.62 Lakh Cr.

- The average Freight Train speed has increased to 44.36 kmph during 2021-22 compared to 42.97 kmph during 2020-21 (+3.23 %) (up to 31.12. 2021).
  With the above efforts, the National Rail Plan aims to increase share of freight traffic from current 27% to 45% by 2030.

Status of Railway Freight in India

Findings of NITI Aayog

- Rail's share in freight transportation in India **has been declining since 1951.**
- In 2020, it **stood at merely 18% as compared to road's share of 71%.** This is due to insufficient rail capacity, especially on certain high-density routes.
- As of 2021, there are **just 8,479 freight trains.**
- **Road-based freight transport**, which is more energy and emission intensive, **has grown at the expense of the Indian Railways.**

Other

- The present **modal share of railways in freight is just 28 percent.**
- India's rail freight quantum as part of its total freight movement – including air, water and road **is only 36 per cent** vis-a-vis China's 47 per cent and the United States' 48 per cent.
- The Golden Quadrilateral and its diagonals which comprise merely 16 per cent of India's rail route length carry about 52 per cent of the nation's passengers **and 58 per cent of freight**.
- The national highways along these corridors are less than 0.5 per cent of India's highway network but carry 40 per cent of the nation's road freight. It shows that **these particular rail and road stretches are overloaded thereby leading to congestion and delays.**

Importance of Railway Freight

- Rail has **lower fuel costs** compared to road transport, especially when moving a high volume of freight.
- Rail also has fewer costs associated with drivers and typically has **better costs for drop trailer programs**.
- Transportation by rail is **more environmentally friendly**. Trains burn less fuel per ton mile than trucks.

- Trains **can handle high volumes of freight**. In fact, one double-stacked train can hold approximately the same amount as 280 trucks. Its capacity is elastic which can easily be increased by adding more wagons. Also, it is a cheaper mode of transport.

- Railways have standardized transit schedules and don't share their tracks with the public like trucks do with the road. For that reason, **trains aren't hindered by traffic** and weather the same way as trucks.

- Railway is the **safest form of transport**. The chances of accidents and breakdowns of railways are minimum as compared to other modes of transport

- Using rail transport as part of an intermodal strategy can have significant benefits. Intermodal is the use of two or more modes for transporting freight. When combining road and rail, trains are used for the long-haul portion of the shipment. Trucks are used to bring freight from the origin to the terminal and then from the terminal to the destination, which is referred to as drayage.

Steps taken by the Government to boost Rail Freight

- 657 Km of **Eastern and Western Dedicated Freight Corridors (DFC)** has been commissioned in 2020-21.

- **Speed of Freight Trains has been doubled** in 2020-21 to 46 kmph from 23 kmph in earlier years.

- Indigenously manufactured **12000 HP Electric locomotive have been introduced for freight movement**.

- **Real Time Information System (RTIS)** has been provided in 2700 electric locomotives for real time tracking of trains.

- **3 New Dedicated Freight Corridors have been identified namely –**

    1. East Coast corridor from Kharagpur to Vijayawada,
    2. East – West Corridor from Bhusawal to Kharagpur to Dankuni and
    3. North-South corridor from Itarsi to Vijayawada.

- Vision 2024 document has been prepared **to develop infrastructure by 2024 to enhance model share of Indian railways in freight transportation.**

- Capacity enhancement work like **doubling/Multitracking have been prioritized** into critical and Super Critical projects for time bound completion.

- At least 505 projects - including 263 doubling, 185 new lines and 57 gauge conversion - are under various stages of execution.
- Dedicated Kisan Rail initiative that allows the movement of perishables such as fruits, vegetables, poultry, meat, dairy and fishery products from production/surplus regions to consumption/deficient regions.

Operational Concerns about the Plan

- **300km + lead share of Rail traffic** has come down from 52% to 32%. NRP plans to arrest and reverse this trend and increase Railways share from 26% to 45% by 2050 . For this to happen railway's cost needs to come down by 30%. The forecast is that total freight traffic will increase from 4700MT to 15583MT and for carrying 45% share, Railways needs to build infrastructure for handling 7012 MT by 2050 , from present level of 1250 MT . To achieve this target Railways aims to encourage private ownership of Rolling stock with innovative designs alongside private freight and passenger trains, wagon holding is expected to increase from 3 lakhs to 11 lakhs , locomotives from 12000 to 47000 and coaches to 1, 50,000 by 2051. Passenger traffic is estimated to grow from 8080 million per year to 19469 million per year.

- **To eliminate detentions** , it is proposed to construct 52 bypasses, and 48 flyovers along Freight and high speed corridors

- **Policy initiatives for** -

    1. PFTs (Private Freight Terminals) / ICDS (Inland container Depots)/ Private sidings - the plan must have provision for lease of land for connectivity, reduction in staff costs and development charges.

    2. Upgradation of existing goods sheds / terminals - the plan envisages private investment in existing facilities and open access for all types of traffic

    3. New Common User Model – All public land for common user facilities and IR to give support on land acquisition (land as equity).

- Various incentives for **reducing cost of transportation** have been enunciated.

- **Funding requirements** for implementation of NRP is estimated to be around 500 billion USD.

- Multiple steps are proposed **to attract private investment in Rail sector** – such as Bilateral international funding arrangements like one with JICA of JAPAN for the Ahmedabad – Mumbai Bullet Train project is one such move.

Way Ahead

As national freight activity grows about five-fold by 2050, India's freight transport ecosystem has a critical role to play in supporting India's ambitious priorities which include global competitiveness, job growth, urban and rural livelihoods, and clean air and environment.

Improved rail mode share, increased logistics efficiency and clean vehicles are the building blocks for a transformative freight paradigm that is within India's reach.

Need of the hour:

1. Improving existing network infrastructure by increasing axle loads,
2. increasing train length,
3. enabling trains to move faster,
4. adding new network capacity by developing specialized heavy-haul corridors
5. more dedicated freight corridors
6. identifying and upgrading corridors with high potential for intermodal transport and
7. ensuring better modal integration across rail, road, and water.

This freight paradigm will meet the plan objectives of being **cost-effective** with reduced transport costs**, clean and optimized** with improved modal share and operational efficiency.

Indian Railways 2050 - Focus on innovation, efficiency, and inclusivity.

- **Technological advancements**

  With implementation of the above Plan, by 2050, Indian Railways will have undergone a profound technological transformation, leveraging cutting-edge innovations to enhance its operational efficiency and **safety standards** . The implementation of high-speed rail networks, magnetic levitation (Maglev) trains, and hyperloop technology will revolutionize long distance travel, reducing travel times and enhancing connectivity between major cities. Additionally, the widespread adoption of artificial intelligence (AI), the Internet of Things (IoT), and blockchain technology will optimize railway operations, predictive maintenance, and passenger safety measures.

- **Sustainability measures**

  By aligning with global efforts to combat **climate change**, Indian Railways in 2050 will prioritize sustainability measures to minimize its environmental footprint. The integration of renewable energy sources such as solar and wind power will reduce dependency on fossil fuels, leading to a significant reduction in carbon emissions. Furthermore, the introduction of eco-friendly train designs, including energy-efficient locomotives and lightweight materials, will contribute to a greener and more sustainable rail network. Additionally, initiatives to promote eco-friendly practices among passengers, such as waste recycling and water conservation, will further enhance the environmental sustainability of Indian Railways.

- **Enhanced passenger experience**

  By 2050, Indian Railways will offer an unparalleled passenger experience, characterized by comfort, convenience, and seamless connectivity. State-of-the-art train interiors will prioritize passenger comfort, featuring ergonomic seating, entertainment systems, and onboard amenities. Advanced ticketing systems, including mobile apps and contactless payments, will streamline the booking process and ensure hassle-free travel. Moreover, the integration of high-speed internet connectivity and digital entertainment platforms will enhance the onboard experience, catering to the evolving needs of tech-savvy passengers. Additionally, enhanced accessibility measures for differently-abled passengers, including wheelchair-friendly facilities and sensory-friendly accommodations, will promote inclusivity and ensure equitable access to rail travel for all.

- **Infrastructure development**

  In 2050, Indian Railways will boast of a modern and robust infrastructure network, characterized by state-of-the-art stations, rail terminals, and transit hubs. The redevelopment of existing stations into multi-modal transit hubs will integrate rail, metro, and bus services, facilitating seamless intermodal connectivity for passengers. Additionally, the expansion of high-speed rail corridors and **dedicated freight corridors** will optimize freight transportation, bolstering India's logistical capabilities and boosting economic growth. Furthermore, investments in smart infrastructure, including digital signaling systems and autonomous train operations, will enhance safety standards and operational efficiency across the rail network.

- Railways play and will continue to play a crucial role in building a nation on social, economic and security fronts. By 2050, Railways will play a vital role in improving the productivity of the transportation system providing the Indian economy an edge over its global peers, strengthening social cohesion by promoting mass mobility and

achieving **environmental goals**. If the Railway is able to move 50% of the country's cargo, then it might bring down logistics costs down to 8% from current levels of double digits.

- Indian Railways by running regular fast trains at 200+ KMPH, connecting major cities spaced 500-800 km apart in less than 4 hours, will provide a better option for commuters than Airways.

- Indian Railways in 2050 will become a carbon-neutral entity making a major contribution towards India achieving environmental SDG goals.

- Safety will be a priority with no Railway- Roadway crossings, with fencing along the tracks, modern signalling systems with modern safety features like anti-collision systems and capability of normal operations under adverse weather conditions like fog.

  INDIAN RAILWAYS of 2050 will adopt state-of-the-art technology for a safe, secured and efficient means of transportation for both freight and passengers. Digitalisation of systems will also lead to greater transparency giving a boost to ease of doing business. Modern cargo and passenger terminals will address issues connected with first and last-mile connectivity bringing down the lead time from doorstep to doorstep.

- **Action plan**

  For this vision cum dream to translate into reality, few steps have been initiated but many more will need to be taken. Indian Railways is a unique system with a track Gauge of 1676 mm called Broad Gauge, which is very different from the standard guage of 1435 mm. This was the reason that back in 2018 when India started working on its first semi-high-speed train - Vande Bharat - the work on its design had to be done from scratch. Similarly for the Anti-collision device - **KAVACH** an indegenous design at a great cost had to be made. With funding of 30-40 billion USD, the government is spending for Railways annually on CAPEX should bring about the desired progress!

  Rail network expansion on an annual basis has increased to around 5000 kms, with 100% Electrification of Tracks, Electronic signalling system and coverage of KAVACH across the network is underway. Major contracts have been awarded for the supply of freight wagons, high-speed Railway coaches and high-horsepower electric locomotives. All these measures would lead to the supply of adequate quantity of rolling stock required for the transportation of men and material; there will be an end to the waiting list of passengers and pending indents at goods terminals.

The action Plan also includes measures to modernize freight and coaching terminals to bring down first and last-mile delays/lacunas. The government has proposed for - station redevelopment schemes and 100 Gati Shakti Terminals (Multi-Modal cargo terminals).

- **International Connectivity**

In today's world with geopolitical uncertainties, Railways can play a major role in developing alternate trade routes to international sea shipping lanes. China has already demonstrated the potential of Railways in international trade through its Belt & Road Initiative. In the vision for Indian Railway in 2050 there should be a plan to have a Trans Asian Railway, connecting Hanoi in Vietnam to Istanbul in Turkey via ASEAN countries including Bangladesh, India, Pakistan, Iran, Iraq and Turkey. Rail lines should be constructed connecting northeastern states of India like Mizoram, South Assam, Manipur and Tripura with Kolkata via Bangladesh. Similarly, a Rail line must be constructed to connect Kathmandu the capital of Nepal with the Indian Railways network. Rail Connectivity of Manipur and Nagaland with Yangoon, a seaport of Myanmar will provide a boost to the economy of the region.

Thus the vision for Indian Railways in 2050 will be a bold and transformative agenda that embraces technological innovation, sustainability, and passenger-centricity. By leveraging cutting-edge technologies, prioritizing sustainability measures, and enhancing the passenger experience, Indian Railways will emerge as a global leader in the transportation sector, driving economic growth, fostering inclusivity, and connecting communities across the nation. Through concerted efforts and strategic investments, we can realize this visionary roadmap and unlock the full potential of Indian Railways as a catalyst for progress and development – Viksit Bharat - in the 21st century.

Viksit Bharat 2047

This Plan envisages a vision to transform India into a developed nation by 2047, the 100th year of independence. This vision encompasses various facets of development, such as economic growth, environmental sustainability, social progress and good governance, to make India a developed nation by 2047. India's vision for a 'Viksit Bharat' by 2047 calls for all stakeholders to work in cohesion, doubling down on efforts to unlock the nation's true potential by uniting industry, innovation, and gender equality for global prosperity.

Railways & Viksit Bharat:

Railway modernisation is the key to India's economic growth and a way forward to achieve the Viksit Bharat or developed India goal by 2047.

Demand for speedy, comfortable, safe and reliable rail transport has burgeoned over the years in tandem with India’s growth. That has spurred a transformation of Indian Railways, focused on safety, enhancement of capacity and induction of modern technology. The transformation is backed by government policies and initiatives such as the National Rail Plan, Amrit Bharat Station Scheme, Gati Shakti Multi-Modal Cargo Terminal, and Electric Locomotive Factory-Madhepura. After all, for the nation to realise its progressive socio-economic goals, it is important that Indian Railways lives up to its fabled moniker – ‘lifeline of the nation’. Under the Viksit Bharat vision, the Viksit Rail component encompasses modernization of railway infrastructure, track and rolling stock, electrification, incorporation of advanced technologies for faster, safer and comfortable journey and network expansion to unconnected areas. The modernisation will ride on an investment plan of Rs 10-12 lakh crore over the next five years, complete with modern world-class facilities. Following the successful deployment of Vande Bharat, new generation of trains – Vande Metro, Vande Sleepers, Amrit Bharat, Namo Bharat, among others – are being developed and rolled out rapidly. To provide connectivity to hitherto unserved areas of the country, Indian Railways is regularly achieving engineering and technological marvels in tunnelling and bridge construction. Indigenization of technology has been a strategic initiative, aimed at reducing dependency on foreign technology and enhancing self-reliance. This involves expansion of the Indigenous train protection system Kavach, modernization of production units, workshops and factories to improve their efficiency and ability to manufacture modern rolling stock and components domestically, and adoption of AI and big data for predictive maintenance. In line with the National Hydrogen Mission, Indian Railways is likely to introduce its first hydrogen train this year. This initiative is part

of a broader effort to enhance the sustainability and efficiency of the national transporter. To segregate freight and passenger traffic and cater to specific requirement, the government is developing dedicated freight corridors (DFCs). Under PM Gati Shakti, three economic corridors – (i) energy, mineral and cement corridors, (ii) port connectivity corridors (iii) high traffic density corridors – have been identified to enable multi-modal connectivity and to decongest and speed up railway network. The new corridors are expected to comprise of over 400 smaller projects and add nearly 40,000 km of new tracks over the next 6-8 years. All these initiatives will help Indian Railways in setting and achieving new world standards.

Indian Railways at a Glance

There is a long way to go for Modernization of Railways for Viksit Bharat -

Strategies to improve Rail Share:

Over the past decade, freight revenue accounted for an average 67% of the GRR of IR. Of the volume of freight traffic carried by the mammoth transporter, nearly 48% is coal traffic. However, with the country's objective to reduce its carbon footprint and industries exploring hydro and solar power, coal traffic may decline in the long term, impacting freight traffic. The IR will likely consider the following options for maintaining and enhancing freight share and revenue:

Truck-on-train: A model like Banas dairy's truck-on-train may be explored for other commodities, such as perishables and automobiles, to provide faster transportation and reduce carbon emission.

Estimated arrival time versus consistency: As passenger trains are timetabled and given first preference, freight trains wait at or before junctions for want of path. As per a report by TERI, the wait time may be 2-6 hours and may lead to increased transit time. Informing customers about approximate transit time and maintaining consistency with regard to arrival time may enable customers to plan onwards dispatch of freight effectively.

Operationalisation of freight corridors: Due to the above mentioned constraint, operationalisation of DFCs, economic corridors and port connectivity projects will bifurcate freight and passenger traffic, provisioning line capacity for specific purposes. This will increase the average speed of trains, reduce travel time and in turn lead to reduction of operational cost.

Indigenisation of railway technology: Indigenisation of technology is a strategic initiative of IR, to reduce dependence and enhance self-reliance. This involves:-

1. **Rolling stock manufacturing**

• Vande Bharat Express is the first semi-high-speed train, designed and manufactured by the Integral Coach Factory (ICF) in Chennai. It showcases India's capability to produce modern, highspeed trains.

• IR has gradually phased out traditional ICF coaches in favour of Linke Hofmann Busch (LHB) coaches, which are safer and more comfortable. Manufacturing of these coaches has been indigenised.

• IR manufactures various electric and diesel locomotives in the domestic market, including the WAG-12 and WAP-7 models.
• IR also plans to run 35 hydrogen trains under the Hydrogen for Heritage initiative. It aims to incorporate hydrogen fuel cells as an alternative to diesel engines. The first of these trains is expected to run on the Jind-Sonipat section of Northern Railways.

2. **Railway infrastructure and signalling**

• Efforts are underway to develop indigenous signalling and train control systems such as the Train Collision Avoidance System (TCAS), which enhances safety and reduces reliance on foreign systems.
• Indigenous technology for laying, welding and maintenance of tracks has been developed to improve the quality and durability of railway tracks.

3. **Electrification and green energy**

• IR is on track to achieve 100% electrification of its broad-gauge network, which will curb carbon emissions and reliance on imported fuels.
• IR has been investing in solar and wind energy projects to meet a significant portion of its energy needs through renewable sources.

4. **Digitalisation and IT systems**

• IR has developed indigenous software solutions for passenger reservations, freight management and operations. Systems such as the Centralised Traffic Control (CTC) and Real-time Train Information System (RTIS) enhance the overall efficiency.

5. Research and development

• The Research Designs and Standards Organization (RDSO) plays a pivotal role in indigenisation of railway technology. RDSO is the sole R&D arm of IR, which acts as the technical advisor to the railway board, zonal railways and production units. Collaboration with private sector companies and start-ups is encouraged to foster innovation.

6. Make-in-India initiative

• The Make in India initiative supports indigenisation of railway technology by encouraging domestic production of railway components and systems. IR is increasingly engaging in public-private partnerships (PPPs) to boost local manufacturing capabilities and technology development. Vande Bharat trains, made under this initiative, showcase India's capability to produce modern, high-speed trains.

• IR is also focussing on sourcing and manufacturing components locally for passenger services.

7. Modernisation of workshops and factories

• IR is modernising its production units, workshops and factories to improve efficiency and ability to produce modern rolling stock and components domestically. It is constantly focused on training and upskilling the workforce to handle advanced technologies and manufacturing processes.

8. Passenger amenities and services

• IR is focused on development of indigenous designs and technologies to modernise railway stations, which includes set up of smart stations with better amenities for passengers. 1,309 Amrit Bharat stations have been identified to offer passengers modern amenities and better accessibility.

9. Export potential

• As IR develops indigenous technologies, there is growing potential to export these solutions to other countries, especially in the developing world. There are plans to launch a standard gauge version of Vande Bharat Trains, which can be exported to different countries.

10. Advanced traffic management & control systems

IR needs to deploy advanced traffic management and control systems to enhance safety, efficiency and reliability across its vast network. A few key systems implemented or developed are

- Traffic collision avoidance system (TCAS): is an indigenous automatic train protection (ATP) system developed by RSDO along with other industry players. It prevents train collisions by automatically controlling the train's speed in case of any signal violation or if the train is on a collision course. IR is rolling out TCAS across high-density routes, significantly enhancing safety.

- Centralized Traffic Control (CTS) systems enable centralised monitoring and control of train movements across large sections of the railway network. This system optimises train operations, reduces delays, and improves overall network efficiency. It facilitates real-time tracking of trains, automated signalling adjustments and centralised decision-making for routing and scheduling of trains. CTC systems are being implemented in phases across high-density corridors and major junctions.

- Automatic Train Control (ATC) : is an advanced system that ensures trains adhere to speed limits and signals by providing automatic control inputs to the braking and propulsion systems. ATC is being implemented in suburban networks and high-speed routes to ensure safety and efficiency.

- Real Time Information System (RTIS) : is an advanced system for real-time tracking and monitoring of train movements. It leverages GPS and satellite communication to provide accurate locations. It is being deployed across various zones, enhancing the ability to provide timely information to passengers and improve operational efficiency.

- Electronic Interlocking (EI) systems replace traditional mechanical and relay-based interlocking systems and offer a more reliable and flexible method of controlling train movements through junctions and stations. It provides enhanced safety through fail-safe operations and remote control capability and has less maintenance requirements. IR is rapidly upgrading to EI systems at key junctions and stations across the network.

- KAVACH: Indigenous Automatic Train Protection (ATP) System KAVACH is an indigenous ATP system developed by IR to prevent train accidents by

controlling train speeds and preventing collisions. It facilitates automatic braking, collision avoidance, SOS alerts, and adherence to speed limits. KAVACH is being installed on busy rail corridors as a cost-effective solution for enhanced safety.

- Predictive maintenance systems use data analytics, AI, and IoT to monitor the condition of tracks, rolling stock and other infrastructure components on a real-time basis, so as to predict failures before they occur. IR is increasingly adopting these systems to reduce downtime and improve safety.

- High Density Network (HDN) projects aim to enhance the capacity of busy routes through advanced signalling, improved track infrastructure, implementation of double-line tracks and better traffic management systems. These enhancements are being prioritised on high-density corridors such as Delhi-Mumbai and Delhi-Howrah routes.

- Integration of 5G networks and IoT devices into the railway infrastructure will enable real-time data transfer and monitoring of train and track conditions, enhanced connectivity and stronger operational control. IR plans to leverage the 5G technology for better connectivity and control across its network.

- Technology for freight transport services: IR has been adopting various technologies to modernise and improve freight transport services. These technologies play a key role in enhancing efficiency, reliability and sustainability of freight transport services and are aligned with broader goals of improving logistics and supply chain management across the country. Some key technologies being implemented or explored for freight transport:

    1. Freight Operations Information System (FOIS) - is a comprehensive system that digitises and manages freight train operations, including scheduling, tracking and billing. It allows customers to track their consignments real-time and improves management of rolling stock and resources.

    2. RFID-Based tracking IR is deploying radio-frequency identification (RFID) tags on wagons and locomotives to enable real-time tracking. This system offers greater visibility on movement of freight trains, reduces delays and improves asset management.

- Dedicated Freight Corridors (DFC): DFCs such as the Eastern and Western DFCs are being developed to separate freight traffic from passenger traffic, allowing for faster, efficient movement of goods. These corridors are equipped with modern signalling systems, high-capacity tracks, and advanced logistics infrastructure.

- Electronic in-train information system (ETIS): ETIS provides real-time data on status of trains, including speed, location and other operational parameters. This improves monitoring and control of freight operations, ensuring timely delivery.

- Long-haul and high-capacity wagons: IR is introducing long-haul freight trains and high-capacity wagons to transport larger volume of goods more efficiently. These wagons are designed for specific commodities, such as steel, coal, or containers, optimising loading capacity and reducing the number of trips required.
- AI and Big Data Analytics: AI and analytics are used to predict when maintenance is needed on tracks and rolling stock, reducing the risk of breakdowns and improving reliability of freight services. AI-driven systems are optimising routes and schedules based on real-time data, traffic patterns and historical performance, ensuring timely delivery of goods.

- Automated and digitalised freight systems: IR has introduced online payment systems and digital platforms for booking and managing freight services, making the process more accessible and user-friendly for customers.

- Smart Freight Operations Optimisation and Real Time Information (SFOORTI) is a dashboard that provides real-time information on freight operations, helping in better planning and optimisation of resources.

Need for Railway Safety for Viksit Bharat 2047:

While IR is making continuous efforts to ensure safe transport of people and goods, every time there is an accident, the efforts come under scrutiny. These accidents highlight the urgent need for comprehensive reforms and stronger protocols to ensure the well-being of passengers and prevent devastating accidents in future. Railway safety is of paramount concern for all as –

- Carry high volume of passengers: With IR operating the world's fourth-largest rail network and millions of people relying on the system for their daily commute, ensuring safety becomes crucial. IR needs to maintain the trust and confidence of the public in the system. Instances of accidents and safety lapses can erode the reputation of the railways and faith of the passengers in the reliability and security of train travel.

- Economic impact: Railways is a crucial component of the country's transportation infrastructure and plays a vital role in the economy. Any disruption due to safety aspects can have an adverse impact on industries and businesses.

- Global standards: The focus on safety is not only crucial for passenger well-being, but also to align with global best practices and meet global standards. Countries such as Japan, China, and some European nations have demonstrated that high safety standards are achievable. Comparison with such nations and benchmarks is bound to happen.

- Regulatory compliance: Safety is a regulatory requirement and a legal obligation for IR. Adherence to safety protocols and regulations is not only necessary to prevent accidents but also to comply with national and international standards. This ensures that the railways operate within a framework that safeguards the well-being of passengers.

Safety performance should be monitored periodically, and few initiatives undertaken by IR, to improve safety of train operations include

- Elimination of level crossings: IR has been working towards elimination of manned level crossings, which are prone to accidents. Efforts are made to incorporate underpasses and overpasses instead. This often leads to an increase in project cost and development timelines. But since it reduces accidents and casualties, this mechanism has been adopted.

- Automatic block signalling: Automatic block is a system in which movement of trains is controlled by stop signals, which are operated automatically by passage of trains past signals. The automatic signalling arrangement facilitates an increase in line capacity without any additional stations being constructed and maintained.

- Interlocking: An arrangement of signals, points and other appliances, operated from a panel, so interconnected by electrical locking that their operations must take place in proper sequence to ensure safety. Till May 21, 2023, 6,427 stations were equipped with electrical/electronic interlocking systems to eliminate accidents

caused by human failure. Additionally, interlocking of level-crossing gates has been provided at 11,093 locations.

- Rashtriya Rail Sanraksha Kosh (RRSK) : The RRSK is a fund created in 2017-18 with a corpus of Rs 1 lakh crore over a period of five years, for critical safety related works. It focuses on replacing and renewing tracks, bridges, signalling, rolling stock, training, and amenities for safety critical staff. The RRSK works are to be funded from Gross Budgetary Support (GBS) and railways revenue/resources, including mobilisation of resources through extra budgetary resources (EBR), as per Ministry of Finance guidelines.

- Deployment of KAVACH: Kavach is an indigenously developed anti-collision train system (developed by RDSO). It is a technology intensive system, which requires safety certification of the highest order. The system assists the locomotive driver in running the train within specified speed limits, by automatic application of brakes and helps the train run safely during severe weather conditions (fog, rain, etc.). The first field trials for passenger trains were conducted in February 2016. Based on experience gained and independent safety assessment of the system by a third party (independent safety assessor: ISA), three firms were approved in 2018-19, for supply of Kavach. Subsequently, Kavach was adopted as a national ATP system in July 2020. Till December 2023, Kavach was deployed on 1,465 route kms and 139 locomotives (including electric multiple unit rakes) on South Central Railways. Efforts are being made to develop more original equipment manufacturers to enhance the capacity and scale up the implementation.

- Video Surveillance Systems: The IR is taking strides from mere CCTV video surveillance to include powerful analytics. AI is being integrated to provide facial recognition, license plate recognition, people counting and motion detection on station premises. Camera analytics can help colour search, differentiate and identify people, search of person based on attributes, monitor attentiveness of staff, unauthorised entry, etc. RailTel is already providing IP-based video surveillance systems at stations and train coaches. This system has video analytics and facial recognition software to ensure proactive high-tech security at railway stations. RailTel is also providing a monitoring facility in all railway zonal/divisional headquarters, which will notch up the surveillance activity, and ensure better security for passengers and railway properties. The target is to provide video surveillance systems at 5,102 stations, of which 308 stations have already been covered.

- Interventions such as equipping locomotives with vigilance control devices (VCD) to ensure alertness of loco pilots, implementation of fog safety devices (FSD), a GPS-based device provided to loco pilots in fog affected areas. This device would enable them to gauge the distance of approaching landmarks such as signals, level-crossing gates etc and thus ensure safety and security.

- Heading towards zero accidents As India continues to grow, demand for safe and reliable rail transport will increase. Continued investment in upgrading tracks, signalling systems, and rolling stock is crucial but technological interventions to strengthen railway safety and minimise human errors will be a crucial factor.

- Leverage advanced technologies and AI: Continuous adoption of technology to reduce human error, enhance safety monitoring, early detection of faults, and real-time decision-making enhance overall safety operations. AI can help manage extensive digital data from station data loggers and microprocessors on locomotives and trains effectively, and can filter out irregularities and highlight recurring abnormalities. Implementing AI-driven predictive maintenance practices for real-time monitoring and response can shift maintenance efforts from where not required towards sections where it is required on priority, and to avert accidents.

- IOT adoption: Integrating legacy assets and infrastructure to communicate amongst themselves to trigger condition-based maintenance requirements needs to be taken up.

- Safety training: Enhanced training modules to sensitise railway staff and stricter adherence to operating procedures and protocols can reduce human error in operations.

- Start-up incubator/ accelerator: Encouraging research in developing innovative safety technologies and practices, tailored to Indian conditions, can lead to breakthroughs in preventing accidents. The innovation policy of IR – 'Start-ups for railways' aims to leverage innovative technologies, developed by Indian start-ups/micro, small and mid-sized enterprises/ innovators/entrepreneurs, to improve operational efficiency and safety . Under this, grant of up to Rs 1.5 crore on an equal sharing basis, with provision of milestone-wise payment, may be provided to innovators for development of a prototype. Upon successful testing of the shortlisted prototype, enhanced funding will be provided to scale up deployment. Establishment of a railway technology-focused start-up incubator/accelerator may be explored. Every alternate year, a cohort of 2-5 start-ups may be selected, groomed and guided by senior railway/ RDSO officials. Even if these result in 2-3

practical innovations over a period of few years, it would be an encouraging sign for the startup ecosystem.

- Strengthen maintenance practices: Prioritise track maintenance, inspections, and infrastructure upgrades to prevent derailments and ensure safe operations. IR needs to deploy mechanised methods of track maintenance and leverage improved technologies to enhance the efficiency and effectiveness of maintenance activities.

- Expand the vendor base: For exponential implementation, robust availability of components and equipment is required. To ensure substantial, reliable and continuous supply of components and equipment, there is need to enhance existing vendor capacity and to bring in new vendors under the shortlisted/ empanelled list.

Need to build a Sustainable Railway System

Indian Railways is actively working on several initiatives to reduce carbon footprint and promote environmental stewardship. These initiatives highlight ' commitment to sustainability and its role in supporting India's broader environmental and climate goals. By adopting these technologies and practices, IR strives to become a greener and more sustainable mode of transport. Here are some key initiatives related to decarbonisation, solar energy, and other green technologies:

- Electrification of rail routes Under the Mission 100% electrification: IR aimed to achieve 100% electrification of its broad-gauge network and planned to gradually shift towards green energy usage for traction and non-traction purposes. IR is inching closer to its mission, with the share of electrified tracks increasing from 24% in 2017 to 40% in 202 and 86.7% by the end of 2022-23. After full electrification IR would become the world’s largest green railway network. Electrification reduces reliance on diesel locomotives, significantly lowering carbon emissions and operational cost. Electricity used for running electric trains is increasingly being sourced from renewable energy, contributing to the overall reduction of carbon footprint. Railways is also in the process of converting majority of its diesel engines into electric ones to further reduce carbon footprint.

- Solar energy initiatives: IR has set a target to install 20 GW of solar power capacity by 2024. Solar panels are being installed on rooftops of railway stations, workshops, and other buildings, as well as on vacant railway land. Few trains have been equipped with solar panels on roofs to power lights, fans and other electrical systems within coaches, reducing the need for diesel generators.

- Wind energy projects: IR is also investing in wind energy projects to generate power for its operations. Wind turbines have been installed in several locations, contributing to the renewable energy mix within overall power consumption.

- Energy efficiency improvements: Trains equipped with regenerative braking systems which convert kinetic energy during braking into electrical energy, which is fed back into the grid or used to power other trains. This reduces energy consumption and enhances efficiency. IR is adopting energy-efficient appliances and systems across its operations, including LED lighting, energy-efficient heating, ventilation and air-conditioning (HVAC) systems, and other low-power devices.

- Biofuels and alternative fuels: IR has initiated trials of blending biodiesel with conventional diesel for its diesel locomotives. This not only reduces greenhouse gas emissions, but also promotes use of renewable resources. Since railways is converting majority of its diesel engines into electric ones, some will be used for repair and shunting purposes. Some locomotives are being modified to run on CNG, which emits fewer pollutants compared to diesel.

- Green certifications and eco-friendly stations: Few railway stations have been certified with the Indian Green Building Council (IGBC) Green Rating. These stations incorporate eco-friendly designs, rainwater harvesting, waste management systems, and energy-efficient lighting. IR is implementing water conservation measures, including rainwater harvesting, water recycling plants, and use of treated wastewater for non-potable purposes.

- Sustainable procurement and waste management: IR is increasingly using eco-friendly material for construction, track laying and other infrastructure projects. This includes use of fly ash for concrete production and recycled materials for track ballast. Waste segregation and recycling programs have been introduced at major stations, along with deployment of bio-toilets in trains to manage human waste in an environment-friendly manner.

- Smart and sustainable urban transport: IR is collaborating with metro and urban transport systems to develop integrated, multi-modal transport solutions that reduce reliance on personal vehicles, thereby reducing urban congestion and pollution.

Inspite of all the above mentioned initiatives and measures **there is a Long Way to Go for Modernisation of Railways for Viksit Bharat!**

Although IR has made considerable progress, it still has a long way to go to meet present and future requirements and meet global standards. IR should adopt a strategic approach to address issues related to infrastructure, technology, sustainability, passenger services and overall operational efficiency. Focus should be on adopting modern infrastructure solutions such as expansion of the high-speed rail network beyond the Mumbai-Ahmedabad corridor to connect major cities, reducing travel time, boosting economic growth and fast-tracking doubling and quadrupling of tracks to increase the capacity of congested routes.

Despite various schemes, private sector participation has not been very forthcoming in railways, as compared to roads and airports. To some extent, private passenger and container train operations can be considered a success. Recently, multi-modal logistics parks (MMLPs) have shown some uptake. Going forward, innovative initiatives are required to leverage capital, efficiency and technology of the private sector.

In order to increase the modal share of railways in freight, so as to cut down on cost of logistics and enhance sustainability in cargo movement, a multitude of initiatives need to be taken. This includes rationalisation of fare, addressing connectivity issues, promoting private sector participation, development of customised wagons and containers, promoting multi-modal connectivity, making railways 'user-friendly' for industries such as e-commerce, and new marketing plans etc.

To transform IR into green railways, 100% electrification of broad-gauge network, energy efficiency of locomotives and trains, harnessing solar power at railway stations need to be initiated in right earnest. Railways may consider mandating all its offices and buildings to use solar panels, harvest rainwater, etc. Adoption of the RESCO model may be considered pan-India, not only to harness solar power, but also to utilise railway land parcels. Additionally, fast-tracking hydrogen-powered trains would provide multi-fold benefits in the direction of green transportation technology, to support zero carbon emission goals as a clean energy source. Deployment of more energy-efficient rolling stock and focus on lightweight material and regenerative braking systems, to reduce energy consumption, would eventually add up towards carbon neutrality.

Besides, adoption of advanced technologies such as AI and ML for predictive maintenance, efficient scheduling and improved safety. All railway coach factories and manufacturing units should be converted to smart manufacturing units with industry. IoT could be utilised for real-time monitoring of trains, tracks, and infrastructure and to ensure timely maintenance and minimal disruptions. Accomplishments of IR illustrate its commitment towards providing efficient, innovative and passenger-centric services, while contributing to the economic progress of the country, through modern infrastructure, safety measures and sustainable feats.