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TOWARDS A SUSTAINABLE FUTURE: LEGAL AND REGULATORY PATHWAYS FOR TRANSFORMING INDIAN RAILWAYS THROUGH GLOBAL BEST PRACTICES

RUMO A UM FUTURO SUSTENTÁVEL: CAMINHOS LEGAIS E REGULATÓRIOS PARA TRANSFORMAR AS FERROVIAS INDIANAS ATRAVÉS DAS MELHORES PRÁTICAS GLOBAIS

JOSÉ NORONHA RODRIGUES
School of Business and Economics, University of the Azores - CEDIS – Centro de I&D sobre Direito e Sociedade, Faculdade de Direito, Universidade Nova de Lisboa, Campus de Campolide, 1099-032 Lisboa, Portugal. Email: jose.n.rodrigues@uac.pt; ORCID ID: 0000-0002-7729-4954

SUMANTA BHATTACHARYA
PH.D scholar in Asian International University, and Policy Analyst, M. Tech, MA in Development Studies, M. Sc in Environmental Science, LLB, MA in Security and Defence Law, MA in Economics, MBA DIA & D, DGand GS, PGDEDS, PGDHUR, MPI (Oxford University). Email: sumanta.21394@gmail.com ; ORCID ID: 0000-0003-2563-2787

TUSHABA SHINDE
IRPS. Director, India. BAMS (Ayurved), MA (Eco), MBA (HR), PhD (Labor Economics), Ex Resource Person in ADB. E-mail- drtushabashinde@gmail.com / ORCID ID: 0009-0009-9350-1085

DORA CRISTINA RIBEIRO CABETE
School of Business and Economics, University of the Azores - CEDIS – Centro de I&D sobre Direito e Sociedade, Faculdade de Direito, Universidade Nova de Lisboa, Campus de Campolide, 1099-032 Lisboa, Portugal. Email: dora.cr.rodrigues@uac.pt; ORCID ID: 0000-0002-0117-8818

ABSTRACT

Objective: The objective of this article is to examine the legal and regulatory framework governing Indian Railways in order to assess its capacity to support modernization, financial sustainability, safety, digital transformation, and environmental protection. Through a comparative analysis of international railway governance models from countries such as Japan, Germany, China, the United Kingdom, France, the United States, and Switzerland, the study aims to identify global best practices that can inform regulatory reform in India and contribute to transforming Indian Railways into a competitive, efficient, and sustainable transport system aligned with constitutional principles and international environmental commitments.

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Methodology: This study employs a qualitative and doctrinal research methodology, combining legal analysis, policy evaluation, and comparative law. Primary sources include Indian legislation, regulatory instruments, policy documents, and landmark judicial decisions, particularly those related to environmental protection and public accountability, while secondary sources comprise academic literature, government reports, and international institutional publications. A comparative framework is used to analyse global railway models, focusing on governance structures, privatization strategies, regulatory autonomy, safety mechanisms, digitalization, and sustainability policies, in order to identify regulatory gaps and propose context-specific reforms for Indian Railways.

Results: The findings indicate that Indian Railways operates within an outdated and fragmented regulatory framework that limits operational autonomy, discourages private investment, and weakens safety and environmental enforcement. The absence of an independent regulator, politically influenced tariff-setting, financial imbalances caused by cross-subsidization, and slow adoption of advanced technologies undermine efficiency and service quality. Comparative analysis reveals that successful international railway systems rely on regulatory independence, transparent pricing, structured public–private partnerships, strong safety oversight, and legally binding sustainability mandates—elements that remain insufficiently developed or inconsistently implemented within the Indian railway system.

Conclusions: The study concludes that meaningful transformation of Indian Railways requires comprehensive legal and regulatory reform grounded in global best practices and constitutional obligations. Establishing an independent railway regulator, strengthening public–private partnership frameworks, modernizing safety and digital governance, and embedding environmental sustainability within binding legal mandates are essential steps toward creating a future-ready railway system. By aligning regulatory modernization with international standards and India's climate and development commitments, Indian Railways can evolve into a resilient, efficient, and sustainable transport network capable of supporting long-term economic growth and social connectivity.

Keywords: Public Private Partnership, Railway Privatization, Modernization of Indian Railway, Railway digitalization.

RESUMO

Objetivo: *O objetivo deste artigo é analisar o quadro jurídico e regulatório que rege a Indian Railways, de modo a avaliar a sua capacidade para sustentar a modernização, a sustentabilidade financeira, a segurança, a transformação digital e a proteção ambiental. Através de uma análise comparativa de modelos internacionais de governação ferroviária, nomeadamente dos casos do Japão, Alemanha, China, Reino Unido, França, Estados Unidos da América e Suíça, o estudo procura identificar boas práticas globais suscetíveis de orientar reformas regulatórias na Índia e de contribuir para a transformação da Indian Railways num sistema de transporte competitivo, eficiente e sustentável, alinhado com os princípios constitucionais e com os compromissos ambientais internacionais.*

Metodologia: *O estudo adota uma metodologia de investigação qualitativa e dogmática, combinando a análise jurídica, a avaliação de políticas públicas e o método do direito comparado. As fontes primárias incluem legislação indiana, instrumentos regulatórios, documentos de política pública e decisões judiciais de referência, em*

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especial as relacionadas com a proteção ambiental e a responsabilidade pública, enquanto as fontes secundárias abrangem literatura académica, relatórios governamentais e publicações de instituições internacionais. É utilizado um quadro comparativo para analisar modelos ferroviários globais, com enfoque nas estruturas de governação, estratégias de privatização, autonomia regulatória, mecanismos de segurança, digitalização e políticas de sustentabilidade, com o objetivo de identificar lacunas regulatórias e propor reformas ajustadas ao contexto da Indian Railways.

***Resultados:** Os resultados indicam que a Indian Railways opera num quadro regulatório desatualizado e fragmentado, que limita a autonomia operacional, desencoraja o investimento privado e fragiliza a aplicação das normas de segurança e ambientais. A inexistência de um regulador independente, a definição politicamente condicionada das tarifas, os desequilíbrios financeiros resultantes da subsidiação cruzada e a lenta adoção de tecnologias avançadas comprometem a eficiência e a qualidade do serviço. A análise comparativa demonstra que os sistemas ferroviários internacionais mais bem-sucedidos assentam na independência regulatória, na transparência tarifária, em parcerias público-privadas estruturadas, numa fiscalização rigorosa da segurança e em mandatos jurídicos vinculativos em matéria de sustentabilidade, elementos que permanecem insuficientemente desenvolvidos ou aplicados de forma inconsistente no sistema ferroviário indiano.*

***Conclusões:** O estudo conclui que a transformação efetiva da Indian Railways exige uma reforma jurídica e regulatória abrangente, fundamentada em boas práticas internacionais e nas obrigações constitucionais do Estado indiano. A criação de um regulador ferroviário independente, o reforço dos modelos de parceria público-privada, a modernização da governação em matéria de segurança e digitalização, bem como a integração da sustentabilidade ambiental em normas jurídicas vinculativas, constituem passos essenciais para a construção de um sistema ferroviário preparado para o futuro. Ao alinhar a modernização regulatória com os padrões internacionais e com os compromissos da Índia em matéria de clima e desenvolvimento, a Indian Railways poderá evoluir para uma rede de transporte resiliente, eficiente e sustentável, capaz de apoiar o crescimento económico de longo prazo e a coesão social.*

***Palavras-chave:** Parceria Público-Privada, Privatização Ferroviária, Modernização das Ferrovias Indianas, Digitalização Ferroviária.*

1 INTRODUCTION

Indian Railways is one of the largest and the most widely spread railway networks of the world. It is an essential part of the economic, social and infrastructural development of the nation. With a 68,000 km network, 7,300 stations and about 8 billion passengers served every year, Indian Railways is not only India's lifeline in terms of transportation, but it is also one of the biggest contributors to the country's growth story. The Railway system is a major contributor to Indias GDP, employs millions of people and is a major link between rural settlements and urban settlements. But to maintain its efficiency and solid growth in the future, there is a need for a well-

designed legal and regulatory framework. Clear legal framework can reduce operations frictions, promote safety, invite investments and technology revamp and make Indian Railways globally competitive.

Over the years, Indian Railways has undergone changes through a series of legal and administrative reforms. When this system was first introduced in 1853, India was under British colonial rule and the railways expanded rapidly in response to the transport needs of an emerging economy. Following Independence, the railway system was nationalized and now rests with the Ministry of Railways, which handles all operations of the Indian railways. Different acts have governed various aspects of Indian Railways, such as the Indian Railways Act, 1989, which serves as the legal basis for the operation, safety regulation, and service of Indian Railways. However, the existing legal regime needs to undergo significant transformations to cater to the modern challenges posed by urbanization, modernization, and increased demand for high-speed and sustainable transport solutions. (Chandra & Mishta, 2024; Rodrigues, Bhattacharya, Cabete & Soares, 2025; Rodrigues & Rodrigues, 2022; Rodrigues, Bhattacharya, Medina & Cabete, 2025; Rodrigues, Bhattacharya & Cabete, 2025).

Good regulation is central to ensuring efficiency, transparency, and accountability in railway management. In contrast to many developed countries where railway services are privatized, or run by a PPP model, Indian Railways is mainly government controlled. Though this guarantees financial security backed by the state, it tends to create bureaucratic inefficiency, slow decision-making, and struggles to modernize the infrastructure. The comparative model analysis identified that the various railway management models adopted in Japan, Germany, USA, and UK allow for focus on liberalization, competitive bidding and regulatory frameworks, which can improve the service quality, infrastructure development and operational sustainability. Hence, it becomes important for the long-term growth of the railways to adopt the best practices in global railway management and integrate those within the framework of the legal regime in India. (Khan & Khan, 2024)

Safety and operational efficiency are the most important areas of governance in railways. Over time, Indian Railways has faced multiple railway accidents, derailments and failures of infrastructure due to outdated policymaking, lack of investment in sophisticated technology and weak regulatory enforcement. As an illustration, the use of safety systems in high-speed rail corridors, signalling systems automation and use of AI-powered predictive maintenance, all have evolved nascently in India. The

inclusion of mandatory safety audits into existing regulations, alongside stricter compliance standards and real-time monitoring systems throughout the network, would be an important step to reducing the risks involved to passengers.

The other issue is the financial health of Indian Railways which is best couched in legal and policy terms. And while it's one of the largest railway networks anywhere, it is also not easy to generate revenue and manage costs. Widespread dependence on passenger subsidies, cross-subsidization on freight, and loss of efficiency on revenue collection, are the contributors to financial trouble. The government has brought in measures like FDI in railways, PPP operation of projects to redevelop stations and corporatization of railway operations, but they must be backed by clear legal mechanisms, a regulatory framework and strong implementation of policy for success. (Khosla, 2000)

Furthermore, the push towards digital transformation and smart railway management requires a regulatory framework that can both facilitate innovation, and a focus on cybersecurity, and data privacy. With the deployment of AI, Internet of Things (IoT), big data analytics, and automation in railway management, policies will also need to be framed around how to regulate digital infrastructure, what data can be protected, and how to promote collaboration by the private sector. (Rodrigues, Medina & Cabete, 2024). These developments are evident in countries such as Japan and Germany, where AI is integrated into predictive maintenance systems, real-time passenger tracking systems, and model ticketing, effectively revamping efficiency and the user experience. Indian Railways must follow such tech-driven governance models, besides creating stringent legal frameworks to deal with cyber threats and operational risks.

A second major impetus for legal and regulatory improvement is sustainability. Therefore, with India striving for carbon neutrality and environmental sustainability, it can be concluded that Indian Railways must shift towards green energy solutions, electrification of tracks, hydrogen-powered trains, and carbon emission reduction. If the system is expected to drive green infrastructure development, energy efficiency and public-private investments into sustainable rail projects, regulation must also reinforce this outcome. Government should legally enforce renewable energy resources like solar energy railway stations and electric locomotives for long-term environmental advantages. (Bokolo, 2024; Rodrigues, Bhattacharya, Sachdev &

Cabete, 2024; Rodrigues, Bhattacharya & Cabete, 2024; Rodrigues, Bhattacharya & Cabete, 2024a)

Finally, stricter legal mechanisms should be implemented to ensure public accountability and protect passenger rights. In developed markets, passengers enjoy consumer protection laws, fiat to compensation for service disruptions and digital grievance redressal mechanisms. In contrast, Indian Railways has been accused of running a service that is slow, lacks amenities and accounts for accidents and mismanagement. "Passenger Rights State Laws, ensuring strict enforcement of Service Quality Regulations, and transparent complaint resolution schemes will help instil faith in the public and enhance the quality of experience for rail customers. (Chouhan, 2021)

The Indian Supreme Court has consistently interpreted the constitutional framework to expand the scope of environmental protection. Article 21, guaranteeing the right to life, has been held to include the right to a clean and healthy environment. (*Virender Gaur v. State of Haryana*, Supreme Court of India, 1995; *Vellore Citizens' Welfare Forum v. Union of India*, Supreme Court of India, 1996). Landmark judgments such as *M.C. Mehta v. Union of India* established the principle of absolute liability for hazardous activities, directly relevant to railway projects involving high environmental risks (*M.C. Mehta v. Union of India (Oleum Gas Leak),* Supreme Court of India, 1987). Similarly, in (*Subhash Kumar v. State of Bihar,* Supreme Court of India, 1991), the Court recognized access to pollution-free water and air as part of Article 21. Such jurisprudence provides a strong constitutional basis for ensuring that railway modernization projects integrate stringent environmental safeguards.

2 LEGAL FRAMEWORK GOVERNING INDIAN RAILWAYS

The legal framework of Indian Railways is a complex and evolving system that underpins its functions, governance, and regulatory oversight. As one of the largest railway networks in the world, Indian Railways is operated by the Government of India through the Ministry of Railways. This framework is structured through various acts, rules, and policies that ensure the efficient operation of rail transport in India, safeguard passenger rights, and support the safety and development of railway infrastructure. India Railways has evolved with time and has witnessed various legislative and policy-

oriented reforms over the years to make it more relevant considering the technical, economic and transport needs of the country. But the ever-growing need for modernization, privatization and efficient delivery of services calls for more dynamic and wider legal framework. (IBEF, 2025).

The Indian Railways Act of 1989 is the primary legislation governing railway operations in India. This act shall cover of provisions about the administration of railways, provisions about provision for safety, providing services to passengers and freight, liability in case of accident and penalties for non-compliance. It lays down the legal basis for fare determination, safeguarding railway properties and control of operations. It also lays down the powers and duties of the railway authorities, including dispute resolution for instances of service disruptions, accidents or breach of contract. Though the Indian Railways Act laid down the foundation at that time, the Act needs to be revised for challenges in areas such as privatization, digitalization, sustainability and others (*The Railways Act,* India Code, 1989).

The Railway Protection Force Act of 1957 is a key legislation for securing railway property. Its legislation is the Railway Protection Force (RPF) Act of 1957, which created the RPF (a paramilitary force with powers to protect railway assets against theft, vandalism, and crime). Caste and community-based reservation is a polarising phenomenon in Indian politics and society, but the RPF has a significant scope as it has the authority to investigate, arrest and maintain law and order within the railway premises in coordination with the aid of law-and-order officials of state and central police. The security framework of this act, however, must evolve to address contemporary risks, especially given the growing threat of cybercrime, as well as digital fraud in railway ticketing and transactions, which has made the existing infrastructure for railway security relatively ineffective in this area, necessitating amendments to the law that incorporates cybercrime regulations and advanced surveillance mechanisms (*The Railway Protection Act,* India Code, 1957).

These are the major legislations and policies related to metro rail in India. The Metro Railways Act, 2002, governs the operation and management of metro rail systems in major cities of India. It lays down provisions for land acquisition, safety standards, fare regulation, and public-private partnership (PPP) models in the development of metro rail projects. As metro rail networks continue to expand in urban areas, this Act plays a crucial role in ensuring their efficient and safe implementation in the near future. It also sets penalties for service outages, damage to infrastructure

and violations of safety standards. With expansion of metro rail networks in the different states comes a need to integrate the metro rail act with urban transportation policies, sustainable mobility solutions, and the smart city initiative for a cohesive legal and operational framework (*The Metro Railways (Operation and Maintenance) Act,* India Code, 2002).

The PPPs have increasingly entered the domain of Indian railway governance, with the legal mechanism enabling various aspects of railways operation to be undertaken by the private sector, from station modernization and freight corridors to high-speed rail projects and rolling stock procurement. The FDI policy, which came into effect in 2014, now allows 100 percent participation in railway infrastructure projects, paving the way for global investors to help modernise the railways. However, issues like land acquisition disputes, financial viability concerns, and other bureaucratic hurdles have impeded smooth implementation of PPP. To ensure sustainable entry of the private sector in rail, it is critical to strengthen the legal framework around investor protection, dispute settlement, and financial transparency (PIB, 2020).

Accident Prevention rules are an important part of railway governance. The Indian Railways Act jurisprudence, under the Railway Safety Rules, which requires safety audits, accident investigations, international safety standards, follow-up and so on. The CRS, an independent body under the Ministry of Civil Aviation, is responsible for railway safety and also clears new railway lines and probes major accidents. Despite these efforts, railway accidents caused by crashing of manufactures, human errors, and obsolete of signalling systems still moderate. At this time, it can be ensured by assuring safety enforcement by legal provisions, judicious investment in AI based predictive maintenance and embracing global best practices by all stakeholders involved in railway safety (Reddy, 2024). To better understand the progress made in railway safety, it is important to examine recent accident trends. The following figure illustrates the decline in railway accidents over the past decade, reflecting the impact of safety reforms and modernization measures (PIB, 2024).

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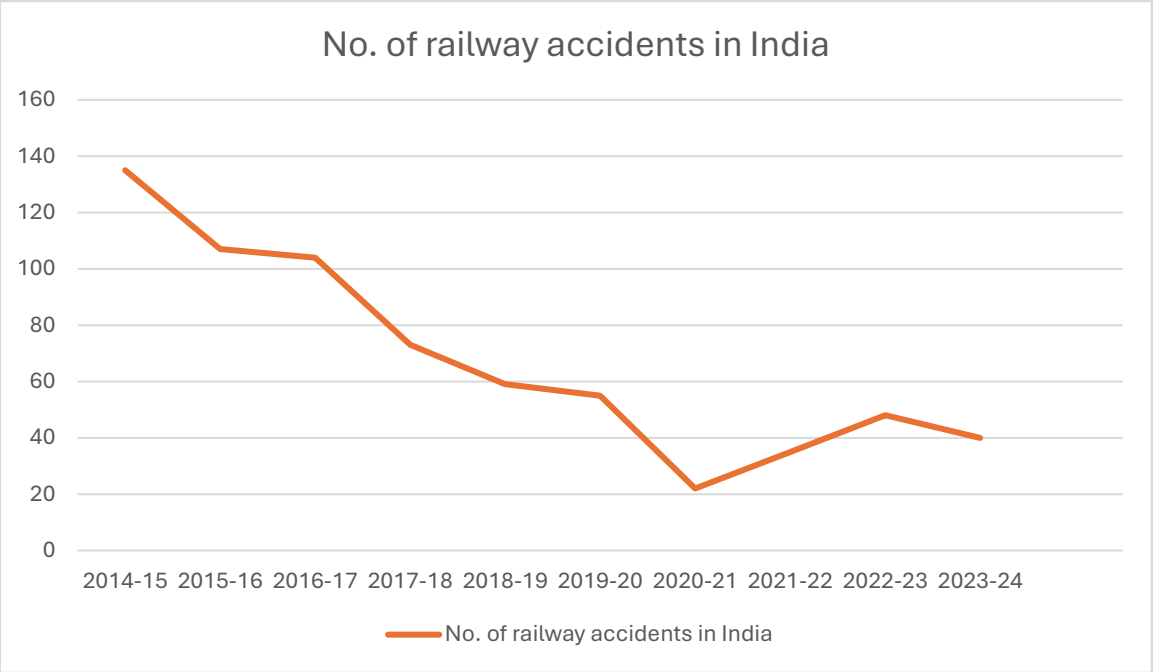

Figure 1: No. of railway accidents in India since FY 2014-25 to 2023-24 (Source: PIB, 2024)

The financial governance framework of Indian Railways is guided by the Railway Budget process, which until 2017 was presented separately from the Union Budget. The merger of the Railway Budget with the General Budget aimed to streamline financial planning, reduce political intervention in fare determination, and ensure greater fiscal discipline. However, Indian Railways continues to face challenges to financial sustainability due to high operational costs, passenger subsidies, and revenue losses. The Rail Development Authority (RDA) was established as an advisory body to help regulate fare structures, promote competition, and recommend financial reforms. Granting greater legal autonomy to the RDA would strengthen financial governance and enhance the efficiency of Indian Railways (*Hindustan Times*, 2025).

Environmental regulations are increasingly becoming an important aspect of railway governance. As per the Environmental Impact Assessment (EIA) guidelines issued under the Environment Protection Act, 1986, railways are also required to undergo a sustainability assessment before project implementation. (*Environment Protection Act,* India Code, 1986). Data from the 2011 Census of India indicates a steady increase in the electrification of railway lines between 2011 and 2019, which has prompted new policy initiatives aimed at developing green railways and promoting environmentally friendly infrastructure to help reduce carbon emissions. Embedding

these environmental mandates into the core legal framework of Indian Railways is crucial to ensure that the national transporter gradually aligns with stringent global climate goals (Milewicz et al., 2023).

The Environment Protection Act (EPA) constitutes the umbrella legislation for environmental protection in India and plays a crucial role in shaping sustainable railway projects. Under Section 3, the Central Government is empowered to take measures to protect and improve the environment, including prescribing environmental quality standards and regulating industrial siting (Milewicz et al., 2023). In the context of Indian Railways, the EPA mandates Environmental Impact Assessments (EIA) for new railway lines, freight corridors, and high-speed rail projects. Judicial interpretations, such as in *Vellore Citizens Welfare Forum v. Union of India* have reinforced the precautionary principle and the polluter pays principle, which are directly relevant to large-scale infrastructure like railways (*Vellore Citizens' Welfare Forum v. Union of India,* Supreme Court of India, 1996). Moreover, the National Action Plan on Climate Change and subsequent State Action Plans emphasize decarbonization pathways in transport, integrating renewable energy and electrification as legal obligations under India's climate commitments (Government of India, 2008).

Railway governance is also critically about passenger rights and grievance redressal mechanisms. The provisions of the Consumer Protection Act, 2019, which explicitly cover railway services as part of the definition of "service," allow passengers to approach legal forums in cases of service deficiency, ticketing fraud, or denial of proper service by the railways or its agencies (Gujarat State Consumer Disputes Redressal Commission, 2021). This includes increased transparency in service delivery through digital platforms enabling real-time grievance redressal, automatic refunds, and compensation policies (Gujarat State Consumer Disputes Redressal Commission, 2021). Improved consumer rights legislation covering railway services, combined with stringent penalties for service failures and enhanced digital grievance platforms, further boost passenger satisfaction and legal accountability (Lexology, 2022). Alongside safety, passenger satisfaction is a critical metric for Indian Railways. The next figure highlights the trend in grievance redressal, showcasing how effectively

the system has been able to respond to passenger complaints over time.

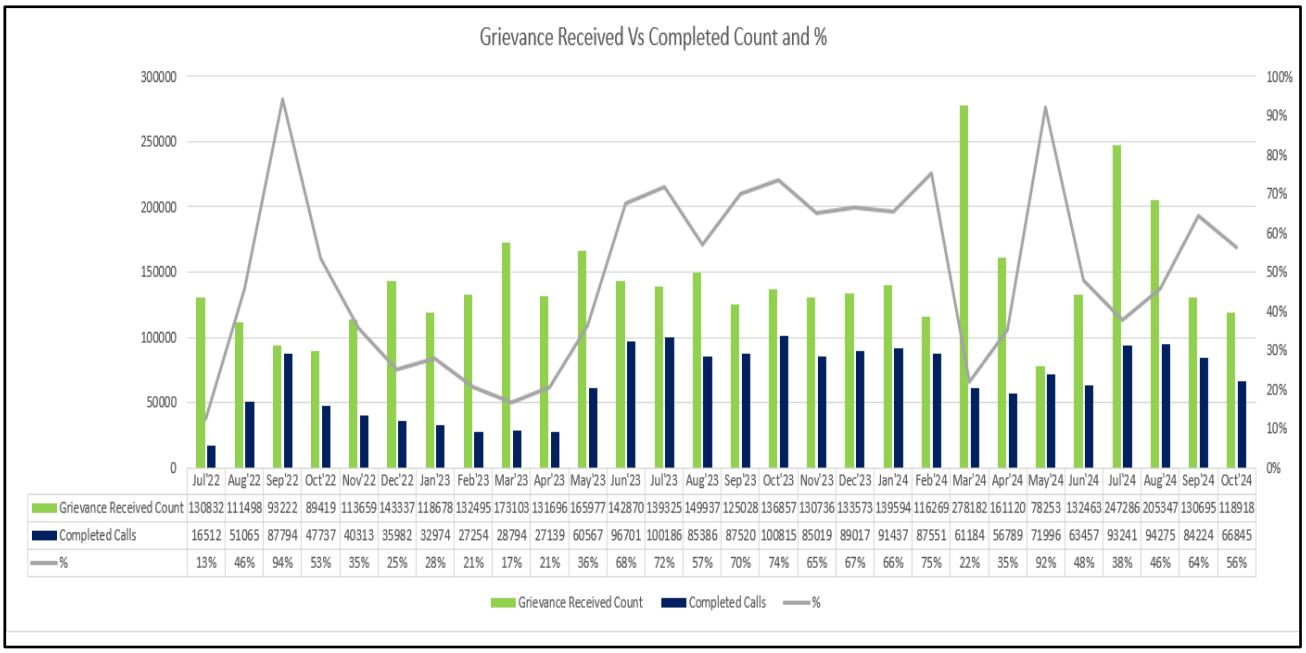

Figure 2: Comparative analysis of the grievances received vs completed from July 2022 to November 2024 (Source: Ministry of Railway, Government of India)

Thus, the legal framework of Indian Railways is both expansive and dynamic, providing a foundation for its safe and sustainable operations and innovation. Though existing laws—such as the Indian Railways Act, Metro Railways Act, and Railway Protection Force Act—are strong, periodic reforms are necessary in light of rising challenges. Transforming Indian Railways into a future-ready transportation network requires initiatives to strengthen regulatory provisions for PPP models, digitalization, environmental sustainability, and passenger rights. This will help establish a dynamic, transparent, and forward-looking legal framework that keeps Indian Railways competitive and efficient by aligning it with global railway management practices (Giunta, 2023).

Globally, railway systems are increasingly being governed by stringent environmental regulations. The European Union's Green Deal emphasizes decarbonization of rail transport through electrification, digital traffic management, and cross-border connectivity, aiming to make rail the backbone of Europe's climate-neutral transport system (European Commission, 2020). Germany's Federal Climate Change Act (2019) sets binding targets for transport sector emissions, with Deutsche Bahn adopting a roadmap to achieve climate neutrality by 2040 (Deutsche Bahn, 2024). In the UK, the Rail Technical Strategy (2020) highlights energy efficiency, alternative fuels, and digitalization as core environmental priorities (UK Government –

Department for Transport, 2021/ UK Government – Department for Transport, 2021; Steele & Roberts, 2022). Such frameworks underline the need for India not only to adopt green railway initiatives but also to embed them within binding legal mandates, ensuring alignment with global environmental governance standards.

A comprehensive view of the legal framework is essential to appreciate the governance structure of Indian Railways. The following diagram maps the key legislations, policies, and regulatory authorities that underpin railway operations in India.

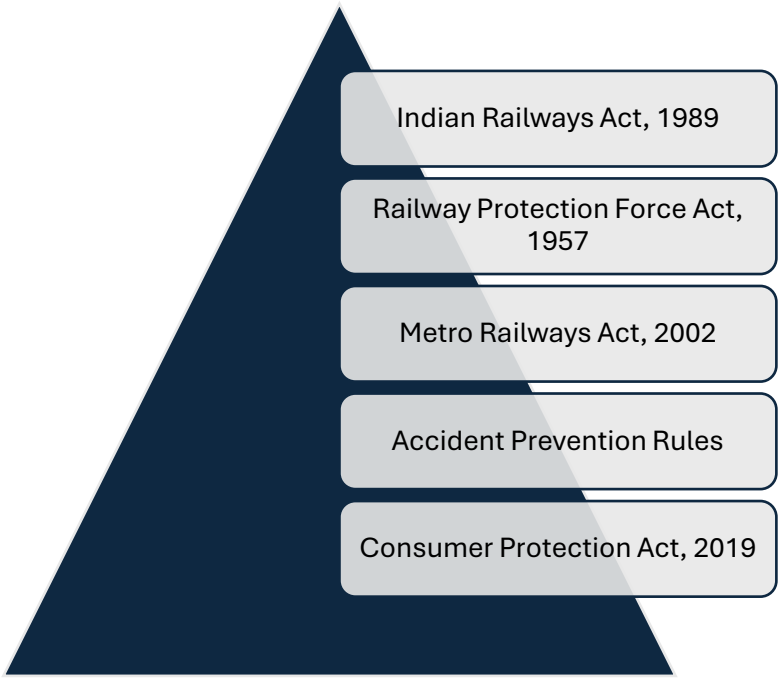

Figure 3: Legal framework for Indian Railways

3. COMPARATIVE ANALYSIS OF GLOBAL RAILWAY MANAGEMENT

Countries with railways such as Japan, Germany, China, and the United States have adopted specialized approaches to drive railway operations, seamlessly integrating high-speed rail systems where necessary while ensuring the financial viability of their networks. The various global models of railway management also provide valuable lessons for Indian Railways in areas such as infrastructure upgradation, quality of service, and regulatory frameworks. This study presents different perspectives on railway governance, privatization, technological reforms, safety regulations, and cost-benefit analysis in prominent railway systems worldwide.

One of the most successful models is Japan's, where a privatized system has been effectively implemented by the Japan Railways (JR) Group.

After the privatization of Japan National Railways (JNR) in 1987, JR companies were created, and railway operations were divided into regional companies. These companies operate with a significant degree of autonomy, funding themselves through commercial activities such as real estate, tourism and logistics. The management of Japan's railways is efficient, punctual and customer-oriented, while the Shinkansen (bullet train) network serves as establishing the world standard of high-speed rail technology. It relies on strict safety regulations, automated signalling, and earthquake-resistant infrastructure. India could adopt the regional management model, similarly, and with more private sector participation (Chi & Han, 2023).

Germany's railway, operated by Deutsche Bahn (DB), follows a hybrid model that combines state ownership with market-based operations. Although DB is technically state-owned, it functions almost entirely independently of the government, operating under a profit-center-based charter that promotes service quality, competition, and environmental stewardship. The German railway management is said to be integrated rather than fragmented, combining rail networks with urban transit systems, which makes it a leading player in multimodal transport solutions. Track access charges were introduced to enable private operators to access railway infrastructure, thus creating competition and improving service. India may learn from this model by introducing track access reform and allowing private freight and passenger trains to run efficiently, while the government can still retain control of railway infrastructure (Hertel et al., 2023).

China Railway Corporation (CRC) has arguably become the global leader in high-speed rail (HSR) expansion, managing one of the most extensive rail networks worldwide. In China, railway development strategically supports state-driven investments, rapid technological adoption, and integration with broader economic plans such as the Belt and Road Initiative (BRI). The Chinese government has heavily subsidized railway expansion, particularly high-speed rail, significantly reducing travel times and enhancing economic integration. China's success in railway management rests on large-scale public funding, advanced research in high-speed rail technologies, and close coordination between railway policies and national infrastructure planning. An important lesson for Indian readers is China's emphasis on long-term investment and infrastructure development, supported by domestic companies manufacturing

high-speed rail components and a streamlined land acquisition policy that enables the rapid expansion of its network (World Bank Group, 2019).

By contrast, the United States has a decentralized system of railway governance, with a strong focus on freight rail, while passenger rail is managed primarily by Amtrak, a publicly funded entity. Unlike Europe and Asia, where railway tracks are largely government-owned, the U.S. model is distinct in that tracks are owned and maintained by private freight rail companies. Freight rail in the U.S. is a highly lucrative business, marked by a competitive environment, advanced logistics, and substantial investment in automation and predictive maintenance technologies. However, passenger rail services face persistent challenges, including funding gaps, aging infrastructure, and limited investment in high-speed rail. For India, the U.S. experience highlights the importance of freight rail efficiency and private sector participation in logistics, demonstrating that greater involvement of private players in freight corridors could significantly enhance revenue generation (Berman, 2023).

In France, the state-owned rail corporation (Société Nationale des Chemins de fer Français or simply SNCF) has seamlessly combined high-speed rail services with non-High-Speed Rail ones. The TGV has drastically improved mobility in France, rapidly becoming a popular transportation medium. The French model relies on government-subsidized infrastructure development, competitive pricing and overseas growth (SNCF is a notable participant in high-speed rail projects across Europe). Many of these successes stem from the French governance model which, like much of Europe, has a framework that colourfully mixes state investment, passenger revenue and partnerships across borders. India's high-speed rail ambitions could benefit from adopting elements of this integrated approach, including sustainable financing, competitive pricing strategies, and robust international collaborations (Zembri, 2011).

United Kingdom's railway network has long been archaic and was thoroughly reorganized when British Rail was privatized in the 1990s. In the U.K. model, infrastructure ownership is separate from train operations, which are run by private entities via competitive franchise bids, with Network Rail managing tracks and signals. Although this model brought in competition that improved customer service, it also created fare increases, financial problems, and inefficiencies in franchise management. Where these types of trends seem to differ over the water in the UK, is in the government ownership of railways, which has been more and more reshaping itself, to becoming a direct authority over many subsidies being brought back under

the government, not only to be sure that trains run on time but watch the financial stability of subsidies, to in a direct and mutual way with the traveller and consumer. The lesson from the UK example for India is one of balanced privatization, as in, ensuring private sector participation does not result in higher fares or disruptions in services, while at the same time retaining the oversight of the government over critical infrastructure (Kabeer, 2021).

The Swiss Federal Railways (SBB) operates a largely integrated, highly punctual and electrified rail network. With unified intercity rail, suburban transit, and bus networks, Switzerland boasts one of the highest railway usage rates per capita. When it comes to punctuality, passenger convenience and environmental responsibility, the Swiss system has it all: heavy emphasis on rail electrification and carbon neutrality goals. Switzerland's prioritization of sustainable rail infrastructure, energy-efficient railway operations, and multimodal connectivity could be relevant for India to develop a greener railway future (Swissinfo, 2025).

Table 1 helps to resume the diverse approaches to railway governance across the world, it is useful to examine how leading countries manage their rail systems. Each model—whether privatized, hybrid, or state-driven—offers valuable insights into efficiency, sustainability, passenger service, and financial viability. The following table provides a comparative overview of railway governance models in Japan, Germany, China, the United States, France, the United Kingdom, and Switzerland, highlighting key features and the potential lessons they offer for Indian Railways.

Country	Governance Model	Key Features	Lessons for India
Japan	Privatized, regional companies (JR Group)	Divided after 1987 JNR privatization; strong autonomy; revenue from real estate, tourism, and logistics; efficient, punctual, safety-focused (Shinkansen as global benchmark)	Regional management with private sector participation and strict safety regulations
Germany	Hybrid (Deutsche Bahn)	State-owned but operates independently; profit-center charter; multimodal integration; track	Introduce track access reform; enable competition in passenger and freight while retaining state control of

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		access for private operators	infrastructure
China	State-driven (CRC)	Largest HSR network; heavy subsidies; integrated with Belt and Road Initiative; public funding + domestic manufacturing; streamlined land acquisition	Emphasize long-term investment, public funding, and coordinated infrastructure planning
United States	Decentralized, freight-dominant	Freight tracks privately owned; Amtrak publicly funded; profitable freight rail; advanced logistics & automation; weak passenger rail	Encourage private sector in freight corridors; prioritize efficiency and logistics
France	State-owned (SNCF)	TGV integrated with conventional rail; subsidized infrastructure; competitive pricing; strong overseas involvement	Integrated financing approach; adopt competitive pricing; strengthen international partnerships
United Kingdom	Privatized operations, public infrastructure	Network Rail manages tracks; private franchises run trains; improved service but fare hikes & inefficiencies; recent trend back to more public control	Balance privatization with government oversight; ensure fare stability and service reliability
Switzerland	Integrated, state-owned (SBB)	Highly punctual and electrified; unified intercity, suburban, and bus systems; strong focus on sustainability and carbon neutrality	Prioritize electrification, punctuality, and multimodal connectivity for a green railway future

Table 1: Global Models of Railway Governance and Lessons for Indian Railways

4. REGULATORY CHALLENGES IN INDIAN RAILWAYS

Indian Railways, one of the largest railway networks in the world, is vital for the Indian government and plays a crucial role in driving the economy, strengthening transport infrastructure, and enhancing social connectivity. Despite its scale and strategic importance, the sector faces significant regulatory challenges that hinder its efficiency, modernization, and financial sustainability. These challenges stem from outdated legal frameworks, bureaucratic inefficiencies, limited private sector participation, financial constraints, and slow adoption of technology. Embedded within these issues are regulatory bottlenecks which, if left unresolved, will prevent Indian Railways from evolving into a globally competitive and future-ready transportation system (Fenske et al., 2023).

One of the major concerns before Indian Railways is the archaic legal and regulatory architecture that oversees its functions. The 1989 Railways Act, which is the sector's "mother" legislation, has not been developed in accordance with the changing dynamics of railway management in the present era. A lot of arrangements are still quite prescriptive and won't allow for more independence in making decisions or conducting commercial operations. Besides, several regulatory authorities, such as the Ministry of Railways, the Railway Board and other government departments, create bureaucratic redundancy that hampers quick implementation of policy. Without a common regulatory framework, decision-making, infrastructure growth, and project delivery become inefficient. A revamped regulatory regime where Indian Railways operates with greater autonomy, yet is subjected to checks and balances, could solve these problems (Goyal, 2014).

Independent regulator's failure for railway tariff setting and infrastructure management is another major issue. Unlike other transportation sectors which have independent regulatory bodies, for example, civil aviation and telecom, Indian Railways operates under direct government control with political interference in pricing, fare structures, and operational decision making. The long-standing lack of an independent regulator setting railway price and service standards hampers both passengers and freight operators, as policymaking tends to be influenced by populism rather than economic logic. An independent Railway Regulatory Authority of India (RRAI) with clearly laid down powers and responsibilities will bring in transparency, promote fair competition and financially sustainable pricing policies (Financial Express, 2023).

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Inefficiencies in project execution, compounded by bureaucratic hurdles, make the regulatory landscape even more complex. Railway infrastructure projects in India are often delayed due to lengthy approval processes, land acquisition challenges, and interdepartmental conflicts. While global railway systems have successfully leveraged the PPP model for infrastructure development, Indian Railways has struggled to sustain private sector participation through public-private partnerships. Although policy initiatives such as station redevelopment, freight corridors, and dedicated high-speed rail corridors aim to attract private investment, investors remain cautious due to regulatory uncertainties, weak contract enforcement, and limited return on investment. Establishing clearer contractual obligations, well-defined risk-sharing mechanisms, and effective dispute resolution frameworks could create a more transparent and investor-friendly regulatory environment, which is essential to strengthening private sector involvement in railway modernization (Shrivastava et al., 2019).

The financial sustainability of many rail systems remains a persistent challenge, largely due to the cross-subsidization of passenger fares through freight revenues. Unlike in many developed economies where railway operations are largely self-sufficient, Indian Railways relies heavily on an internal subsidy mechanism, with higher freight tariffs offsetting unrealistically low passenger fares. This, however, results in uncompetitive freight rates, driving sectors toward alternative modes of transport such as road and air. Railway finances could be strengthened through regulatory reforms that encourage dynamic pricing, flexible tariff structures, and increased freight privatization—while ensuring passenger affordability is not compromised. Moving toward a more transparent, market-driven pricing system, where subsidies are limited to essential social services, could significantly improve revenue generation and secure long-term financial sustainability (Beria et al., 2025).

Financial sustainability is closely tied to the competitiveness of freight transport. The following comparative chart illustrates the per-ton-kilometer costs of railway, road, and air transport in India, providing insights into the challenges Indian Railways faces in maintaining freight market share.

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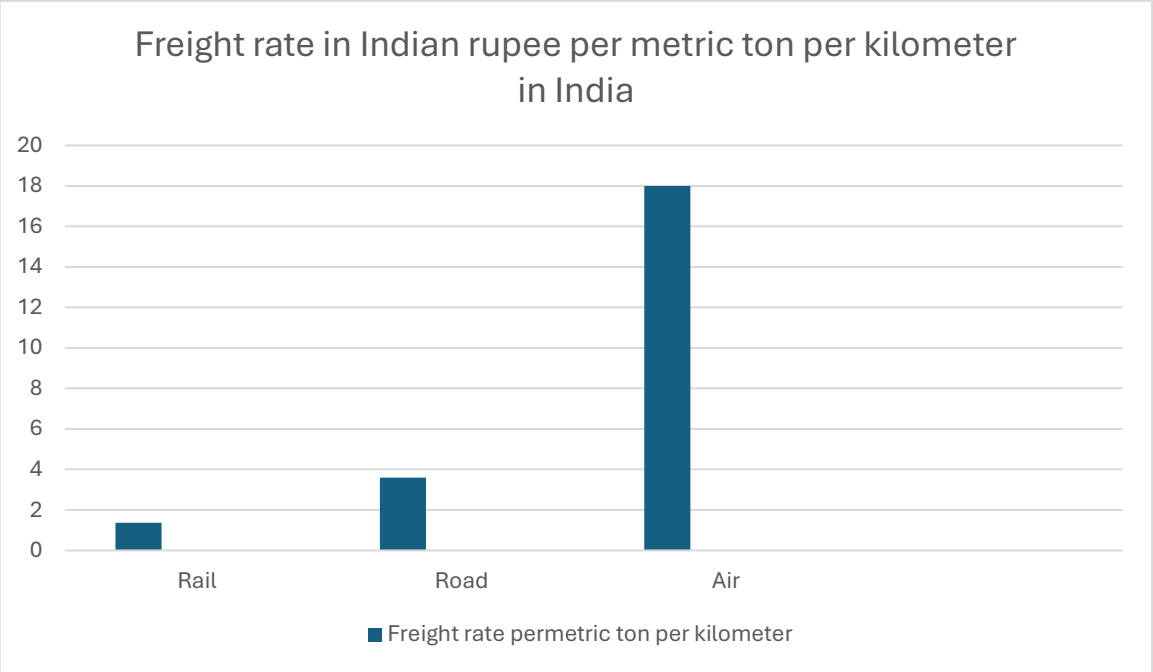

Figure 4: Comparative study of the freight rate in railway, road, and air in India in 2021 (Source: Statista 2025 - Sun, 2021)

Another critical aspect of railway privatization and grant privatisation is the absence of clear regulations. The liberalization of passenger train operations in India is a crucial step towards establishing a competitive rail industry; however, in order to ensure the success of the initiative, a comprehensive regulatory framework still needs to be developed that would govern the operations between the public and private sector. The challenges often faced by private players include track access policies, infrastructure-sharing agreements, revenue-sharing models, and competitive neutrality. Unlike the models in Germany or the UK, where the industry is opened up to private operators on a level playing field vis-a-vis state-run railway companies, the regulatory structure is still not in place in India to ensure a fair competitive environment. Defining track access charges; clarifying operational guidelines and performance benchmarks would pave the way for smoother entry of private players into the railway ecosystem (Dhameja & Dhameja, 2021).

Safety regulations and compliance frameworks remain significant regulatory challenges for Indian Railways. With one of the largest passenger volumes globally, safety and risk management are central to its operational strategy. However, accidents caused by derailments, signaling failures, and human errors continue to occur despite numerous safety initiatives. The enforcement of railway safety is currently fragmented, with multiple agencies overseeing different aspects, often causing delays in

implementation. Strengthening deterrence through enhanced enforcement powers, mandatory safety audits, and leveraging technology for monitoring by the Commission of Railway Safety (CRS) would improve regulatory effectiveness. Additionally, establishing clear accountability structures and accelerating the implementation of long-promised safety modernization plans—such as automatic train control systems and predictive maintenance technologies—are essential (Crawford & Kift, 2018).

There are also regulatory challenges for the integration of technological advances within Indian Railways. Automation, artificial intelligence, and Internet of Things (IoT) technologies have been adopted and acted upon by global railway systems to improve their overall performance, efficiency, and passenger experience, while regulations governing such technology adoption in India are not clearly defined. This is also true for issues connected to data privacy and cybersecurity, interoperability of railway technology, and AI-based frameworks for decision-making. Like the consumer products we enjoy, setting high-level regulations for smart railway systems, digital ticketing platforms and AI-driven predictive analytics for maintenance would be useful to accelerate the deployment of these modern railway technologies (Sarp et al., 2024).

Another layer for regulatory complexity is environmental sustainability. As concerns grow over climate change and the carbon footprint, railway systems across the world are shifting to green energy, railway electrification, and sustainable practices. While Indian Railways has been given ambitious targets for electrification and carbon neutrality, the regulatory framework for energy efficiency, green financing, and environmental compliance for railway projects is fragmented. Policies related to the integration of renewable energy, building of green freight corridors, and sustainable development of the railway must also be strengthened to ensure adherence to international environmental standards for long-term sustainability (Press Information Bureau, 2022).

Finally, the labour and workforce modernisation challenges facing Indian Railways must be addressed by the regulatory framework. Railway sector is one of the leading public sector employers with over 1.2 million employees in India. But inflexible workforce policies, intricate service rules and an unwillingness to adopt performance-based employment structures in a timely manner are impeding workforce efficiency. Regulatory bottlenecks faced by automation, digitalization, and workforce restructuring between labour unions and employee welfare make automation difficult.

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Progressive labour laws, skill development initiatives, and regulatory policies that ensure a balance between automation and job security would help in smoothly transitioning to modern railway operations (India Brand Equity Foundation, 2024).

As a result, Indian Railways is still not on track to become a world class state-of-the-art railway operation. Regulatory bottlenecks facing the sector range from outdated legal frameworks, bureaucratic inefficiencies, financial imbalances and safety concerns to lack of participation by the private sector and technological gaps. Tackling the challenges requires comprehensive reform of regulations including an independent regulator for railways, single-window clearance mechanisms for projects, a clear policy for private participation, updated tariffs, an outcome-oriented safety regime and tech-based models of governance. It will further enable Indian Rails to unlock the potential of innovation, empowered decision making and economic growth thereby enhancing the value for passengers and maximizing freight operations; While this is primarily based on available data up to October 2023, Indian Railways has already announced a thrust in this direction through potential strategic regulatory reforms (Narayan & Reddy, 2025).

To contextualize the challenges discussed, the next figure presents a summary of the major regulatory bottlenecks confronting Indian Railways today. This visual overview helps clarify how different issues intersect to affect the sector's growth and modernization.

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Figure 5: Regulatory Challenges in Indian Railways

5 STRATEGIC POLICY RECOMMENDATIONS

A comprehensive and modern policy framework is essential for Indian Railways—one that ensures efficiency, competitiveness, environmental sustainability, financial resilience, regulatory modernization, safety, private sector participation, and integrated technology adoption. Similar frameworks have been advocated in recent policy and academic research, underscoring the need for structural reforms in Indian railways (Raghuram et al., 2023).

The key policy must be the creation of an independent regulatory authority to oversee tariff structures and competition as well as infrastructure-sharing policy. Indian Railways does not have a dedicated regulator with autonomous decision-making powers as is the case with other transport sectors like aviation and telecom. A well-defined jurisdiction for the proposed Railway Regulatory Authority of India (RRAI) would depoliticize fare-setting mechanisms and establish market-driven pricing with transparency in railway operations. The role of the regulatory body would also be to

oversee participation by the private sector, arbitration of disputes, and the maintenance of quality control to facilitate the rendering of services in an efficient manner. An effective regulatory authority would, on the one hand, create a level playing field for all public and private players involved in the sector while maintaining accountability and service efficiency (Raghuram et al., 2023; Chhabra, 2011).

A second key policy recommendation is liberalising railway operations to attract investment from the private sector. Though the government has begun to take steps to introduce private operators on some routes, policies detailing access to the tracks, revenue-sharing and operational guidelines are still unclear. Infrastructural, operational and financial concessions will also lead to greater comfort for investors. In addition, a well-defined Public–Private Partnership (PPP) model for the redevelopment of stations, the development of freight corridors as well as for high-speed rail projects would help in accelerating the pace of infrastructure. Drawing lessons from successful international models like Japan's privatized Shinkansen train system or Britain's Train Operating Companies model combined with Railtrack model where the franchise is strictly bounded while operators can make profits and provide quality service, Indian Railways contracts must be structured to allow for private participation in a way that ensures the protection of national railway interests (Swain & Pradhan, 2020).

Railway electrification and the adoption of green technologies must also be examined in the context of India's international environmental obligations. Under the Paris Agreement (2015), India committed to reducing the emissions intensity of its GDP by 33–35% by 2030 relative to 2005 levels and achieving net-zero emissions by 2070 (Marik & Dutta, 2023a). Indian Railways' target of becoming a net-zero carbon emitter by 2030 places it at the forefront of India's climate action agenda (Shrivastva & K.C., 2024).Furthermore, railway electrification aligns with Sustainable Development Goals 9 (Industry, Innovation, and Infrastructure) and 13 (Climate Action) by promoting sustainable transport and reducing fossil fuel dependency (Shrivastva & K.C., 2024). Similar commitments are visible in the European Union's Green Deal, which mandates the doubling of high-speed rail traffic by 2030 as part of its 55% emissions reduction target (Kampp et al., 2025).

Financial restructuring and revenue diversification are also priorities. The contribution of Indian Railways towards cross-subsidization of passenger fares with freight revenue has resulted in an uncompetitive freight tariff regime, which has driven industries to switch to other modes of transport. Such a dynamic price model that

strikes a balance between affordability and financial viability would ease pressures on current freight tariffs and would also make passenger fares more sustainable moving forward. Moreover, Indian Railways must also work on non-fare revenue where they can focus on communicating stations, advertisement, real-estate transit-oriented development around railway corridors, and integrate digital service. From a long-term perspective, a better alternative would be to monetize railway land assets, as has been successfully done in countries such as Hong Kong and Singapore (Kampp et al., 2025).

Renovation of Railway infrastructure for only high-speed rail, dedicated freight corridors, electrification, and smart railway stations. While projects like the Mumbai-Ahmedabad Bullet Train and Dedicated Freight Corridors (DFC) are a step in the right direction, policy measures must ensure timely execution and cost control. To bridge the financing gap, we will need a dedicated Infrastructure Investment Fund supported by sovereign funds, global investors and multilateral banks. Also, policy supportive for indigenous manufacture of railway components, modernisation of rolling stock, automated train control systems will contribute to technology self-reliance. Policy frameworks should be developed to integrate the adoption of Building Information Modeling (BIM) and Artificial Intelligence (AI) for the use in railway planning, predictive maintenance and operational efficiency (Sitharamaraju et al., 2020).

One of the most important aspects in railway operations is safety, hence, a national railway safety strategy has to be employed, with strict measures. There is a patchwork of regulations on railway safety spread across several agencies with partial duties. The Railway Safety Board should be integrated, have enforcement powers, and enforce compliance, legitimate independent safety audits and accident prevention mechanisms. Monitoring technologies such as AI-powered predictive maintenance systems and automatic train control should be mandated as policy measures to reduce the occurrence of human errors and infrastructure failures. The implementation of the Kavach Train Collision Avoidance System (TCAS) reflects this policy direction, as highlighted in field trials reported by Times of India (Times of India, 2025).

Encouraging efficiency also requires ensuring that the workforce is modernised, and human resources are optimised, so policy frameworks should focus on that as well. As one of the largest employers in the country, Indian Railways grapples with several challenges, such as an aging workforce, skills gap and inflexible employment structures. There is a need for a policy change that encourages performance-based

recruitment, skills upgrade and computer literacy training. For all of this to seamlessly translate into tech led operations, structured re-skilling programs should be planned for the employee base commensurately alongside new tech roll outs like AI configured ticketing, AI led train scheduling and freight digitization etc. Also, rationalizing recruitment processes, and onboarding of lateral hires from engineering, AI, and logistics would maximize workforce efficacy (Times of India, 2025).

Policy has to emphasise on Sustainability and green railway initiatives. Indian Railways target net-zero carbon emissions by 2030, policy measures must carve out specific road maps for adopting green energy, railway electrification, hydrogen-powered trains, and sustainable station designs (Ahsan et al., 2023). The production of more solar and wind energy, the increasing electrification of railroads (which reduces the need for polluting diesel-powered locomotives), should also be policy priorities. Incentives for green freight corridors, sustainable designs for railway stations and water conservation measures should be introduced. Moreover, a carbon credit trading mechanisms for these railway sustainability projects could also provide a secondary source of revenue whilst allowing compliance with international environmental obligations (Marik & Dutta, 2023b).

Integrating digital technologies into regulation is crucial for operational efficiency. AI-enabled predictive maintenance, optimized scheduling, intelligent ticketing, and robust cybersecurity frameworks should be incorporated under a National Railway Digitalization Roadmap. Studies advocate close collaboration with global tech firms and research institutions to build indigenous AI solutions (Marik & Dutta, 2023b).

Finally, as alluded to above, international collaboration and benchmarking could yield invaluable lessons for forthcoming rail policies. Harnessing global best practices from countries like Japan, Germany, China, and France, Indian Railways should implement international operational standards, safety protocols, and efficiency models. Even policy agreements with foreign railway organizations, sharing of technology, and active participation and facilitation in international railway development summits would keep India one of the global leaders in railway innovation (Marik & Dutta, 2023b).

As we look forward to paving way for a new era of growth for Indian Railways it is critical to have a structured, guided policy framework driven by regulatory reforms & enablement of private sector participation, enforceability of financial restructuring,

safety, workforce expansion & upgrade, sustainability & digital transformation. All together this sprite policy recommendation if implemented could turn the Indian railways a world class, well elaborate transportation network that could contribute to the Indian economy, logistics equity and sustainability objective.

Finally, the following figure outlines the key strategic policy recommendations proposed in this study. It synthesizes the measures required for Indian Railways to achieve efficiency, financial resilience, and global competitiveness.

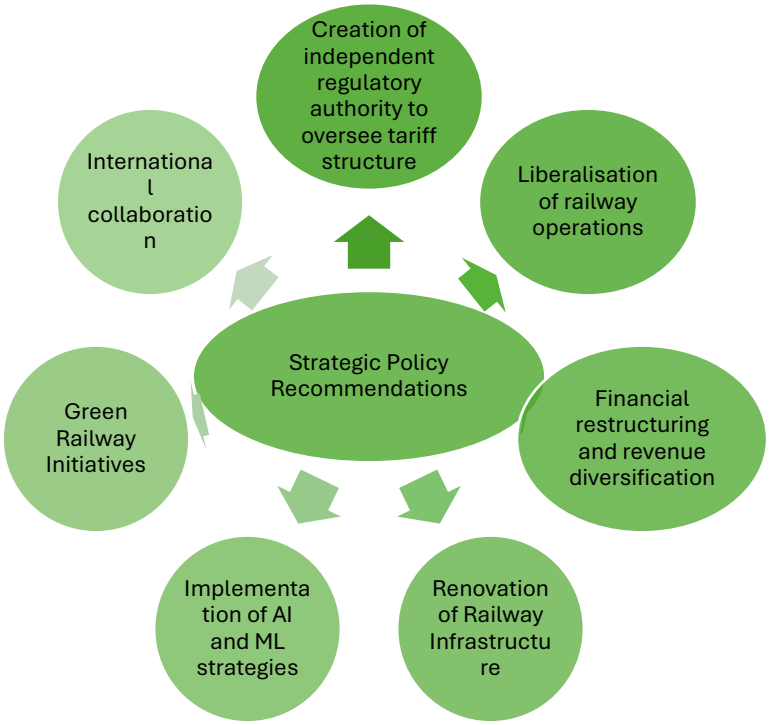

Figure 6: Strategic Policy Recommendations for development of Indian Railways

6 CONCLUSION

The future of Indian Railways, therefore, depends on a legal framework — well defined — regulatory modernization and policy interventions. It is a significant contributor to Indian economic development, connectivity and sustainability, being among the largest railway networks in the world. Nonetheless, it is still held back from its true potential by regulatory hurdles, financial obstacles, and operational inefficiencies.

The modernization of Indian Railways must be approached not only as a matter of governance and economic efficiency but also as a constitutional and international

obligation under the framework of environmental law. Anchoring reforms in the Environment Protection Act, 1986, expanding reliance on renewable energy, and ensuring compliance with India's Paris Agreement commitments will be pivotal in making Indian Railways a cornerstone of sustainable development. Judicial precedents from the Indian Supreme Court reinforce the imperative of embedding environmental safeguards into railway policy. Comparative experiences, from the European Green Deal to Germany's Climate Protection Act, demonstrate that binding legal frameworks can successfully align transport infrastructure with long-term sustainability goals. Thus, the future of Indian Railways depends on a holistic legal architecture that integrates climate resilience, environmental protection, and sustainable mobility at its core.

In order to develop a strong future-ready railway system, a multi-dimensional approach must be adopted focusing on governance, private sector participation, safety, sustainability and digital transformation at railways. This would boost transparency, efficiency, and competition in the sector through a separate and independent regulatory authority.

Liberalising railway operations, and service delivery through structured public-private partnerships will attract investment, dynamic pricing models and the generation of non-fare revenues through an integrated transport ecosystem that will lessen reliance on freight revenue cross-subsidization in the sector. Moreover, innovations like AI, predictive maintenance, and the investment in high-speed rail infrastructure would elevate both efficiency measures and the passenger experience.

There needs to be sustainability for the future at the core of operations, with a strong commitment to railway electrification, the adoption of green energy, and carbon-neutral targets. Moving forward, international collaboration and global best-practice benchmarking will be essential in modernising Indian Railways.

Investment in railways in the present will create big employment opportunities in the future, up-skilling Indian manpower and making Indian Railways a world-class transportation network, laying the framework for economic growth and technological leadership leading the foundation for a future-ready India with far-reaching economic ramifications.

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