BRICS TRANSPORT
VOL. 4 ISSUE 4 2025
TRANSPORT HISTORY
ИСТОРИЯ ТРАНСПОРТА

Review article
UDC 625
doi: 10.46684/2025.4.7
EDN: JGISXY

Development of passenger transportation on Indian railways: The end of the 20th and the first decades of the 21st century

Vladislav B. Zakharov[1]✉, Egor Komarov[2]

[1] Emperor Alexander I Petersburg State Transport University (PGUPS); St. Petersburg, Russian Federation
[2] Independent researcher; St. Petersburg, Russian Federation
[1] vlad_zaharov@mail.ru✉; https://orcid.org/0009-0000-7195-3632
[2] komar77@internet.ru

ABSTRACT At the end of the 20th century and in the first decades of the 21st century, India achieved significant success in modernizing its rail transport. Good progress has been achieved in almost all branches of the railway sector. The infrastructure has been improved — the Project Unigauge, a nationwide initiative aimed at converting the country's railway network into a single wide (1,676 mm) gauge system, has been almost completed. Currently, broad gauge railways account for about 97% of the total operational length. In parallel with the reconstruction of the tracks, many bridge crossings have been renovated, and improvement of station and logistics facilities is underway. The electrification of broad gauge tracks is nearing completion; electrified lines currently account for more than 99% of their total length. Railway automation, telecontrol and telecommunication systems are being intensively modernized, and digital technologies are being increasingly used. The rolling stock is being radically updated, including both traction facilities and passenger and freight carriage fleets. High-speed traffic is developing, and the construction of India's first specialized Mumbai–Ahmedabad high-speed rail line is being completed. The article examines one of the activities of the railways of India — long-distance railway passenger transportation. The authors continue their historical research of the period from the appearance of the first railways in India in the 19th century to the present day. The previous parts of the study were published in this journal in 2023–2024[1].

KEYWORDS: Indian railways, passenger transportation, passenger rolling stock, EMU, passenger travel classes, travel comfort, ticket booking

For citation: Zakharov V.B., Komarov E. Development of passenger transportation on Indian railways: The end of the 20th and the first decades of the 21st century. *BRICS Transport*. 2025; 4(4):7. https://doi.org/10.46684/2025.4.7. EDN: JGISXY.

Обзорная статья

Развитие пассажирских перевозок на железных дорогах Индии: конец XX столетия — первые десятилетия XXI века

В.Б. Захаров[1, 2]✉, Е. Комаров[1, 3]

[1] Петербургский государственный университет путей сообщения Императора Александра I (ПГУПС); г. Санкт-Петербург, Россия
[2] Независимый исследователь; г. Санкт-Петербург, Россия
[1] vlad_zaharov@mail.ru✉; https://orcid.org/0009-0000-7195-3632
[2] komar77@internet.ru

[1] Zakharov V.B., Komarov E. Railways of India. An important stage of modernization is completed — unification of track width. *BRICS Transport*. 2023;2(2):1-12. https://doi.org/10.46684/2023.2.1.
Zakharov V.B., Komarov E. Railways of India. Time to update and upgrade. *BRICS Transport*. 2023;2(3):1-12. https://doi.org/10.46684/2023.3.3.
Zakharov V.B., Komarov E. Passenger Rolling Stock of Indian Railways in the First Half-Century of Their Operation. *BRICS Transport*. 2024;3(1):1-14. https://doi.org/10.46684/2024.1.2.
Zakharov V.B., Komarov E. The development of passenger carriage design and passenger service on the railways of India: The end of the 19th – the first half of the 20th century. *BRICS Transport*. 2024;3(4). https://doi.org/10.46684/2024.4.3.

АННОТАЦИЯ В конце XX в. — в первые десятилетия XXI в. Индия добилась значительных успехов в модернизации железнодорожного транспорта. Положительные результаты были достигнуты практически во всех отраслях железнодорожного комплекса. Совершенствовалась инфраструктура — практически завершен общенациональный проект Unigauge, направленный на объединение железнодорожной сети страны в единую рельсовую систему с переустройством ее на широкую колею 1676 мм. В настоящее время железные дороги широкой колеи составляют около 97% всей эксплуатационной длины. Параллельно с реконструкцией путей обновлены многие мостовые переходы, совершенствуется станционное и логистическое хозяйство. Близок к завершению процесс электрификации магистралей широкой колеи, сегодня электрифицированные линии превышают 99% общей их протяженности. Интенсивно ведется модернизация систем железнодорожной автоматики, телемеханики и связи, все шире используются цифровые технологии. Кардинально обновляется подвижной состав: как средства тяги, так и пассажирский, грузовой вагонный парк. Развивается скоростное движение, завершается сооружение первой в Индии специализированной высокоскоростной железнодорожной магистрали Мумбаи – Ахмадабад.

В статье рассматривается одно из направлений деятельности железных дорог Индии — дальние пассажирские перевозки. Авторы продолжают историческое исследование периода от появления первых железных дорог в Индии в XIX в. до наших дней. Предыдущие части опубликованы в настоящем журнале в 2023–2024 гг.[2].

КЛЮЧЕВЫЕ СЛОВА: железные дороги Индии; пассажирские перевозки, подвижной состав; электропоезда; электросекции; EMU; классы проезда пассажиров, комфорт проезда; бронирование билетов

Для цитирования: *Захаров В.Б., Комаров Е.* Развитие пассажирских перевозок на железных дорогах Индии: конец XX столетия — первые десятилетия XXI века // Транспорт БРИКС. 2025. Т. 4. Вып. 4. Ст. 7. https://doi.org/10.46684/2025.4.7. EDN: JGISXY.

PHENOMENON OF DEVELOPING A NEED FOR MASS PASSENGER TRANSPORTATION IN INDIA

By 2024, the population of India exceeded 1.46 billion people[3]. Despite the fact that residents of India are less mobile than in many other countries, the number of passengers on rail transport, as the most accessible mode of transport for the majority of the population, is high, and in absolute terms, the number of passengers carried is higher than in China. For instance, in 2023, Indian railways (excluding metro systems) carried 6,396.0 million passengers as compared to 2,798.7 million passengers in China, despite the fact that the population numbers of the two countries are close. However, in China, rail travels cover on average longer distances, hence higher annual passenger figures: 1,341,037 million passenger-kilometers (2023) in China compared to 958,919 million passenger-kilometers in India. Nevertheless, this figure is also high in India[4].

High passenger traffic in India is largely contributed to by a significant number of the country's holidays, primarily religious ones. While India is a secular state, various studies show that less than 1% of its population consider themselves non-religious. The main religions practiced are Hinduism (about 80% of the population), Islam (about 14%), Christianity (2.5–3%), Sikhism (about 2%), and Buddhism (about 1%)[5].

In India, adherents of all religions have their own holidays. The country has 18 non-working public holidays during a year. For comparison, South Korea has

[2] *Захаров В.Б., Комаров Е.* Железные дороги Индии. Завершается важный этап модернизации — унификация ширины колеи. Транспорт БРИКС. 2023. Т. 2. Вып. 2. Ст. 1. https://doi.org/10.46684/2023.2.1.
Захаров В.Б., Комаров Е. Железные дороги Индии: время обновления и модернизации. Транспорт БРИКС. 2023. Т. 2. Вып. 3. Ст. 3. https://doi.org/10.46684/2023.3.3.
Захаров В.Б., Комаров Е. Пассажирский подвижной состав железных дорог Индии в первые полвека их работы. Транспорт БРИКС. 2024. Т. 3. Вып. 1. Ст. 2. https://doi.org/10.46684/2024.1.2.
Захаров В.Б., Комаров Е. Развитие конструкций пассажирских вагонов и обслуживание пассажиров на железных дорогах Индии: конец XIX — первая половина XX столетия. Транспорт БРИКС. 2024. Т. 3. Вып. 4. Ст. 3. https://doi.org/10.46684/2024.4.3.
[3] Current World Population. URL: https://www.worldometers.info/world-population/.
[4] Statistics — Synopsis. 2025 UIC Publication 2024. URL: https://uic.org/IMG/pdf/railway_statistics_synopsis_2024web_1866037339.pdf
[5] BRICS. Trade Union Forum. URL: https://tufbrics.org/ru/info/28/.

17, Japan has 15, and Russia has 14 public holidays. In developed Christian countries, the average number of public holidays ranges between 11 and 13 (11 in the United States, 12 in Italy, and 13 in Germany)[6].

In 2025, India declared 78 religious holidays, mass public ceremonies, and remarkable dates of varying significance, from national holidays to events in individual states, groups of states, and municipalities[7].

In India, it is usual to celebrate holidays both of one's own faith and of other faiths with friends, acquaintances, co-workers, and neighbours. Because of this, the country's legislation limits the number of non-working days allotted to employees. Most of them have the right to choose 2 out of the 24 restricted holidays based on their nationality or religion.

Many Indians have a deeply ingrained traditional notion that during holidays they must visit their family members, friends, and, with the rise of prosperity in recent decades, often distant relatives — not just by degree of kinship but also literally "distant", those living far away. What seemed impossible just half a century ago — visiting relatives on holidays — is increasingly becoming the norm today, filling trains, buses, and planes on pre-holiday days.

In addition to religious holidays, there are secular ones, as well as numerous festivals, fairs, exhibitions, and popular sports competitions often held in the country. For example, the calendar of the main national fairs, exhibitions and festivals (excluding sports events) for January–December 2025 includes 51 events[8].

RAILWAYS AS INDIA'S MAIN MODE OF TRANSPORT FOR MASS, LONG-DISTANCE PASSENGER TRANSPORTATION. IMPROVING THE PASSENGER RAIL ROLLING STOCK FLEET

Previous publications by the authors provide an overview of the main stages in the development of the passenger rolling stock fleet, from the inception of the Indian railways in the 19th century to the mid-20th century[1, 2]. A major achievement of the Indian railways after the country's independence in 1947 was the creation of its own coach-building industry.

In 1955, Integral Coach Factory (ICF), one of the first major mechanical engineering companies in the independent India, was established in Chennai (known as Madras before 1996), with technical assistance from Swiss Car and Elevator Manufacturing Corporation Ltd.

Fig. 1. ICF coach with Second Class seats on the Mumbai (CSMT)–Pune Pragati Express (12125). Photo by the authors. March 2019

Indian engineers in cooperation with Schweizerische Wagons- und Aufzügefabrik AG (SWS, Swiss Railcar and Lift Factory Corporation, known colloquially as "Wagi", which was based at Schlieren, canton of Zurich, Switzerland) designed a new 22.2 m long (over buffers), 3.2 m wide, and 4.0 m high 1,676 mm gauge unibody coach that could travel at a maximum speed of 130 km/h. It is important to note that by the mid-20th century, a significant portion of the rail coach fleet of the Indian railways still had either a wooden body frame or a wooden body on a steel frame [1].

Release of new rail coaches fully meeting the requirements of the 1950s started on October 2, 1955. The ceremony was attended by India's Prime Minister Jawaharlal Nehru.

Starting with 350 coaches per year, the Integral Coach Factory now manufactures 1,800 coaches per year of different types and various comfort level (class), air-conditioned and non-air-conditioned coaches, trailer and motor carriages (*Fig. 1*).

For more than 30 years, ICF coaches were the backbone of India's rail coach fleet. However, by the late 1980s, the overall obsolescence of coaches built in the late 1940s became increasingly evident.

The management and engineers of Indian Railways embarked on a search for structural concepts to create a new 1,676 mm gauge lightweight coach capable of traveling at a greater maximum speed of at least

[6] Public holidays in various countries. 2023. URL: https://www.snegovik.ru/articles-new-year/skolko-otdykhayut-v-raznykh-stranakh/.

[7] Holidays and Observances in India in 2025. URL: Holidays and Observances in India in 2025.

[8] Calendar of Events in India for 2025. Embassy of India Economic and Commerce Wing. Manila. URL: https://www.eoimanila.gov.in/docs/1733396115CALENDAR_OF_EVENTS_IN_INDIA2025-2026.pdf.

160 km/h. Besides, the coach was supposed to be safer in operation than ICF coaches, and in particular to prevent telescoping of the vehicle bodies in train collision accidents[9].

In 1995, Linke-Hofmann-Busch (LHB) was chosen as a contractor. Later it changed its owner and became Alstom LHB GmbH in 1998. The company was awarded two contracts: to design a new high-speed coach for the 1,676 mm gauge and to transfer technology and launch manufacturing of coaches at an Indian facility[10].

In 1998, the first LHB high-speed rail coaches were manufactured. During test runs, they reached a speed of 180 km/h (the maximum speed in commercial service is 160 km/h). In 2000, large-scale manufacturing of various types of rail coaches began, including service carriages with electric generators and luggage compartments (*Fig. 2*, *3*).

At present, coach-building factories in India manufacture a wide range of passenger rail coaches. The rolling stock will soon be supplemented with vehicles manufactured by Kinet Railway Solutions, a Russian-Indian joint venture, which will launch the production of the Vande Bharat[11] — modern, high-speed AC multiple-unit trains for the 1,676 mm gauge. The train is a proprietary Indian solution of the Integral Coach Factory in Chennai as part of the Make in India initiative launched by the Indian Government (*Fig. 4*). The prototype was created in 2018 and reached a speed of 183 km/h during test runs. (Its design speed is 160 km/h.) The train is made up of 8, 16 or 20 coaches of various classes and is designed for operation on routes of up to 800 km.

The first Vande Bharat Express was put into operation in February 2019. In January 2025, 66 trains were in operation providing services on more than 150 routes, including 15 trains of 16 coaches, 8 trains of 20 coaches, and 43 trains of 8 coaches [2, 3].

Vande Bharat trains are manufactured at several coach-building factories in India and have proven themselves as reliable, economical, and comfortable vehicles for passengers. A decision was made to buy several thousands of these trains in the coming years [4]. In 2022, the Government of India announced an international tender for setting up manufacturing of the latest modification of the Vande Bharat in India.

Fig. 2. LHB coach with air conditioning and three-tier sleeping berths (3AC) (with reserved seats). Photo by the authors. March 2019

Fig. 3. LHB carriage with an electric generator and luggage compartment. Photo by the authors. March 2019

Fig. 4. One of the first Vande Bharat trains[12]

In 2023, a consortium led by Transmashholding JSC, Russia, won a USD6.5 billion international tender for the design, manufacturing and 35-year maintenance of 1,920 coaches for long-haul Vande Bharat electric trains in three passenger classes. Kinet Railway Solutions, a Russian-Indian joint venture, was established for this purpose [2]. The prototype of the first Vande Bharat from Kinet Railway Solutions is ex-

[9] Telescoping occurs when the underframe of one carriage smashes through the other carriage's body as a result of a catastrophic collision. The resulting appearance of the two vehicles resembles the tubes (segments) of a telescope (spyglass) inserted into each other.

[10] Linke-Hofmann-Busch (LHB). URL: https://transportpedia.org/manufacturers/lhb.

[11] Initially, this was known as "Train 18". In 2018, the name was changed to "Vande Bharat" (meaning "I glorify India" or "I bow to India" in Hindi).

[12] Make in India: creating a new center for railway engineering Rolling Stock. ТМХ Август, 2023. URL: https://rollingstockworld.ru/proizvodstvo/make-in-india-sozdavaya-novyj-czentr-zheleznodorozhnogo-mashinostroeniya/

Fig. 5. Exterior of the new Vande Bharat train designed by Kinet Railway Solutions. Design presentation[13]

Fig. 6. Interior of a sleeper compartment on the new Vande Bharat train designed by Kinet Railway Solutions. Design presentation[13]

Fig. 7. Interior of a Vande Bharat sleeper coach designed by Kinet Railway Solutions. The coach has an open-plan layout with two-tiers of berths for passengers (similar to a Russian-style "reserved seat" coach). Design presentation[13]

pected to be released in 2026 [4]. In March 2024, the company published a computer-aided design visualisation of the exterior and interiors of the new train coaches (*Fig. 5–7*).

CURRENT STRUCTURE OF PASSENGER COACHES ON INDIAN RAILWAYS BY TRAVEL CONDITIONS AND COMFORT LEVEL

In India, railways remain the cheapest and most affordable mode of transport. Passengers riding on roofs of trains and literally hanging on to the outer structures of carriages, once typical of the country's railways, have almost become a thing of the past or can be seen on very rare occasions. Nevertheless, it is quite difficult to buy a ticket for many railway lines on the eve of public holidays, religious or public activities, trains are overcrowded, often exceeding the standard capacity, especially in cheaper classes. Indian Railways has to organise and introduce additional "holiday trains" in pre-holiday periods. Organise and introduce are not reserved and passengers occupy the entire space of the coach. The launch of these trains is widely announced before major holidays [5].

India has 11 classes of passenger trains and coaches, varying by the travel comfort level, seating type, availability of basic and additional services, and fare [6–9].

There are two main groups of coach classes, primarily depending on whether air conditioning is available or not. Given the climatic conditions in most regions of India, it is air conditioning in passenger rail coaches that determines the level of travel comfort during significant periods of the year.

In travel documents, coaches with air conditioning are designated as "AC" (air-conditioned). To designate an air-conditioned coach, the "A.C." letters are usually written on its side wall.

AC (Air-conditioned) Classes

1AC or 1A. *AC First Class: air-conditioned sleepers*

Passengers are accommodated on berths in two- and four-berth compartments with lockable doors (*Fig. 8*). At the ends of the corridor, each coach has two toilets, an Asian-style toilet[14] and a Western/European-style toilet. The latest series of coaches are provided with environmentally friendly, vacuum evacuation toilets, which passengers can use at any time, including the dwell time at a station

Each berth is provided with a full bedding set and a pillow. For all air-conditioned classes, bedding is included in the ticket price. First Class is the most expensive among sleepers.

[13] The public was shown the design of Russian trains for intended for Indian Railways. March 2024. URL: https://salt.news/promishlennost/publike-prezentovan-dizajn-rossijskih-poezdov-dlya-indijskih-zheleznyh-dorog

[14] The so-called Asian or squat toilets are common in some Asian and African countries. In many Muslim countries, washing with water is a mandatory cultural practice and it is easier done in this type of toilet than in a sitting position in European toilets.

a *b*

Fig. 8. AC1 LHB coach: *a* — exterior on the Rajdhani Express (Mumbai–Delhi Rajdhani); *b* — AC1 two-berth sleeper on the Rajdhani Express. This is a two-berth compartment on the Mumbai–Delhi Rajdhani Express. *Photos courtesy of Nonstop Eurotrip [8]*

2AC or 2A. ***Two-Tier Class:*** Two-tier berths with air conditioning. There are compartments without doors (thick fabric curtains are available) along the side aisle, each has four berths across the coach and two side berths. Each berth is provided with a pillow, sheet, blanket, and face towel. There are two toilets at each end of the coach (in total, four): an Asian toilet and a Western one. In these carriages, washbasins are installed in the entrance vestibules. The price for the air-conditioned two-tier class is almost half the cost of the AC First Class (*Fig. 9*).

3AC or 3A. ***AC Three-Tier: Air-conditioned coaches with berths arranged in three tiers in transverse bays and two tiers in side longitudinal bays.*** These coaches also have bays without doors (and without curtains) as in two-tier coaches, but the transverse rows have three berths one above the other, at the lower, middle, and upper tier. During the daytime, the middle berth is folded down, allowing three passengers to sit on the lower berth. The side berths are arranged in two tiers only (no middle berth is available). Each berth is provided with a pillow, sheet, and blanket.

3E ***AC Three-Tier-economy. Air-conditioned coaches with all berths arranged in three tiers, including in side bays.*** What differs it from 3AC is that side longitudinal bays have one more berth. This class is the cheapest among air-conditioned sleepers.

EA. ***Executive Anubhuti Chair Car:*** **Air-Conditioned Executive Class with comfortable, soft collapsible seats — the so-called Anubhuti coaches (in Hindi Anubhuti means feelings, sensations).** Relatively wide seats are arranged in rows in a 2+2 configuration across the coach and spaced relatively far apart, providing passengers with some degree of privacy (*Fig. 10*). Recently, branded express trains have been

Fig. 9. Interior of a bay on a 2AC coach. View from the four transverse sleeping berths to the two longitudinal berths, with the lower berths converted to seats during the daytime. *Photos courtesy of Nonstop Eurotrip [8]*

Fig. 10. Interior of Executive Anubhuti Chair Car (EA) on the Shatabdi Express[15]

[15] Anubhuti AC chair for Shatabdi. The Hindu. December 2017. URL: https://www.thehindu.com/news/cities/Hyderabad/anubhuti-ac-chair-for-shatabdi/article22277934.ece

Fig. 11. Interior of CC coach of the Vande-Bharat train. Photos courtesy of Nonstop Eurotrip [8]

provided with mechanised seats with remote controls, so that passengers can convert them into a berth-like sleeping space, similar to business class on airplanes. Additional amenities include TV sets mounted on the front seatbacks. This class is quite popular with wealthy people traveling on daytime trains with a travel time of up to five hours. These executive class coaches are included in several comfortable express trains, such as the Tejas Express, Gatimaan Express, and Shatabdi Express. The ticket price is close to that for domestic air flights.

EC. ***Executive Chair Class: Air-conditioned coaches with comfortable collapsible seats*** (Air-Conditioned Executive Chair Class). Chairs are arranged in a 2+2 configuration across the carriage and have no additional equipment that is available on EA coaches.

CC. ***AC Chair Car: Air-conditioned coaches with soft chairs*** arranged in transverse rows in a 2+3 configuration (*Fig. 11*). The chairs are narrower than those in the Executive Chair Class and are closer to each other. This class of coaches is most frequently found in daytime trains with travel times of up to five hours.

Non-Air-Conditioned Classes

F or FC. ***First Class without air conditioning.*** In this class, coaches are arranged in the configuration similar to that of air-conditioned first class coaches. Bedding is available for an extra fee. In recent years, this class of coaches is gradually put out of service (*Fig. 12*), and passengers are increasingly giving preference to 1C or 2C coaches.

SL. ***Sleeper Class.*** Coaches are arranged exactly in the same configuration as those with three tiers of berths, but have no air conditioning. Bedding is not included in the ticket price, but is available for an extra fee. Passengers are increasingly opting for 2AC coaches over these ones.

2S. ***Second Class.*** In India, this class provides an opportunity to travel by rail on reserved seats at the lowest price. The majority of second class coaches (*Fig. 13–17*) have wooden benches placed installed

Fig. 12. Non-air-conditioned first class (F or FC) ICF coach. Photo by the authors, 2019

a *b*

Fig. 13. Non-air-conditioned second class (2S) ICF coach: *a* — exterior of a train at the platform before boarding (the luggage ready for loading); *b* — interior of a coach with benches, each for three passengers. Photo by the authors, 2013

Fig. 14. Non-air-conditioned 2S ICF coach. Asian/squat toilet. Photo by the authors. 2019

Fig. 15. Non-air-conditioned 2S ICF coach. European/western toilet. Photo by the authors. 2019

Fig. 16. Non-air-conditioned 2S ICF coach. Entrance vestibule. Washbasin. Photo by the authors. 2019

across the central aisle of the carriage. Each bench can accommodate three passengers. Most second class coaches have no window glass, but are equipped with grilles to prevent unauthorized persons from getting into the carriage from platforms and protect passengers from accidental falling out. As windows have no glazing, but there are thick pull-down curtains (these can be seen in *Fig. 13*, *a*), passengers can ventilate the cabin.

GN. *Unreserved/General Class.* The class name "GN" stands for General Number (*Fig. 18*). It uses both seating coaches and coaches with two- or three-tier berths (similarly to SL coaches). This is the cheapest class. Similarly to non-air-conditioned second class, the majority of these coaches have no window glazing, but there are fixed grills and thick drop-down curtains.

To conclude this overview of the structure of passenger train classes of Indian Railways, let us compare approximate fares on the example of a trip by the

Fig. 17. Non-air-conditioned 2S ICF coach. Entrance vestibule. Folding berth for an on-duty attendant. Photo by the authors. 2019

Fig. 18. Non-air-conditioned ICF coach. GN: unreserved/general class with seating. Photo by the authors. 2019

New Delhi Rajdhani Express 2050 along the 1,072 km railway route between New Dehli and Samastipur where an approximate travel time is 18 hours 30 minutes. For reference, the travel time by air is 2 hours 57 minutes.

Indian Railways has fixed travel fares for different passenger coach categories. The AC First Class fare is approximately equivalent to the cost of a flight. For the route in question, a passenger will pay 3,500 rupees for AC First Class, 2,700 rupees for AC 2, and 1,455 rupees for AC 3 (as of 2022).

MODERN RESERVATION AND TICKETING SYSTEM ON INDIAN RAILWAYS

Until the late 20th century, India had a generally archaic ticketing system, where tickets could be bought at railway stations. The system was limited to individual railway companies. Accounting for and registration of available tickets, distribution of seats for selling through specific ticket offices, and similar operations were done manually by railway operators with the use of telephone and telegraph [10].

Passengers had many complaints regarding the system. Booking errors, duplicate tickets sold, and misuses were frequent, for example, tickets for popular destinations were bought up and then resold at a higher price, etc.

In 1999, the Government of India founded, through its Ministry of Railways, the Indian Railway Catering and Tourism Corporation (IRCTC). It was designed to organize a system for booking and selling railway tickets, on-board catering, and tourist services [10].

On August 3, 2020, IRCTC launched an online ticketing system for Indian Railways. This digital innovation marked the switch from conventional ticket offices to online booking via an accessible platform. The launch of the IRCTC website was a revolutionary step in the development of ticket booking for millions of travellers [9].

In general, the system made the booking process more transparent for passengers. It also takes account of various factors when providing railway tickets to different groups of passengers, based on differences in their social status, gender, age, and so on. The system became more publicly perceived as a fairer one, given the existing shortage of carrying capacity in passenger traffic, especially on pre-holiday days.

In 2012, the Rolling Deposit Scheme (RDS) was introduced to simplify booking. It is a sort of a “wallet” that allows customers to book tickets using the deposited funds they deposit. In 2013, IRCTC expanded its services to include hotel and air travel booking.

When buying tickets for long-distance trains via the IRCTC system on the official website of Indian Railways (irctc.co.in), as well as through a ticket office at a railway station, one passenger can get no more than six tickets per train, which should be kept in mind when traveling as a large group. The IRCTC system does not guarantee that your seat and seats of your companions will be next to each other — it is a kind of lottery. When

booking a ticket, you can state your preferences, such as “window”, “aisle”, “lower berth”, “side berth”, etc., but in reality, it is only upon boarding when the passenger learns where their seat is.

The exceptions are the air-conditioned Executive Chair Class (EC); air-conditioned First Class coaches with sleeping berths (1AC); AC Chair Class; and non-air-conditioned First Class (FC).

For all the other classes, when boarding the train, you must check whether your ticket is listed on the so-called charts, displayed on special information stands on platforms or outside of the coach. Charts may be displayed one or two hours before the train departure, but sometimes this happens just a few minutes before the departure (*Fig. 19–21*). An automatically generated seat number is indicated in charts. A seat is selected by computer based on the gender and age information for all the passengers traveling in the class.

Since usually there are not enough seats for everyone on any train, the e-ticketing system has special protocols for those who want to buy tickets: RAC (Reservation Against Cancellation) and WL (Waiting List).

The queue for tickets under the RAC protocol starts forming immediately after all of the reserved seats have been sold. After a while, no RAC seats are left and the system begins to generate a WL queue.

WL tickets indicate mean that all seats on the train have been sold out, but you can buy a place in the queue. When buying a place in the queue, a potential passenger is assigned a unique number which shows how many people are ahead of them on the waiting list. If someone cancels their ticket, the system automatically allocates it to the next person in the queue.

RAC tickets mean that passengers have purchased half a seat (for example one lower side seat). If someone cancels their ticket, the seats are first allocated to RAC members and then to WL members. If no one cancels a ticket, two RAC members are guaranteed one lower berth.

The booking and ticketing system of Indian Railways is constantly improved to benefit passengers and improve capacity utilization. Until the summer of 2025, the above mentioned chartrs (booking schemes) were prepared and displayed four hours before the departure, which created difficulties and uncertainty for passengers, especially those arriving at stations from regions. Currently, measures are being taken to ensure chartrs are prepared eight hours before the departure [11, 12].

The IRCTC system serves millions of people every day by booking and selling railway tickets, which is not easy, given the limited transport resources on railways, as well as personal needs, financial capabilities, timeframes, and limitations of each of millions

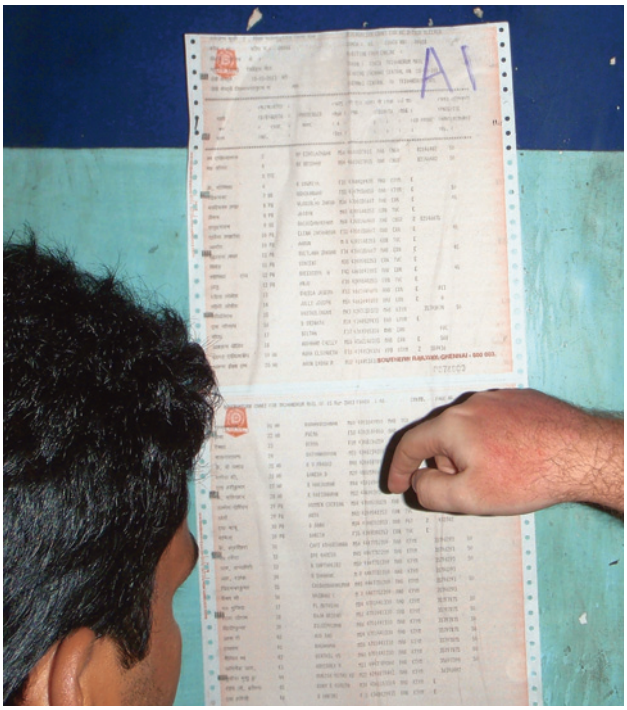

Fig. 19. Chart with names and surnames of passengers displayed on an information stand or on the outside of the coach before train departure. It replaces tickets and boarding passes for passengers who have purchased e-tickets and presented their ID. Photo by the authors. 2013

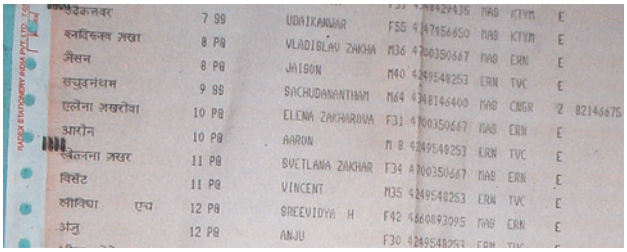

Fig. 20. The authors’ names and surnames on a passenger chart. Photo by the authors. 2013

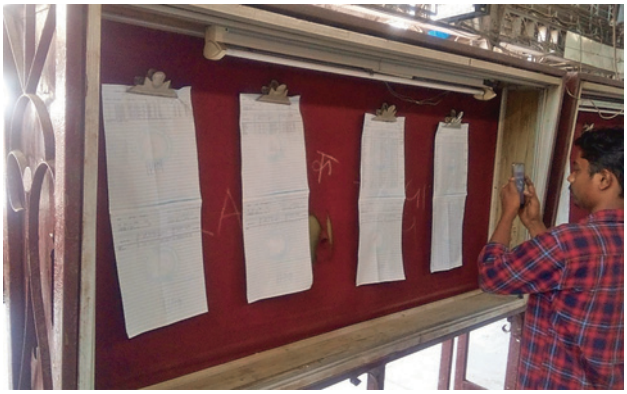

Fig. 21. Information stand on a passenger platform with charts listing names and surnames of passengers holding RAC and WL tickets. Photo by the authors. 2019

of people. In order to take into account all the priorities and satisfy the majority of interested passengers, the IRCTC system has introduced quotas for allocation of train seats among different categories of potential passengers[16].

Annually, quotas on the number of passengers in various transport (service) classes are set for 19 categories of passengers based on a review of the domestic passenger railway market in different classes/segments of transport. Some examples of quota categories include women; women over 45 years of age or women with children under 12 years of age traveling unaccompanied; people with disabilities; the military personnel; railway workers traveling for business; parliament members; foreign tourists, etc. The announced quota system for each line and each day helps manage the public perception of ticket shortage as an unpleasant but manageable situation[16].

TOURIST AND LUXURY TRAINS ON INDIAN RAILWAYS

The story of long-distance passenger traffic on Indian railways would be incomplete without a brief description of increasingly popular highly comfortable trains known as luxury trains, as well as tourist trains attracting growing attention among both residents and foreign visitors [13].

Some luxury trains operate on routes overlapping with those of regular trains, but they differ from the latter in their refined luxury and comfort of coaches, including premium dining carriages. After all, the purposes of luxury trains, as well as regular ones, is to bring passengers from point A to point B, while providing them with a particularly comfortable, even luxurious, travel experience.

Tourist trains travel along special routes. What is important for travellers is not the fact that they travel to a certain destination, but the journey as such, where they have an opportunity to do sightseeing along the way, visiting beautiful natural sceneries or monuments of architecture and history.

Coaches of the majority of tourist trains have similar comfort classes as those above 2C and 3C found in modern Indian long-distance passenger trains, and they are ICF and LHB carriages.

At the same time, a number of tourist trains are distinguished by a high level of comfort and exquisite design of their carriages and hence can be referred to as luxury tourist trains. Designed to provide a very comfortable leisure experience, in terms of their functionality, they are close to river, sea or ocean cruise ships[17]. Luxury tourist trains are made up of highly comfortable coaches, but the design of some carriages also allows travellers to enjoy good views of the surroundings, as well as take photos and videos [13].

In some cases, tourist trains have an observation carriage (*Fig. 27–30*) at the rear of the train[18]. These carriages are used on the majority of world's railways as service ones for technical inspections of the track by managers and engineers of various levels. Due to increased train speeds, modern observation carriages have an enclosed rear area with wide panoramic windows on three sides.

On routes abundant in mountainous areas, tourist trains often have the so-called "dome cars", so that passengers can more easily get what can be notionally called "vertical views" or "vertical panoramas"[19]. These have a glazed roof or glazed sections on the top shaped as a glass dome or hump projecting several tens of centimetres above the roof (within the safe upper clearance of the train).

Apart from luxury tourist trains, relatively inexpensive tourist trains affordable to the general public that have a modest design, but are comfortable are increasingly operated by Indian Railways. In recent years, the rail coach-building industry in India has been manufacturing carriages for these trains that are close to standard ones in terms of comfort levels and technical equipment.

As a result of the Project Unigauge implemented by Indian Railways, broad-gauge rail lines currently account for about 97% of the total operational length of the country's railway network. Most metre- and

[16] IRCTC Quota List. URL: https://www.redbus.in/indian-railways/irctc-quota-list.
[17] Cruise ships are large passenger ships used mainly for vacationing. Unlike ocean liners, which are used for transport, cruise ships typically embark on round-trip voyages to various ports of call, where passengers may go on tours known as "shore excursions".
[18] Known since as early as the mid-19th century, these carriages originally had an open platform with railings at the rear of a vehicle. Passengers could safely go out onto it as the train moved. Being somewhat protected from the wind by the end wall of the carriage, passengers could enjoy a nearly 360-degree view of the surrounding terrain "running away" from the train. In the late 19th century, especially in the United States, observation cars were popular on luxury trains.
[19] A dome car is a type of passenger carriage that has a glass dome on the top of it, so that passengers sitting on the upper level of the carriage can have an all-round view of the surroundings or look upwards to capture vertical views of the mountains, which is impossible in regular passenger carriages.

Fig. 22. The Golden Chariot luxury tourist train [13]

narrow-gauge railways have been converted to broad-gauge or closed.

Some of metre- and narrow-gauge railways in India have been recognized as historical heritage and preserved. Their routes usually run through picturesque areas, making them extremely attractive to tourists. Regular routes of many broad-gauge railways also pass through picturesque natural areas. Thus, broad-, metre-, and narrow-gauge trains operate as tourist trains in India.

Luxury trains are made up of both older luxury saloon coaches that have undergone complete overhaul and renovation and new ones manufactured for the purpose on the basis of ICF and LHB passenger coaches. In recent decades, quite a few saloon coaches built in the first decades of the 20th century that are distinguished by sophisticated finishes, but technically too obsolete for regular operation have been taken out of service. Some of them have been thoroughly rebuilt including the restoration of the undercarriage, body, and braking equipment, and outfitted with modern air conditioners, sanitary facilities, and other devices. The interiors have been restored, too. These coaches have been put into operation as part of luxury trains and luxury tourist trains with the original corporate livery (*Fig. 22*).

At a rough estimate based on data available on the Internet and reference publications, there are more than fifty luxury trains, luxury tourist trains, and tourist trains in India.

On January 27, 1989, Indian Railways and Rajasthan Tourism Development Corporation (RTDC) put into service one of the first luxury tourist trains, the Palace on Wheels. It operates between Delhi and the state of Rajasthan[20], which is known for its royal culture and beautiful palaces. The train covers about 3,000 km, running through the cities of Jaipur, Jaisalmer, Jodhpur, Udaipur, and Ranthambore in eight days and bringing travellers to Agra to see one of the wonders of the world, the Taj Mahal (*Fig. 23*)[21] [13].

Fig. 23. Bedroom of a Presidential Suite on the Palace on Wheels luxury tourist train[21]

[20] Rajasthan is the largest state in India. Founded in 1949 in the historical region of Rajputana, it is located in the northwest of the country. Its capital and largest city is Jaipur.
[21] The Palace on Wheels. URL: www.thepalaceonwheels.org.

Fig. 24. Dining carriage on the Maharajas' Express luxury tourist train[23]

Fig. 25. Kitchen of the dining carriage on the Maharajas' Express[23]

We will use this train as an example to examine how luxury tourist trains are set up and arranged. The train has 20 carriages, 14 of which can accommodate 82 travellers. There are two classes of suite cabins: two Super Deluxe Presidential Suites and 39 Deluxe cabins.

In addition to 14 coaches with tourists, the train has a spa carriage offering a wide range of services to travellers, two dining carriages, and two service carriages for the train crew and service staff, which also have stockroom. The train has an electric power carriage, which supplies power for air conditioning, lighting in carriages, operation of eco-friendly evacuation toilets, etc. Other luxury tourist trains are set up approximately in the same way as the Palace on Wheels. The total number of carriages on various trains ranges from 14 to 23 (the Maharajas' Express)[22, 23].

The suites on the Palace on Wheels are named after precious stones. They are decorated using the colour of the corresponding stone and are lined with silk and velvet. The suite has a bedroom (*Fig. 23*), a study with a desk and sofa, and a private bathroom. Adjacent to the suite there is a service compartment for a butler [13].

Some of the interiors of passenger coaches on luxury tourist trains are shown below (*Fig. 24–26*).

Apart from luxury tourist trains, Indian Railways operate tourist trains for a broader range of travellers — people with middle income. For traveling on narrow-, metre-, and broad-gauge tracks, coach-making factories in India produce special tourist coaches known as "Vistadome" (from the English words *vista* (a distant view) and *dome*)[24] (*Fig. 27–30*).

Tourist routes also run along the metre- and narrow-gauge railways that still remain in service. In addition, a number of these lines are currently listed as Indian and UNESCO World Heritage Sites and taking a trip on them is of particular interest.

An earlier article published by the authors describes the rolling stock that was used for regular passenger traffic in the mid-20th century on metre- and

Fig. 26. Fitness centre on the Deccan-Odyssey luxury tourist train[25]

[22] The longest passenger train Prayagraj Express operates between New Delhi and Prayagraj and has 24 carriages.
[23] The Maharajas' Express. URL: https://www.tripadvisor.ru/Attraction_Review-g304551-d15133137-Reviews-Maharajas_Express-New_Delhi_National_Capital_Territory_of_Delhi.html
[24] The Vistadome. Enjoy expansive views of memorable routes. URL: https://artsandculture.google.com/story/the-vistadome-enjoy-expansive-views-of-memorable-routes-rail-enthusiasts-society/SwUhyI0V7j1BIA?hl=en.
[25] The Deccan Odyssey. URL: https://www.tripadvisor.com/Attraction_Review-g304554-d628517-Reviews-Deccan_Odyssey-Mumbai_Maharashtra.html#/media-atf/628517/354872336:p/?albumid=-160&type=0&category=-160.

Fig. 27. Vistadome (AC TOURIST CAR (LWTFCZAC/WTFCZAC). The glass roof and observation area at the rear of the coach are visible[24]

Fig. 28. Vistadome (AC TOURIST CAR (LWTFCZAC/WTFCZAC) with an observation area with wide glass windows at the rear of the coach[26]

Fig. 29. Vistadome (AC TOURIST CAR (LWTFCZAC/WTFCZAC). Interior of an observation area with wide glass windows at the rear of the coach[24]

narrow-gauge railways in India[27]. Later these carriages were also included in trains on tourist routes that opened on these lines.

In recent years, interest in tourist trips on historical railways, including metre- and narrow-gauge lines, has increased significantly. India's coach-making factories currently produce the second model of the Vistadome narrow-gauge carriage designed for tourist trains (*Fig. 31–34*).

The Him Darshan Express[28], a tourist train made up of 762 mm gauge Vistadome coaches, took its first trip on December 26, 2019 on the Kalka–Shimla Railway[29],

Fig. 30. Interior of the Vistadome (AC TOURIST CAR (LWTFCZAC/WTFCZAC) coach with tourists [14]

[26] The Vistadome Experience. URL: https://www.tripoto.com/karnataka/trips/the-vistadome-experience-3b4f69901a5636271.
[27] Zakharov V.B., Komarov E. Passenger Rolling Stock of Indian Railways in the First Half-Century of Their Operation. *BRICS Transport*. 2024;3(1):1-14. https://doi.org/10.46684/2024.1.2.
Zakharov V.B., Komarov E. The development of passenger carriage design and passenger service on the railways of India: The end of the 19th — the first half of the 20th century. *BRICS Transport*. 2024;3(4). https://doi.org/10.46684/2024.4.3
[28] The name Him Darshan Express (The Himalayas Darshan Express) derives from a popular tourist viewpoint, the Himalaya Darshan, in the Himalayan foothills along the Kalka–Shimla railway.
[29] A 96.6 km long narrow-gauge mountain railway opened in 1903 connects Kalka (a city in Northern India, the state of Haryana) and Shimla (the capital of the state of Himachal Pradesh and a mountain resort in Northern India). The line made it possible to comfortably travel to the previously virtually inaccessible town of Shimla in the mountains in just six to seven hours. Small trains operated on this narrow-gauge line were called "toy trains" — a name still often used nowadays, especially by journalists.

Fig. 31. The first Kalka–Shimla Him Darshan Express with the first generation of Vistadome coaches with the glass roof. Departure from Kalka station. December 26, 2019 [15]

Fig. 32. Interior of the first-generation Vistadome coaches with the glass roof on the Kalka–Shimla Him Darshan Express [15]

Fig. 33. The Kalka–Shimla Him Darshan Express tourist train with the first-generation Vistadome coaches with the glass roof[30]

which is a UNESCO World Heritage Site [15]. The carriages looked much like old narrow-gauge ones, but had the glass roof for vertical views (*Fig. 31–33*). The train had one air-conditioned first-class coach.

In 2023, the Rail Coach Factory at Kapurthala[31] began to manufacture modern, comfortable 762 mm gauge Vistadome coaches with seats, panoramic windows, and a glass roof (*Fig. 34*, *35*). All carriages have air conditioning facilities [16].

CONCLUSION

By the end of the first quarter of the 21st century, a significant progress has been made in the development of passenger travel on the Indian railways, which remain the primary mode of transport in the country with the largest population on the globe.

Passenger transport was improved through the implementation of the Project Unigauge, which has

[30] https://www.business-standard.com/article/current-affairs/trial-run-of-vistadome-coaches-on-kalka-shimla-route-to-be-conducted-soon-123010800177_1.html

[31] Founded in 1985, it is a coach-building factory of Indian Railways in the state of Penjab. Currently, it manufactures new LHB and MEMU passenger coaches and narrow-gauge railway carriages.

Fig. 34. A train comprised of new Vistadome coaches on the Kalka–Shimla Railway. A power carriage can be seen in the middle of the train [16]

Fig. 35. Interior of the new Vistadome coaches on the Kalka–Shimla Railway [16]

integrated the country's entire railway network into a 1,676 mm gauge system, accounting for about 97% of the total operational length of railways in India.

The near completion of the electrification of broad-gauge trunk lines, which currently account for about 99% of the total operational length, is also very important for enhancing the operation of the country's railways. This has made it possible to increase speeds, the weight of freight trains, and the length of passenger trains, and improved compliance with the timetable for passenger trains. The projects to build a single broad-gauge railway system and electrify the Indian railways were implemented in combination with the renewal of the rolling stock fleet, both freight and passenger carriages and traction units, using powerful electric locomotives and modern multiple unit passenger trains for both commuting and long-distance travels.

The electrification of railways has significantly improved the environmental situation, brought the country closer to zero carbon emissions, and substantially reduced its dependence on exports of liquid hydrocarbon fuels for diesel locomotives. In India's locomotive fleet, diesel locomotives are gradually converted into stand-by power units intended for use in emergency situations, in particular, in case of climate disasters (hurricanes, natural calamities), when disruptions to railway power supply are possible.

It should be noted that the country's transition to a single railway system with a broad gauge of 1,676 mm, which is not a standard gauge in the world, is likely to create difficulties in operating both the standard 1,435 mm (HSR) and broad gauge rail systems in passenger traffic in the future. This is predicted based on ambitious plans to build a high-speed rail (HSR) network, which, according to international experience, can be assumed to be built on a standard 1,435 mm gauge.

Nevertheless, we can currently see a significant progress in the comprehensive modernization of Indian railway transport, a dramatic improvement in passenger service, making it more accessible to people, and increasing travel speeds, comfort, and safety levels.

REFERENCES

1. Integral Coach Factory. *Accelerating the design process with ENOVIA*. URL: https://www.3ds.com/insights/customer-stories/integral-coach-factory/.

2. *Воронин Д.* Мантуров рассказал о проекте российско-индийского скоростного поезда [Voronin D. Manturov spoke about the Russian-Indian high-speed train project]. *Lenta.ru. Economy*. 20.08.2025. URL: https://lenta.ru/news/2025/08/20/manturov-rasskazal-o-proekte-rossiysko-indiyskogo-skorostnogo-poezda/.

3. ट्रेन में जहाज जैसी सुविधा... दिवाली से पहले रेल यात्रियों को मिलेगी स्लीपर वंदे भारत की सौगात! [A ship-like facility in the train... Rail passengers to get sleeper Vande Bharat Ki saagat ahead of Diwali!]. *Hindi News Business railway*. 11.10.2025. URL: https://navbharattimes.indiatimes.com/business/railway/first-ac-coach-of-sleeper-vande-bharat-could-be-unveiled-ahead-of-diwali/articleshow/124471898.cms.

4. Barua K. List of all vande bharat express trains in India 2025. *JAGRAN JOSH*. 10.11.2025. URL: https://www.jagranjosh.com/general-knowledge/list-of-vande-bharat-trains-in-india-1673878045-1.

5. Mishra A.K. Indian Railways: रेलवे का बड़ा फैसला, दिवाली और छठ पूजा के लिए फिर चलाई ये नई स्पेशल ट्रेनें, देखें Time Table [Indian Railways to launch special trains for Diwali and Chhath Puja]. *Jagran*. दैनिक जागरण; 15.10.2025. URL: https://www.jagran.com/bihar/bhagalpur-indian-railways-latest-news-ministry-of-railways-gave-good-news-to-train-passengers-as-new-special-trains-started-for-diwali-and-chhath-2025-40010033.html.

6. Ivana D. Seat Types on Indian Railways. *trainspread.com*. 04.01.2025. URL: https://www.trainspread.com/india/indian-train-seat-types/.

7. Maurya S. Ac से लेकर स्लीपर तक, जानें भारतीय रेलवे में कितनी तरह की होती है सीट [From Ac to sleeper, know how many seats are there in Indian Railways Let us know in this article How many types of seats are there in Indian Railways and which seats are comfortable]. *Herzindagi. Herzindagi Hindi*. 15.07.2022. URL: https://www.herzindagi.com/hindi/diary/berth-types-in-train-article-203059.

8. Train travel in India — a beginner's guide | How to buy tickets online. *www.seat61.com*. URL: https://www.seat61.com/India.htm.

9. Vichar Amrit. जानें ट्रेन के 1st, 2nd, 3rd AC में फर्क, क्या-क्या मिलती हैं सुविधाएं [Know the difference between 1st, 2nd, 3rd AC of the train, what facilities are available]. आजकाल. URL: https://www.amritvichar.com/article/239399/know-the-difference-between-1st-2nd-3rd-ac-of-the-train-what-are-the-facilities-available#gsc.tab=0.

10. Snehal Ratnaparkhi. The history of IRCTC: From PUBLIC SECTOR UNDERTAKING TO MARKET LEADER. Samco Securities. *Samco.in*. 07.03.2024. URL: https://www.samco.in/knowledge-center/articles/the-history-of-irctc/.

11. Indian Railways set to launch smarter, faster ticketing system: All you need to know. *India Today*. 02.07.2025. URL: https://www.indiatoday.in/india/story/indian-railways-ticket-booking-system-upgrade-2748107-2025-06-30.

12. Indian Railways announces three big steps for train ticketing! New charting, Tatkal ticket booking, reservation system — what they mean for passengers. *Times of India*. 02.07.2025. URL: https://timesofindia.indiatimes.com/business/infrastructure/indian-railways-announces-three-big-steps-for-train-ticketing-new-charting-tatkal-ticket-booking-reservation-system-what-they-means-for-passengers/articleshow/122143108.cms.

13. Bakshi P. Go beyond first class luxury aboard the most expensive trains in India. *Travel + leisure Asia India*. 18.05.2024. URL: https://www.travelandleisureasia.com/in/destinations/india/expensive-train-rides-in-india/.

14. Kaushik K., Bakshi P. Explore these scenic Indian journeys with Vistadome Coaches. *Travel + leisure Asia India*. 29.12.2023. URL: https://www.travelandleisureasia.com/in/destinations/india/indian-destinations-you-can-travel-to-in-vistadome-coaches/.

15. New Him Darshan Express train starts between Kalka and Shimla. *The Economic Times | Industry*. URL: https://economictimes.indiatimes.com/industry/transportation/railways/new-him-darshan-express-train-starts-between-kalka-and-shimla/sight-seeing-from-the-train/slideshow/72989558.cms/.

16. Toy Train: 115 साल पुरानी टॉय ट्रेन अब बन जाएगी इतिहास, कालका-शमिला ट्रैक पर दौड़ेंगे सेमी-वस्टिाडोम कोच [115-year-old toy train to become history, semi-vistadom coach to run on Kalka-Shimla track]. साल पुरानी. 30.05.2023. URL: https://www.amarujala.com/shimla/four-semi-vistadome-coach-on-kalka-shimla-heritage-railway-track-by-kapurthala-rail-coach-factory-2023-05-30?pageId=1.

Bionotes

Vladislav B. Zakharov — Cand. Sci. (Eng.), Associate Professor of the Railway Department; **Emperor Alexander I St. Petersburg State Transport University (PGUPS)**; 9 Moskovsky ave., Saint Petersburg, 190031, Russian Federation; SPIN-code: 7503-1282, ID RSCI: 662988, ResearcherID: IST-9636-2023, ORCID: 0009-0000-7195-3632; vlad_zaharov@mail.ru

Egor Komarov — **Independent researcher**; Saint Petersburg, Russian Federation; komar77@internet.ru.

Об авторах

Владислав Борисович Захаров — кандидат технических наук, доцент кафедры «Железнодорожный путь»; **Петербургский государственный университет путей сообщения Императора Александра I (ПГУПС)**; 190031, г. Санкт-Петербург, Московский пр., д. 9; SPIN-код: 7503-1282, РИНЦ ID: 662988, ResearcherID: IST-9636-2023, ORCID: 0009-0000-7195-3632; vlad_zaharov@mail.ru

Егор Комаров — **независимый исследователь**; г. Санкт-Петербург, Россия; komar77@internet.ru.

Contribution of the authors: the authors contributed equally to this article.
The authors declare no conflicts of interests.
Заявленный вклад авторов: все авторы сделали эквивалентный вклад в подготовку публикации.
Авторы заявляют об отсутствии конфликта интересов.

Corresponding author: Vladislav B. Zakharov, vlad_zaharov@mail.ru.
Автор, ответственный за переписку: Владислав Борисович Захаров, vlad_zaharov@mail.ru.

The article was submitted 14.10.2025; approved after reviewing 12.11.2025; accepted for publication 28.11.2025.
Статья поступила в редакцию 14.10.2025; одобрена после рецензирования 12.11.2025; принята к публикации 28.11.2025.