



RailTech 2023

Innovative Technologies for Indian Railways

August 2023

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Deepak Sood
Secretary General, ASSOCHAM

MESSAGE

Indian Railways, with its extensive network spanning vast terrains, has been a lifeline for millions of passengers and a crucial catalyst for the movement of goods across the country. The Indian Railways have played a critical and historical role in transforming our great nation. In recent years, our railway sector has undergone a remarkable change, driven by a relentless pursuit of innovation and the integration of cutting-edge technologies.

Today, we stand on the verge of a new era where emerging technologies hold the potential to revolutionize the way our railways operate, enhancing safety, efficiency, and sustainability. Embracing innovation is not merely an option; it is imperative to meet the growing demands and challenges faced by the Indian Railways. The seamless integration of digital advancements, data analytics, and automation has redefined the way we envision railway operations and infrastructure. High-speed trains, intelligent signaling systems, and smart maintenance practices have become synonymous with progress, safety, and efficiency. Technology has streamlined operations and improved the experience of passengers.

As we stride forward, sustainable development has become an integral aspect of policy perspectives in railway modernization. While the Government has been taking various initiatives towards creating a modern rail system, numerous challenges are also being faced with regard to the adoption of futuristic technologies, which make way for the private sector to support the Government. With the aim of decreasing delays and improving the overall performance of the railway system, operations and infrastructure, we need to optimize resource utilization and drive desired investment further in these solutions.

Railways being one of the key focus areas of ASSOCHAM, our efforts are to give valuable inputs to the Government for suitable policy formulation and bring comprehensive support to the industry. In this context, ASSOCHAM, jointly with Resurgent India, has prepared this report to highlight the major initiatives being taken by Indian Railways toward its modernization. We acknowledge the efforts made by the experts in preparing the report, which will be presented at the International Conference 'RailTech -2023: Innovative Technologies for Indian Railways.' We hope the document will provide essential insights to policymakers, industry leaders and stakeholders.

Deepak Sood



Jyoti Prakash Gadia
MD & CEO
Resurgent India

FOREWORD

India's railway system stands out for a variety of reasons in terms of size and density and is the third largest railway network in the world. From the implementation of the Kavach-Automatic Train Protection (ATP) system and the introduction of the engine-less, self-propelled Vande Bharat Express to introducing Vistadome trains to promote tourism, Indian Railway has taken several steps to modernise its infrastructure. However, to develop Indian Railways into a world-class transportation network, it needs to contend with overloaded infrastructure, traditional signalling systems and poor track maintenance, amongst others.

Even so, the rise in digitalisation in Indian Railways can help overcome these challenges. The use of quantum computing technology and data analytics is aiding to create an integrated transportation system and is helping the railways in this transformative journey. Digital technology, in general, has enhanced the operations of Indian Railways in terms of manufacturing, design, network efficiency, operational efficiency, punctuality, infrastructure, services, consumer experience, safety and maintenance.

The Government of India has also helped in the development of innovative technologies, products and technological solutions for the railways. It has motivated and encouraged entrepreneurs and innovators to come forward; the allocation of a record amount to the railways in the budget of 2023-24 reflects the government's commitment to the expansion and development of Indian Railways.

The report will provide essential insights into the much-needed technological solutions for the Indian Railways and help make the rail transport system in the country more efficient, sustainable, and accessible for all citizens.

I hope this report will pave the way for brainstorming creative solutions for the Indian Railways, and I wish ASSOCHAM the very best for the upcoming conference.

Jyoti Prakash Gadia

Jindal Rail Infrastructure Limited

Complete Freight Car Solutions

BFNV Wagon jointly designed by RDSO and JRIL with Industry Partner JSW Ltd. for steel coils



ACT1 (Autocar Taller wagon) jointly designed by RDSO and JRIL with Industry Partner IVC Logistics for SUV over SUV



SUV loaded on both decks

Innovative Freight Car Solutions for efficient transportation by rail

Industry centric solutions to improve rail modal share

Key differentiators: Proven capabilities in design & engineering, planning & execution and a constant focus on quality

State-of-the-art manufacturing facility

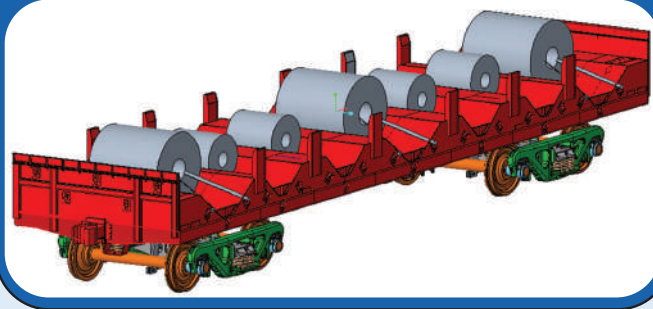
Services offered:

- ⇒ Multi-purpose high capacity wagons
- ⇒ Development of wagon designs to global practices
- ⇒ Indigenous development of wagon accessories

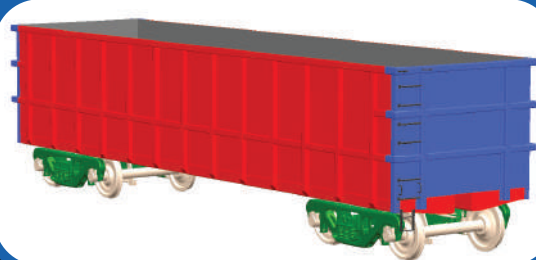
BOSM wagon jointly designed by RDSO and JRIL with Industry Partner JSPL



CMP (Coil Multipurpose wagon) for hot rolled/cold rolled coils, steel plates/billets/containers



Gondola wagon for Export



Optimisation using Smart Techniques



For more information please contact:

Jindal Rail Infrastructure Ltd., Jindal ITF Centre, 28, Shivaji Marg, New Delhi-110015
 Contact Nos. +911166463983/84, Email - Info.Jindalrail@jindalrail.com, Web: www.jindalrail.com

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1.

A Brief Overview

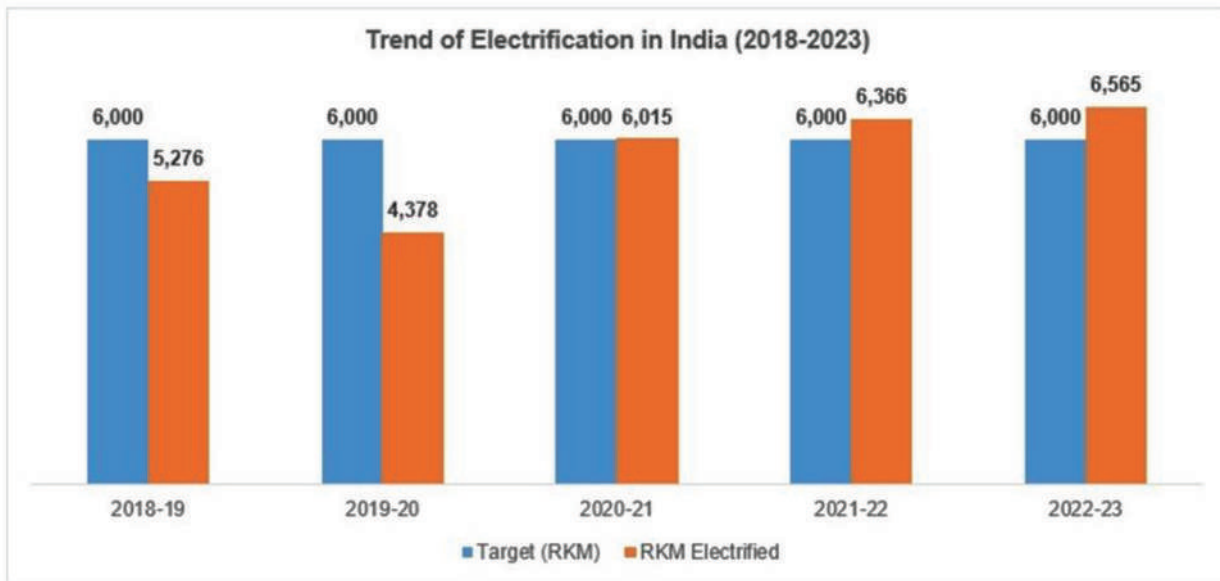
India has experienced remarkable economic growth and is projected to become the third-largest economy globally by 2030. The Indian Railways plays a crucial role in driving the development of various industries while enabling the mobility of millions of people. Notably, India boasts the world's fourth-largest railway system and the second-largest rail network managed under a single entity, covering an impressive 123,542 km of tracks and approximately 7,350 stations. As the largest rail network in Asia and a prominent global transportation organization, the Indian Railways has embraced advancements in science and technology, leading to significant changes over the years. With a dedicated workforce exceeding 1.2 million employees and extensive operations, ample opportunities exist for innovation aimed at enhancing efficiency.

The Indian government has taken initiatives to establish a robust innovation ecosystem, encouraging the seamless exchange of technology and information among various stakeholders to create a resilient system. The Ministry of Railways introduced the “Start-ups for Railways” policy in June 2022, aiming to provide funding to Indian start-ups, MSMEs, entrepreneurs, and innovators for the development of cutting-edge products and cost-effective solutions. To engage start-ups in this endeavour, the ministry launched an official web portal and issued 11 problem statements, seeking innovative solutions.

The primary goal of this policy is to harness the power of innovative technologies from emerging Indian entrepreneurs to enhance operational efficiency and safety measures within the Indian Railways. It targets improving quality, reliability, and maintenance issues. Additionally, the National High-Speed Rail Corporation Limited (NHSRCL) plans to initially cater to 17,900 passengers per day in each direction, with a vision to increase this number to 92,900 passengers per day per route by the year 2053.

Here's an overview of key achievements and initiatives of the Indian Railways.

- 1. Electrification:** From April to October 2022, the Indian Railways successfully achieved 1,223 Route Kilometres (RKMs) of electrification, a notable increase of 36.64% compared to the previous FY 2021-22. As part of the Make in India project, more than 95% of components for electric locomotives are domestically sourced, following the Department for Promotion of Industry and Internal Trade (DPIIT) directives on public procurement.



Source: Indian Railways

2. **Freight Traffic:** In the year 2021-22, the national conveyor loaded 1,418.1 MT of freight, marking a significant 15% growth from 2020-21. The National Rail Plan aims to further expand the freight traffic share from the current 27% to 45% by 2030.
3. **Technologically Superior Coaches:** As of 30th November 2022, Indian Railways has produced 35 Linke Hofmann Busch (LHB) Vistadome coaches. These coaches come equipped with advanced features such as an anti-climbing arrangement, air suspension with a failure indication system, and offer passengers a panoramic view.
4. **Vande Bharat Trains and Tejas Express:** As part of the Make in India initiative, the country's first indigenously manufactured high-speed train, Vande Bharat Express, has been developed by the Integral Coach Factory, Chennai. The procurement of 44 rakes of Vande Bharat Trains has commenced, with six of them already operational on Indian Railways. Additionally, Tejas Express, the country's second privately operated train service, offers four pairs of premium, fully air-conditioned, superfast travel, capable of reaching speeds of up to 180 km/hr.
5. **Vertical Lift Railway Sea Bridge:** India's first Vertical Lift Railway Sea Bridge, connecting the mainland with Rameswaram Island, is presently 84% complete.
6. **One Station, One Product:** The One Station, One Product program has been successfully implemented, with 535 stations and 572 outlets accomplishing its objectives.
7. **Employment and Green Energy Project:** With approximately 1.3 million employees, Indian Railways is the largest employer in India and the eighth largest in the world. The "Green Energy

Project” aims to install 200 MW of wind plants and 1,000 MW of solar power plants by 2022-2023, with over 204.82 MW of renewable energy already installed.

- Private Participation in Bullet Train Projects:** Indian Railways is inviting private players to participate in the construction and operation of new bullet train projects under a Public Private Partnership (PPP) model, with an estimated cost of US\$ 121 billion (Rs 10 trillion).



- Kavach Safety Technology:** The affordable and Safety Integrity Level 4 (SIL-4) certified technology, 'Kavach,' has been successfully trialed between Gullaguda and Chitgidda Railway stations in South Central Railway. The government aims to expand this technology to cover 34,000 Km of the network, including 2,000 Km in 2022-23.

Integration of New Technologies in Indian Railways:

- Real-Time Train Information System (RTIS):** Indian Railways, in collaboration with ISRO, has developed the Real-Time Train Information System (RTIS), which is being installed on locomotives to automatically acquire train movement timing at stations. Currently, 2,700 locomotives are equipped with RTIS devices, and an additional 6,000 locomotives spread across 50 loco sheds will be covered in Phase-II rollout, utilizing ISRO's satellite communications hub. The primary use of RTIS is to provide real-time train status information. However, the Centre for Railway

Information Systems (CIRIS) aims to leverage this data to unlock artificial intelligence (AI) capabilities, enabling more accurate ETA (Estimated Time of Arrival) estimation and exploring other potential applications.

2. **Future Railway Mobile Communications System (FRMCS):** India plans to adopt the 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE) and New Radio as part of the Future Railway Mobile Communications System (FRMCS). This forward-looking technology will serve as a global industry standard for rail communications, contributing significantly to the digitization process of the Indian Railways. The FRMCS was developed by the International Union of Railways in collaboration with various players in the rail industry.
3. **Ultrasonic Flaw Detection (USFD):** For routine safety inspections, Indian Railways employs Ultrasonic Flaw Detection (USFD) to examine rails and welds at predetermined frequencies. The Research Design and Standards Organisation (RDSO) uses USFD manual testing, which relies on ultra-high frequency sound waves to inspect metal components. This technology has proven to be a versatile and sensitive tool for preventive maintenance, ensuring the safety and integrity of railway tracks.
4. **Predictive Asset Maintenance System (PAMS):** The Indian Railways has implemented the Online Monitoring of Rolling Stock (OMRS) system, which incorporates the Wheel Impact Load Detector (WILD) or Wheel Condition Monitor (WCM) and the Acoustic Bearing Detector (ABD) or Rail Bearing Acoustic Monitor (RailBAM). OMRS continuously monitors the condition of each train's equipment, identifying any defects in wheels and bearings. This system allows for the real-time generation of defect reports and alarm notifications, enabling proactive and condition-based predictive maintenance practices. This shift from "Time-Based Maintenance" to "Condition-Based Predictive Maintenance" has significantly improved rolling stock maintenance procedures.

2.

Rise in Railway Digitization in India

The global transportation industry is undergoing a significant shift towards creating innovative and user-friendly mobility systems. Rail transportation, in particular, is recognized as a crucial component of this transformation. To adapt to the rapidly evolving business environment driven by information and communication technology (ICT), rail operators need to update their strategies and procedures.

Digital transformation is the key to expanding rail transport in today's economy.



The Power of Digitalization in Railways

Digitalization is a continuous cycle of convergence between the physical and the virtual world, leading to the transformation of several economic sectors. In the railway industry, digital transformation has been propelled by technologies like the Internet of Things (IoT), cloud computing, data analytics, mechanisation, intelligent machines, and automation. The advent of concepts like Industry 4.0, Railway 4.0, and digital railway showcases the modern requirements of the digital economy.

Embracing Technological Advancements

The Indian Railways has recognized the need for digital transformation and has identified several key areas for improvement. Collaboration with technology and logistics partners, passenger-friendly applications, application integration, freight consumer convenience, data analytics, cashless commerce, dashboards and alerts, and mobile applications are among the primary focus areas.

Modernising Railway Operations

Indian Railways has made significant strides in digitising its services and operations. The Real-Time Train Information System (RTIS), developed in collaboration with ISRO, has revolutionised computerised chart preparation and passenger train data management. Thousands of electric and diesel locomotives have been equipped with Remplot, enabling automated management charting. The railways have also introduced the Unreserved Ticketing System (UTS) terminals for automated unreserved ticket issuance at rest stations.

Advancements in Signal Systems and Maintenance

To enhance safety and productivity, Indian Railways is modernising its signal system by implementing the Modern Train Control system with a Long Term Evolution (LTE)-based Mobile Train Radio Communication (MTRC) system. The modernization of signaling system includes the adoption of advanced train control and signaling technologies such as Automatic Block Signaling (ABS), Block Proving by Axle Counters (BPAC), amongst others. The introduction of Industry 4.0 in modern passenger car plants has further boosted productivity. Additionally, the use of drone-mounted cameras and 3D scanning technology for bridge inspections showcases the railways' commitment to utilising cutting-edge solutions for rail maintenance.

Streamlining Procurement Procedures

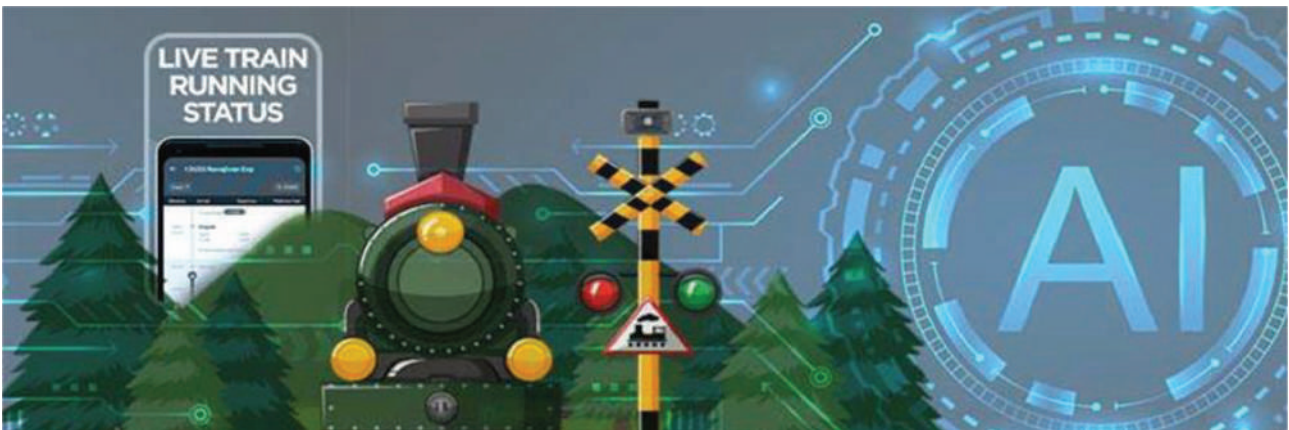
Indian Railways has achieved end-to-end digitalization of its procurement procedures. This digital transformation has streamlined processes such as request processing, tender publication, tender finalisation, and material assessment. All these advancements have resulted in improved efficiency and accountability in procurement and assessment.

Digitization of Railway Supply Chain:

Digital transformation has become a key focus for the railway industry, enabling the integration of digital technology into all aspects of railway operations. The utilisation of digital technologies extends to various areas such as coach design, signalling and traffic control, freight management, train services, workforce administration, and customer support. The adoption of digitalization has paved the way for improved safety measures, predictive maintenance, data analytics, and overall modernization of the railway system. These advancements are not only improving the efficiency and safety of railway operations but also enhancing the overall travel experience for passengers.

1. Artificial Intelligence (AI)

Artificial Intelligence (AI) is making significant contributions to the railway industry in various ways. Its applications range from enhancing customer experience to optimising processes and maintaining assets. By utilising AI tools and techniques, railways can achieve route optimization, real-time train movement monitoring, crew management, and improved logistics chain integration. The application of AI and data analytics is central to enhancing the operational efficiency of the entire railway system.



2. Biometric Token System (BTS)

The Biometric Token System (BTS) is introduced to smoothen the process of boarding unreserved coaches. Passengers traveling in the general coach, where seats are not reserved, are provided with a token a few hours before the train's departure. The data collected through this system helps analyze crowd patterns and passenger numbers, enabling better management of train services.

3. Contactless Travel

In the wake of the pandemic, contactless travel has become crucial for ensuring passenger safety. Railways have implemented contactless tickets, which are QR-coded and sent to passengers' mobile phones upon booking. These QR codes are scanned at station premises to update and verify passenger details. The adoption of contactless travel using QR code-enabled tickets has made commuting easier and safer for passengers.

4. Driverless Train Operations (DTO)

Autonomous trains, commonly referred to as driverless trains, function automatically without human involvement and are supervised by control centers. DTO brings flexibility to train operations, reduces human errors, and improves coach availability for service. The Delhi Metro, with its automated metro network, has become one of the world's elite metros operating fully automated train systems.

7. Head on Generation (HOG) System

The Head on Generation (HOG) system provides a cost-effective, reliable, and energy-efficient power supply system for coaches. This system, implemented in End On Generation trains, utilizes power cars equipped with DG sets at both ends. By drawing power from Over Head Equipment (OHE) through converters in electric locomotives, the HOG system significantly reduces diesel fuel consumption and energy costs.

6. LiDAR Technology

LiDAR (Light Detection and Ranging) technology is being adopted for ground surveys in railway projects. This remote sensing technology uses pulsed lasers to measure distances and provides accurate details of areas along the alignment. The National High-Speed Rail Corporation Limited (NHSRCL) is utilizing LiDAR technology for the ground survey in various high-speed rail corridors to gather essential data and ensure precise project planning.

7. Online Monitoring of Rolling Stock (OMRS)

The Online Monitoring of Rolling Stock (OMRS) system plays a crucial role in identifying and addressing faults in rolling stock. OMRS monitors the health of each rolling stock, detects defective bearings and wheels, and generates real-time alarms to take corrective action before any line failures occur. Indian Railways is actively adopting these maintenance systems to move towards predictive maintenance, ensuring better reliability and safety.

8. Cybersecurity

Cybersecurity has become more critical than ever before, given the increasing vulnerability of railway systems to cyber threats. Ticketing, freight operations, train operations, and asset management heavily rely on IT systems that are susceptible to attacks. Implementing cybersecurity measures based on industry standards is essential to protect key infrastructure and ensure the secure operation of railway systems.



Challenges in the digital Transformation of Indian Railways:

The Indian railway system, one of the largest in the world, has been a vital mode of transportation for over a century. With the advancements in technology, there is a growing need for digital transformation in the Indian railways to improve efficiency, safety, and customer experience. However, this transformation comes with its own set of challenges.

Infrastructure Bottlenecks

One of the major challenges in the digital transformation of Indian railways is the existing infrastructure bottlenecks. The railway system is burdened with aging infrastructure, which hampers the implementation of new digital technologies. The pace of new project execution is often hindered by socioeconomic issues related to land acquisition and escalating project costs. Gauge conversion and signal upgrades are also major obstacles in strengthening the infrastructure. The absence of modern automated signaling across the network further adds to the complexity.

To address these challenges, the Indian railways needs to prioritize infrastructure development. The mission to promote an ungauged system, which was first announced in 1992, needs to be accelerated. The conversion of meter/narrow gauge to broad gauge should be expedited. Additionally, the adoption of modern automated signaling systems should be prioritized to enhance the efficiency and safety of the railway network.

Decongesting the Existing Network

Another significant challenge in the digital transformation of Indian railways is the congestion in the existing network. The construction of Rail Over Bridges and Rail Under Bridges should be expedited to eliminate level crossings, which are a major cause of congestion. Signal automation should be implemented on high-capacity routes to improve the flow of traffic. The commissioning of Dedicated Freight Corridors can also provide a long-term solution to the existing network's congestion problems.

Unlocking Technical Capabilities

India is a hub of technical innovation across various sectors, and the railways have the potential to leverage these capabilities for their digital transformation. However, there are challenges in fully exploiting these technical capabilities. The slow adoption of advanced technologies and reluctance to accept changing technology trends have hindered the progress of the Indian railways.

To unlock the technical capabilities, the Indian railways need to embrace innovation and collaboration. The successful induction of technically advanced coaches, such as Alstom LHB coaches, should be expanded. The production of LHB coaches should be ramped up to meet the growing demand. The



stagnation of projects like the Vande Bharat Express, which showcases India's potential in high-speed rail travel, should be addressed through effective project management and a willingness to adapt to new technologies.

3. Future Technologies in Indian Railways

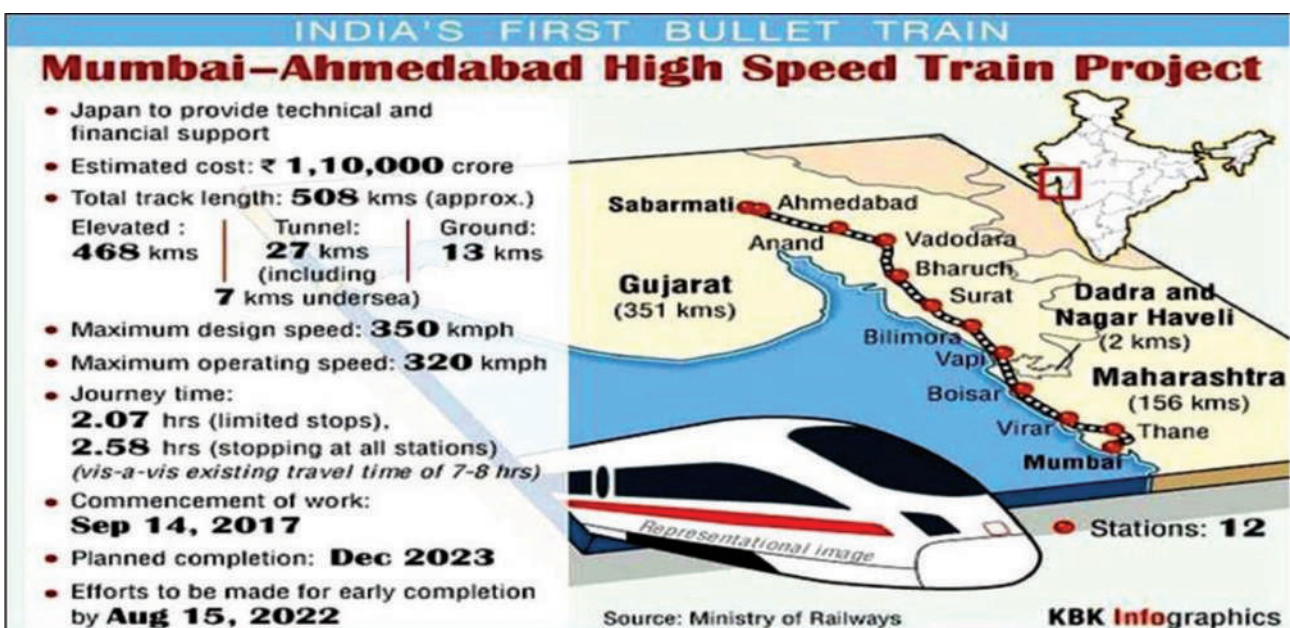
The world of railway technology is on the cusp of a major revolution. As countries strive to enhance their transportation systems, India has taken a significant step forward with the introduction of the Vande Bharata Express, its first semi-high-speed train. But this is just the beginning. India's vision extends far beyond creating a world-class intercity train. The goal is to modernise the railway system and embrace digitalization, paving the way for safer, more efficient, and technologically advanced train travel.

The Vande Bharata Express: A Game-Changer for India's Railways

The Vande Bharata Express made its debut in February 2019, connecting New Delhi to Varanasi. This semi-high-speed train is not only a symbol of progress but also a testament to India's capability to plan, develop, and produce cutting-edge trains domestically. However, the significance of the Vande Bharata Express goes beyond its sleek design and speed. It marks the initiation of a comprehensive transformation of India's railway signalling system, transitioning to digital Automatic Train Protection (ATP) and Train Collision Avoidance Systems (TCAS).

Enhancing Safety with ATP and TCAS

Automatic Train Protection (ATP) and Train Collision Avoidance Systems (TCAS) are vital innovations in railway technology. These systems play a crucial role in ensuring the safety of trains and enabling



them to operate at high speeds. ATP acts as a safeguard against collisions, overspeeding, and dangerous signal passing. By constantly monitoring the train's speed and comparing it to the allowed speed, ATP triggers emergency braking if necessary.

TCAS, on the other hand, analyses location and sensory data to identify potentially hazardous situations caused by human error or equipment malfunction. With the integration of TCAS, the Vande Bharata Express can travel faster and safer. Developed domestically by Indian research groups and suppliers, the ATP and TCAS technologies function similarly to the European Train Control System (ETCS) but at a lower cost for Indian Railways.

Digitising India's Railway Signalling System

The introduction of the Vande Bharata Express sets the stage for the modernization of India's ageing railway signalling system. The TCAS system is fully integrated into the railway signalling infrastructure, relying on communication between trains and a central control system. It incorporates trackside equipment, sensors, Internet of Things (IoT) devices, and locomotive-based control equipment. By electronically transmitting line-side information to the locomotive, TCAS eliminates the need for the driver to constantly monitor signals such as "track work ahead" or "stopped train ahead." 2837 stations have been provided with Electronic Interlocking (up to 30.11.2022) covering 44% of IR. ABS was provided on 3643 Route km. The Indian Railways has been gradually adopting these advanced signaling technologies to transform its operations and make the network more robust and efficient.

The Long-Term Vision: Gigabit Trains and Digital Railway Operations

The ultimate goal of global digital train operations is to reduce congestion, improve punctuality, enhance safety, and expand line capacity. By implementing digital train operations and wireless train-to-train communication, trains can operate at closer intervals while maintaining safety margins. Real-time computer analysis of the surrounding blocks allows for the precise identification of safe zones.

In addition, passengers benefit from improved connectivity, onboard monitoring for safety, and high-quality mobile broadband and voice services. The Future Railway Mobile Communications System (FRMCS) architecture and services can be seamlessly integrated into India's railway system while retaining the ATP and TCAS applications connected via the FRMCS network.

Leveraging 3GPP Technologies for Railway Innovation (Needs to be elaborated)

To achieve these ambitious goals, India is following the footsteps of European nations by adopting 3GPP Long Term Evolution (LTE) and New Radio as the foundation technologies for railway applications. This approach not only ensures future-proof compatibility with the global standard for

railway communications, the Future Railway Mobile Communications System (FRMCS), but also enables the implementation of a wide range of FRMCS features.

FRMCS, developed in collaboration with stakeholders in the rail sector, is the International Union of Railways' (UIR) future global telecommunications system. Its deployment, coupled with 3GPP technologies, offers numerous benefits for railway innovation, particularly in the areas of ATP and TCAS.

The Power of ATP and TCAS Enabled by 3GPP Technologies

ATP and TCAS rely on robust communication networks to operate effectively. The adoption of 3GPP technologies allows for seamless integration of these safety systems into the railway signaling infrastructure. LTE, with its ultra-reliable and low-latency communication capabilities, provides the necessary support for ATP and TCAS, as well as passenger connectivity.

Modern Rolling Stock

The railways ministry has plans to acquire new rolling stock worth over Rs 3.14 trillion in the upcoming financial year, according to the national transporter's annual rolling stock programme for 2023-24 (FY24). In the Rolling Stock Programme (RSP) 2023-24, 500 Vande Bharat trains, 35 hydrogen fuel-based trains, 4,000 newly designed automobile carrier coaches with side entry, 5,000 LHB coaches, 58,000 wagons, 100 Vistadome coaches and 1,000 refurbished premier trains. This move aims to meet the growing demand for high-speed trains in India and improve the overall passenger experience.

Scaling Up Production

To achieve the increased production target, the Integral Coach Factory (ICF) in Chennai will play a crucial role. ICF will produce an additional four sets each month, contributing significantly to the overall production. At the same time, the Modern Coach Factory (MCF) in Amethi and the Rail Coach Factory (RCF) in Kapurthala will continue to manufacture 10 sets each per month.

The Revised Rolling Stock Plan

The revised rolling stock plan encompasses an increase in the overall production of various types of coaches and trains. The target for producing wagons and locomotives has seen an increase from 9600 units to 21000 units and 1181 units to 1390 units respectively in the year 2022-23. This expansion also involves the production of 400 semi-high-speed Vande Bharat trains by the year 2025. However, rail experts express concerns over the feasibility of meeting this target, given IR's current manufacturing capacity. The budget estimate for upgrading rolling stock has also decreased for the financial year 2023-24 by 18%. Nevertheless, IR is determined to enhance its production capabilities and cater to the increasing demand for efficient and comfortable rail travel in India.

Hi-Tech Systems for Detecting Railway Track Defects

Railways are the lifeline of any transportation system, and it is crucial to ensure their safety and reliability. The Indian Railways, one of the largest railway networks in the world, has implemented various hi-tech systems to detect and prevent track defects. These systems include Track Recording Cars (TRC), Oscillation Monitoring Systems (OMS), Ultrasonic Flaw Detection using Single Rail Tester (SRT) and Double Rail Tester (DRT), and the upcoming Self-Propelled Ultrasonic Rail Testing (SPURT) Car. Additionally, trials are being conducted for the Ultrasonic Broken Rail Detection (UBRD) System, Rail Fracture & Intrusion Detection System using distributed optical fibre sensing, Loco-Vision Analytics, and Rail Integrity Monitor system (RIM).

Signalling and Telecommunication

Improving train control and communication is essential for enhancing safety. The European Train Control System (ETCS) and communication-based train control (CBTC) are two systems used for automated train protection. ETCS, which is widely implemented by major railway systems, involves track-side or radio-based communication technology to ensure efficient train operations and increase track capacity. Although significant investment is required to upgrade all trains to operate without track-side signals, the long-term benefits include better reliability, maintainability, and safety. The budget estimate for the year 2023-24 has increased from 2428 crore to 4198 crore.

Mechanization of Track Construction

Track laying is a significant part of infrastructure projects undertaken by rail systems. Indian Railways can utilise track-laying machines to improve the speed of construction. Multipurpose track-laying machines, which operate on patented techniques, are suitable for handling large panels and can be used to enhance the speed of creating infrastructure. These machines operate head-on, allowing monitoring without disturbing scheduled trains. Indian Railways should consider adopting such machines on a large scale at zonal levels to expedite track laying.

Mechanization of Electrification

In order to achieve extensive electrification, Indian Railways must prioritise the implementation of cutting-edge technologies. Self-propelled overhead electrification laying trains (SPOLT) and eight-wheeler self-propelled multi-utility vehicles (SPMUV) are examples of machines used for efficient



electrification. These machines have automatic tensioning arrangements, guide masts, and instrumentation for ensuring proper tension and uniform rotation of wiring drums. By leveraging such mechanisation techniques, Indian Railways can accelerate the process of electrification and improve overall infrastructure.

Usage of Prefabrication

Prefabrication techniques can significantly improve the efficiency and structural integrity of construction projects. Indian Railways can adopt standardised designs and prefabrication practices to streamline operations. By precasting construction elements at a central location and transferring them to the construction site as needed, construction time and manpower costs can be reduced. Prefabrication also improves safety and simplifies operations at the construction site. Indian Railways should incorporate prefabrication as a standard operating procedure for all construction works to ensure consistent quality and efficiency.

Digitization at Railway Stations

Digital technologies are transforming railway stations into smart stations, offering enhanced features and services. Access control systems can ensure that only authorised personnel have access to station facilities, enhancing security and passenger experience. Implementation can be done in a phased manner, starting with a combination of digital and manual access control to educate passengers about the new technology. Real-time information systems can provide passengers with accurate and up-to-date information about train schedules and delays, improving reliability and convenience. GPS systems can track trains in real-time, allowing passengers to plan their journeys more efficiently. These digital solutions have been successfully implemented by rail networks such as JR East, JR West, and SNCF.



Ticketing

Digital ticketing systems and open-loop smart cards are revolutionizing the ticketing and fare collection process. Omnichannel ticketing experiences provide passengers with multiple options for ticket purchase and collection, making the process more convenient. Open-loop smart cards, such as contactless cards and QR codes, enable seamless entry and exit at stations, reducing the need for manual ticket inspections. These technologies streamline the ticketing process and improve the overall passenger experience.

Train Experience

Digital innovations can greatly enhance the overall train experience for passengers. Wi-Fi connectivity on trains allows passengers to stay connected during their journeys, improving productivity and entertainment options. Infotainment systems provide passengers with access to movies, TV shows, and other multimedia content, enhancing their travel experience. App-based systems can offer personalised recommendations, onboard services, and real-time updates, further improving the passenger experience. By leveraging these digital capabilities, Indian Railways can make train travel more enjoyable and convenient for passengers.

4. Rail Industry Trends

The introduction of high-speed trains in India has been a game-changer for the Indian Railways. The success of the Vande Bharat Express trains has paved the way for the development of more high-speed trains. In the upcoming budget, the government is expected to announce the addition of over 400 new rakes of semi-high-speed Vande Bharat trains. These trains provide a comfortable and efficient mode of transportation, reducing travel time and enhancing the overall experience for passengers.

The Mumbai-Ahmedabad High-Speed Rail Corridor (MAHSR), also known as the bullet train project, has faced challenges due to land acquisition issues. However, the government remains committed to its completion. As of December 31, 2022, the overall physical progress on the 508.09 km corridor was 24.73%. The government has allocated INR 19,102 crore for the National High-Speed Rail Corporation Limited (NHSRCL) in the financial year 2022-23, and the project is expected to be completed by 2027. Once operational, the bullet train will revolutionize travel between Mumbai and Ahmedabad, providing a faster and more efficient mode of transportation.

Hydrogen-Powered Trains: A Green Initiative

As part of its commitment to environmental sustainability, the Indian Railways is undertaking the development of hydrogen-powered trains. These trains, which operate on fuel cell technology, are designed to replace older trains that were built in the 1950s-60s. Hydrogen-powered trains offer several advantages, including fuel efficiency, minimal noise pollution, and zero emissions. They are set to bring about a transformational change in the daily lives of Indian citizens, providing a greener and more sustainable mode of transportation.



India will become the second country after Germany to introduce hydrogen-powered trains. The trains will emit only steam and evaporated water, making them environmentally friendly. While the exact launch date is yet to be revealed, the design of the hydrogen-powered trains is expected to be

finalized between May and June 2023. The upcoming budget may feature important announcements regarding these trains, highlighting the government's commitment to sustainable development.

Major Railway Projects

In addition to the aforementioned initiatives, several major railway projects are underway to enhance connectivity and promote economic development in various regions of India. Let's take a closer look at some of these projects:

Chenab River Railway Bridge

The Chenab River Railway Bridge is a significant project aimed at connecting the Kashmir Valley to the rest of India through a rail network. This ambitious project involves the construction of the world's highest single-arch railway bridge over the Chenab River in Jammu and Kashmir. As a component of the Udhampur-Srinagar-Baramulla rail link initiative, the bridge spans 1.3 km and was constructed with a budget totaling \$9.2 crore. It is a joint venture between Afcons Infrastructure (India), VSL India, and Ultra Construction & Engineering Company of South Korea. The completion of this project will enhance connectivity to the Kashmir Valley, boosting tourism and trade in the region.

Operation of Rapid Train

The Rapid Train project aims to connect Delhi with Meerut by operating a high-speed train. The railway corridor for this project will be completed in three sections, with the first section connecting Sahibabad to Duhai Depot, covering a distance of 17 km. The railway track work on this section has been completed, and the installation of overhead equipment is underway. From March 2023, the Rapid Train will become operational for passengers between Duhai Depot and Sahibabad. This project will significantly reduce travel time between Delhi and Meerut, enhancing connectivity and improving the overall transportation experience.

Bairabi-Sairang New Line Railway Project

The Bairabi-Sairang New Line Railway Project aims to connect Mizoram, a northeastern state, with the rest of the country. This project will play a crucial role in enhancing communication and commerce in the region, fostering economic development in Mizoram. The project involves the creation of an additional 51.38 km of railway track in the northeast, facilitating better connectivity and promoting tourism and trade in the region.

Bhalukpong-Tawang Line

The Bhalukpong-Tawang line is a strategically important railway project in the northeast region of India. It caters to the extensive needs of the military in the region, where tensions with China have

escalated. The planned railway route will consist of numerous tunnels and will be constructed at elevations exceeding 10,000 feet. Once completed, this project will not only enhance connectivity but also strengthen India's defense capabilities in the region.

The Indian Railway Budget for the fiscal year 2023-24 represents a significant milestone in the development and modernization of the country's railway system. The government's focus on infrastructure development, high-speed trains, and green initiatives such as hydrogen-powered trains reflects its commitment to providing world-class transportation services while promoting sustainability. Additionally, major railway projects like the Chenab River Railway Bridge, Rapid Train, Bairabi-Sairang New Line Railway Project, and Bhalukpong-Tawang Line are set to revolutionize connectivity and foster economic growth in their respective regions. With increased investments and innovative initiatives, India's railway system is poised to enter a new era of development and efficiency.

Policy Perspective: 2023-24

After the merger of the Railway budget with the General Budget from the year 2017-18, the Railway receipts and expenditure have been a part of the documents of the General Budget. The expenditure of the Railways is now a part of Demands for Grants of the Ministry of Finance like other Ministries/Departments of Government of India.

- The total Capital Outlay for the Ministry of Railways for the year 2023-24 has been kept at Rs. 2,60,200 cr including Rs. 10,000 cr. as Gross Budgetary Resource contribution for Rashtriya Rail Sanraksha Kosh (RRSK), Rs. 200 cr for Nirbhaya Fund and Rs. 1,000 cr. from the contribution by IR from their Internal Resources. A Capital outlay of Rs. 2.40 Lakh Cr. has been provided for the Railways in the General Budget 2023-24.
- The highest allocation of Rs. 1,20,000 cr. has been earmarked for New lines for connectivity to Hilly area and Border areas, Rs. 46 80,000 cr. for New Line connectivity for energy corridors and Rs. 75,000 cr. for Doubling/ tripling/quadrupling/flyover/bypass works on Indian Railways except energy corridors to augment capacity of existing lines.
- Infrastructure creation, augmentation and modernisation are the thrust areas for Indian Railways. Indian Railways has prepared an ambitious plan of expansion in rail infrastructure and network by FY28 so that freight loading in absolute tonnage of 3000 MT could be achieved by FY30 (Mission 3000 MT). Under Mission 3000 MT over 1200 works have been identified/prioritised to be completed within 5 years with projected Capex of 8.45 Lakh Cr, which are at various stages of execution.
- The ministry of Railways has identified 1275 railway stations across the country for development under newly launched 'Amrit Bharat Station Scheme' wherein Engineering, Procurement & Construction (EPC) contracts have already been awarded at 50 stations under this scheme.

- It has also been announced that One Hundred Critical Transport Infrastructure Projects for last and first mile port connectivity have been identified with an investment of Rs. 75000 Cr. including Rs. 15000 Cr. from private sector.
- Railway will use Hydrogen as fuel for its Heritage Hill and Tourist Railways under ‘Hydrogen for Heritage’ initiatives for which they have planned to acquire and operate Hydrogen Trains. It has envisaged to run 35 (thirty five) Hydrogen trains under “Hydrogen for Heritage” at an estimated cost of Rs. 80 crores per train and ground infrastructure of Rs. 70 crores per route on various heritage/hill routes.

Besides, IR has also awarded a pilot project for retrofitment of Hydrogen Fuel cell on existing Diesel Electric Multiple Unit (DEMU) rake along with ground infrastructure at the cost of Rs 111.83 crores which is planned to be run on Jind– Sonipat section of Northern Railway. Field trials of the first prototype on Jind –Sonipat section of Northern Railway is expected to commence in 2023-2024.

- Gati-Shakti Units have been created in IR at Board as well as field level, to bring synergy and team working among all Ministries and Departments in sanctioning and execution of projects. This has facilitated single window clearance of projects for Zonal Railways, other ministries and State Govt. units/ directorates.
- Indian Railways has taken several steps to prioritize and timely delivery of project such as Indian Railways has formulated the National Rail Plan. The National Rail Plan is aimed to formulate strategies based on both operational capacities and commercial policy initiatives to increase modal share of the Railways in freight to more than 40%.

Key Objectives of the National Rail Plan

The National Rail Plan encompasses several key objectives that will shape the future of Indian Railways. These objectives are aimed at revolutionizing freight transportation, reducing transit time, improving passenger services, and promoting sustainable development. Let’s delve into each objective in detail:

Increasing Modal Share of Railways in Freight Transportation

One of the primary goals of the National Rail Plan is to increase the modal share of Railways in freight transportation to 40%. To achieve this, the plan focuses on implementing strategic operational capacities and commercial policy initiatives. By enhancing the efficiency and competitiveness of rail freight, the plan aims to attract a larger share of the market and reduce the burden on other modes of transportation.

Reducing Transit Time of Freight

To make freight transportation more efficient, the National Rail Plan aims to substantially reduce transit time by increasing the average speed of freight trains to 50 km/h. By enhancing the speed of freight operations, the plan seeks to improve the overall logistics and supply chain management, making rail transportation a more attractive option for businesses.

Vision 2024: Accelerated Implementation of Critical Projects

To expedite the completion of vital projects by 2024, Vision 2024 has been introduced as a component of the National Rail Plan. These projects include 100% electrification, multi-tracking of congested routes, upgradation of speed to 160 km/h on Delhi-Howrah and Delhi-Mumbai routes, upgradation of speed to 130 km/h on all other Golden Quadrilateral-Golden Diagonal (GQ/GD) routes, and elimination of all level crossings on GQ/GD routes. Vision 2024 aims to expedite these projects to enhance the operational efficiency and safety of the railway network.

Identifying New Dedicated Freight Corridors

In order to meet the growing demands of freight transportation, the National Rail Plan focuses on identifying new dedicated freight corridors. These corridors will be strategically planned to connect major industrial and consumption centers, enabling seamless movement of goods across the country. By establishing dedicated freight corridors, the plan aims to reduce congestion on existing routes and enhance the efficiency of freight transportation.

Identifying New High-Speed Rail Corridors

In addition to freight transportation, the National Rail Plan also emphasizes the development of high-speed rail corridors. These corridors will enable the operation of high-speed trains, enhancing connectivity and reducing travel time between major cities. By integrating high-speed rail networks into the existing railway infrastructure, the plan aims to provide a faster and more convenient mode of transportation for passengers.

Assessing Rolling Stock and Locomotive Requirements

To ensure the smooth functioning of passenger and freight services, the National Rail Plan focuses on assessing the rolling stock requirement for passenger traffic and the wagon requirement for freight transportation. By accurately estimating the demand for locomotives and rolling stock, the plan aims to optimize resource allocation and enhance the overall efficiency of the railway system.

Private Sector Participation

The National Rail Plan recognizes the importance of private sector participation in various aspects of railway operations. It encourages the sustained involvement of the private sector in areas such

as operations and ownership of rolling stock, development of freight and passenger terminals, and the development and operation of track infrastructure. By leveraging the expertise and resources of the private sector, the plan aims to foster innovation and improve the overall quality of railway services.

Investment Requirements

The National Rail Plan also addresses the financial aspects of its implementation. It assesses the total investment required for the plan's execution and provides a periodic breakdown of the capital investment. By estimating the financial requirements, the plan aims to ensure the availability of adequate funds for the successful implementation of the proposed initiatives.

Supercritical and Critical Projects

To expedite the implementation of crucial projects, the National Rail Plan has identified 58 super critical projects and 68 critical projects. These projects span a total length of 3750 km and 6913 km, respectively, with a combined cost of ₹39,663 Crore and ₹75,736 Crore. By prioritizing these projects, the plan aims to address pressing infrastructure needs and enhance the overall efficiency of the railway network.

Vision for Sustainable Development:

The National Rail Plan recognizes the importance of sustainable development in the railway sector. It emphasizes the twin objectives of 100% electrification and increasing the modal share of freight transportation. By electrifying the railway network, the plan aims to reduce carbon emissions and promote green energy.

The Ministry is taking measures on a continuing basis to improve the financial position and internal resource generation. Improvement of passenger interface, 13 periodic rationalization of fare and freight rates and focus on increasing the share of non-fare revenue sources in Railways is also being undertaken to increase total revenue. The policy perspective for the Indian Railways in 2023-24 focuses on infrastructure development, modernization, and financial sustainability. The allocation of a record amount in the budget reflects the government's commitment to the growth and improvement of the railway sector in India.

5. The Future of Indian RailTech

Indian Railways must quickly transform itself using AI (Artificial Intelligence) and quantum computing technology. For the country to keep up with the rest of the world, rapid change is necessary, and Indian Railways should lead the change by implementing cutting-edge ideas and technologies.

Data Analytics:

The Indian Railways' diverse operations may be optimized with the aid of insightful data analytics. It can be used to lower operating costs, increase the effectiveness of train timetables, and improve maintenance. Indian Railways can forecast demand for trains and make plans to allocate enough resources by analyzing data. This in turn can help to lessen delays and traffic congestion. By offering improved services and aiding in the creation of an integrated transportation system, data analytics may also significantly improve the consumer experience.

Trainguard MT

The Siemens-developed Trainguard MT is another cutting-edge railway signaling system that raises the bar for automation. By properly reproducing information regarding the precise train position via a digitalized track database, the Trainguard MT effectively permits constant communication between the train and the track equipment. The information is more accurate than that provided by a conventional signaling system, which enables improved network management and the expansion of the number of trains that can run at any given moment while maintaining higher levels of safety.

High-Speed Corridors and Dedicated Freight Corridors

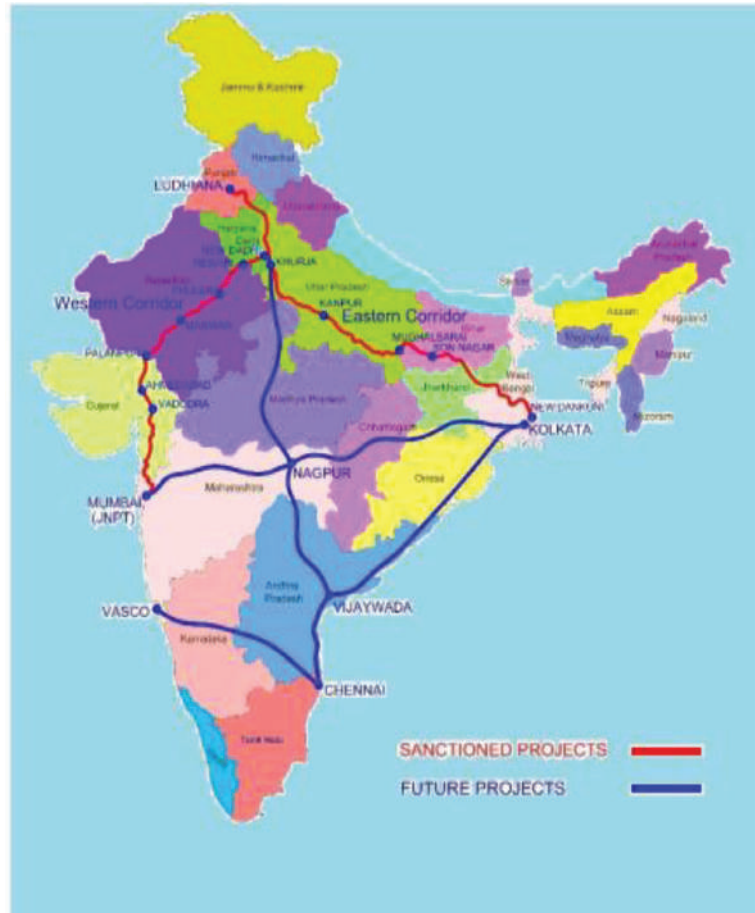
The second half of the decade is expected to witness the commissioning of new Dedicated Freight Corridors and High-Speed Passenger Corridors, along with the multitracking and signaling upgradation of congested routes. The design, development, building, maintenance, and operation of dedicated freight lines are the responsibility of Dedicated Freight Corridor Corporation of India Limited (DFCCIL). A total of 3,381 route km of two corridors, the Eastern DFC (1,875 route km) and the Western DFC (1,506 route km), have been approved for construction in the first phase by the Indian government. Starting in Sahnewal, close to Ludhiana in Punjab, the Eastern Corridor will travel through the states of Haryana, Uttar Pradesh, Bihar, and Jharkhand until coming to

an end at Dankuni in West Bengal. The Western Corridor will pass through the states of Uttar Pradesh, Haryana, Rajasthan, Gujarat, and Maharashtra as it runs from Dadri in Uttar Pradesh to JNPT in Mumbai.

With the introduction of Dedicated Freight Corridors, Indian Railways hopes to create a paradigm shift in freight operation with the primary goal of reducing unit cost of transportation through increased freight train speed, improved wagon turn-around, and increased payload to tare ratio by introducing higher axle load wagons on the rail network, improved locomotive utilization, and improved immobilization. The ultimate goal is to dramatically minimize operation and maintenance (O&M) costs and

transfer the savings forward to the customer in the form of cheaper transportation and logistics costs. These kinds of initiatives will help the Indian railway system operate more effectively and with greater capacity.

The Indian railways have been at the forefront of embracing technological advancements to enhance safety, efficiency, and passenger experience. Initiatives like KAVACH, Vande Bharat trains, and the redevelopment of stations have been undertaken to ensure a safe and better journey experience for passengers. These indigenous technologies and modernization efforts contribute to the overall transformation of the railway sector.



About ASSOCHAM

The Knowledge Architect of Corporate India

The Associated Chambers of Commerce & Industry of India (ASSOCHAM) is the country's oldest apex chamber. It brings in actionable insights to strengthen the Indian ecosystem, leveraging its network of more than 4,50,000 members, of which MSMEs represent a large segment. With a strong presence in states, and key cities globally, ASSOCHAM also has more than 400 associations, federations, and regional chambers in its fold.

Aligned with the vision of creating a New India, ASSOCHAM works as a conduit between the industry and the Government. The Chamber is an agile and forward-looking institution, leading various initiatives to enhance the global competitiveness of the Indian industry, while strengthening the domestic ecosystem.

With more than 100 national and regional sector councils, ASSOCHAM is an impactful representative of the Indian industry. These Councils are led by well-known industry leaders, academicians, economists and independent professionals. The Chamber focuses on aligning critical needs and interests of the industry with the growth aspirations of the nation.

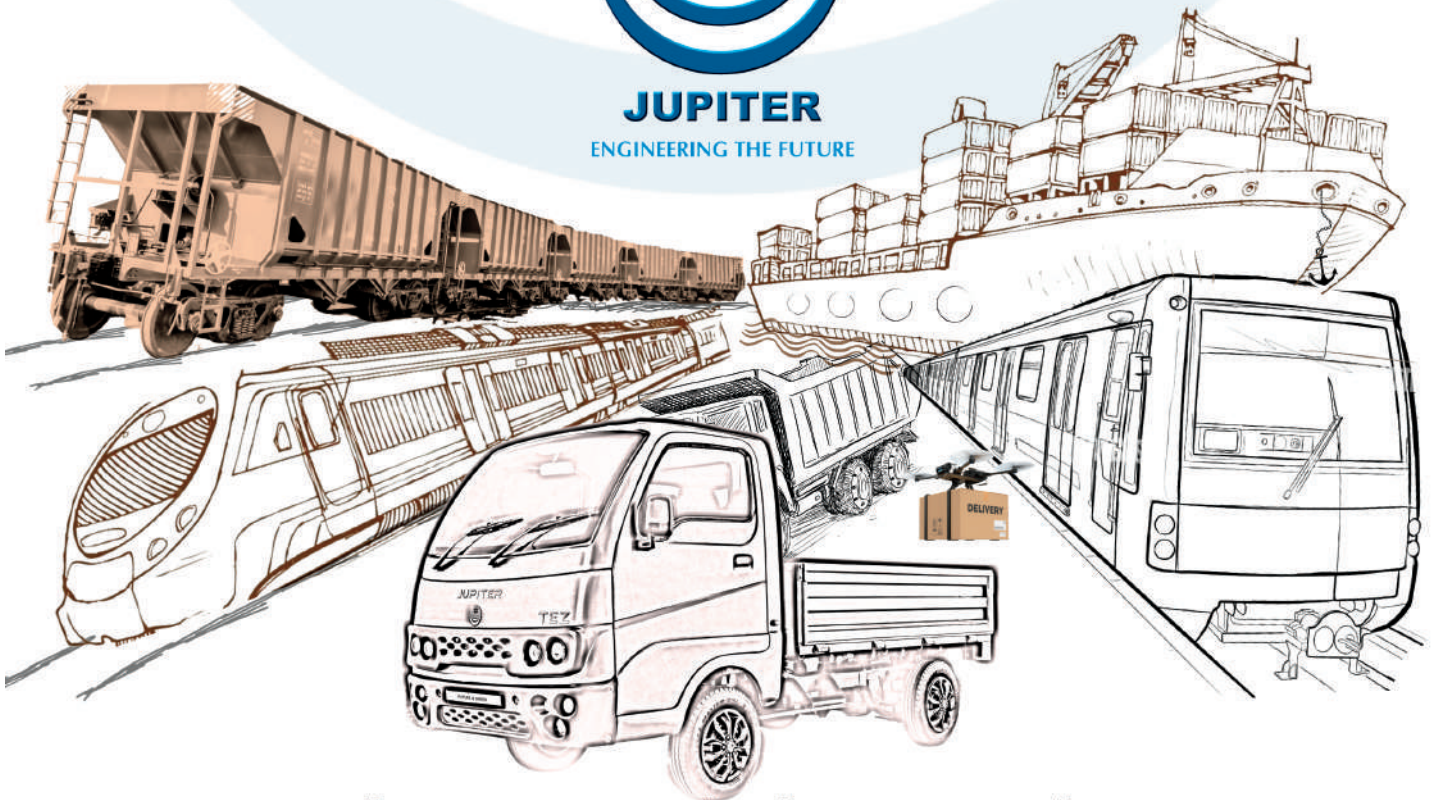
ASSOCHAM is driving four strategic priorities – Sustainability, Empowerment, Entrepreneurship and Digitisation. The Chamber believes that affirmative action in these areas would help drive an inclusive and sustainable socio-economic growth for the country.

ASSOCHAM is working hand in hand with the government, regulators, and national and international think tanks to contribute to the policy making process and share vital feedback on implementation of decisions of far-reaching consequences. In line with its focus on being future-ready, the Chamber is building a strong network of knowledge architects. Thus, ASSOCHAM is all set to redefine the dynamics of growth and development in the technology-driven 'Knowledge-Based Economy'. The Chamber aims to empower stakeholders in the Indian economy by inculcating knowledge that will be the catalyst of growth in the dynamic global environment.

The Chamber also supports civil society through citizenship programmes, to drive inclusive development. ASSOCHAM's member network leads initiatives in various segments such as empowerment, healthcare, education and skilling, hygiene, affirmative action, road safety, livelihood, life skills, sustainability, to name a few.



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