IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

VOLUME : 10 ISSUE : 03 Print / Issue Publication Date: 03-Sep-2025

ISSN : 2455-2143

DOI : 10.33564/IJEAST.2025.v10i03.010

Indexed In

Google SCHOLAR OPEN ACCESS doi Crossref

WWW.IJEAST.COM

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International Journal of Engineering Applied Sciences and Technology, 2025
Vol. 10, Issue 03, ISSN No. 2455-2143, Pages 53-56
Published Online July 2025 in IJEAST (http://www.ijeast.com)

REIMAGINING INDIAN RAILWAYS FOR SAFER AND EFFICIENT PASSENGER EXPERIENCE

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Abstract: **Indian Railways is a state-owned enterprise that is organised as a departmental undertaking of the Ministry of Railways of the Government of India. Being one of the world's largest rail networks transporting over 23 million passengers daily, The Indian Railways continue to face critical issues including overcrowding, disorganized boarding, safety hazards, loosing personal belongings and luggage, and lack of modern safety systems. This research proposes a redesign of the railway experience with practical and adaptable solutions such as queue-based boarding zones, QR-coded luggage tracking and time-based entry for crowded stations. This study aims to reduce congestion, improve safety, and create a more structured and intelligent travel experience across both suburban and intercity train systems.**

Keywords: **Indian Railways, Safety, QR-coded luggage tracking, queue-based boarding**

I. INTRODUCTION

Indian Railways is the fourth largest Railway network in the world after US, Russia and China. Nearly 20,000 trains are run carrying more than 2.5 crores passengers every day. In terms of passenger kms Indian Railways (IR) tops the list, with 1046 billion passenger-kilometre (pkm) [2]. It plays a vital role in connecting cities, towns, and rural areas, serving as an essential mode of transport for millions of Indians every day [4]. As of 2024, it manages the fourth largest national railway system by size with a track length of 135,207 km with more than 1.2 million employees [3]. Despite its vast scale and critical role in national connectivity, Indian Railways continues to face persistent issues in operations and passenger service challenges.

Over 100,000 train-related deaths occurred in India between 2017 and 2021, according to a 2022 report published by the National Crime Records Bureau. This also includes cases in which passengers fell from carriages and were hit by speeding trains in addition to train collisions [5]. Trains are the fastest as compared to road travel in cities like Mumbai. Due to its extensive reach across Mumbai city, its suburbs as well as Thane, Karjat, Kasara, Panvel and Navi Mumbai, it is the most widely preferred mode of travel. One the most challenging problem is of overcrowding [6].Over 1.71 lakh cases of theft have been reported by passengers in trains till 2018, theft being one of the major problems in travelling by IR [7].

In high-traffic stations such as Dadar and along the Western Line, boarding trains poses a serious challenge for passengers due to overcrowding and unregulated rush. Multiple incidents of injuries and even fatalities have been reported as a result of passengers being pushed or falling while attempting to board moving trains. In 2023–24 alone, the number of commuters injured in such accidents rose from 2,441 to 2,697. Kalyan recorded the highest number of deaths from train falls, with 116 fatalities [8]. Over the past two decades, more than 51,000 people have lost their lives on Mumbai's suburban rail network, which operates under the Western and Central Railway zones [9].

To address the issue of overcrowding at major railway stations, permanent waiting areas are being established outside stations prone to heavy footfall, allowing passengers to wait safely until their trains arrive. This measure is aimed at reducing platform congestion and improving overall crowd management. Pilot projects for this initiative are already underway at New Delhi, Anand Vihar, Varanasi, Ayodhya, and Patna railway stations[10].

Additionally, the Ministry of Railways has introduced new foot-over-bridge (FOB) designs, including 12-metre-wide and 6-metre-wide structures with ramps, to facilitate smoother passenger movement. To further enhance crowd surveillance, an extensive network of CCTV cameras is being deployed both within stations and in their surrounding areas [10].

II. PROPOSED SOLUTION

Despite several safety measures, Indian Railways (IR) continues to face challenges related to crowd control,

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boarding chaos, and luggage security with some cases not being addressed. This study proposes an effective and adaptable system for structured boarding and efficient luggage security in IR. The core of this system includes QR-coded luggage tagging, Zone-based boarding. The following sections describe how this technique operates.

2.1 QR coded tags on luggage linked to ticket ID

- QR coded tags added to passenger's luggage and linked to the passenger's ticket ID or Passenger Name Record (PNR) number which generates at the time of booking. This makes it easier to recover stolen items and prevents them from being permanently lost.
- In every station, the QR code must be scanned and should match the passenger's ticket ID or PNR or else the passenger's luggage would get flagged as unauthorized [11]. If luggage is lost or stolen, and someone attempts to exit the station with it, the system will flag the bag due to a mismatch in ownership. An alert will be triggered at the exit point, and the station where the original owner registered the luggage will be notified of its location. The passenger would also be informed by being messaged about the lost luggage's location.
- The ticket and the luggage shall be scanned using a scanner which identifies if the QR code is linked to the ticket ID. For passengers travelling in groups or family, each of the passenger shall have their own unique QR code but be linked to the same ticket ID.
- While QR codes themselves do not provide real-time location tracking, they serve as reliable digital identifiers when integrated with a checkpoint-based scanning system [12]. This enables luggage verification and monitoring at critical station points, reducing the risk of theft and loss.

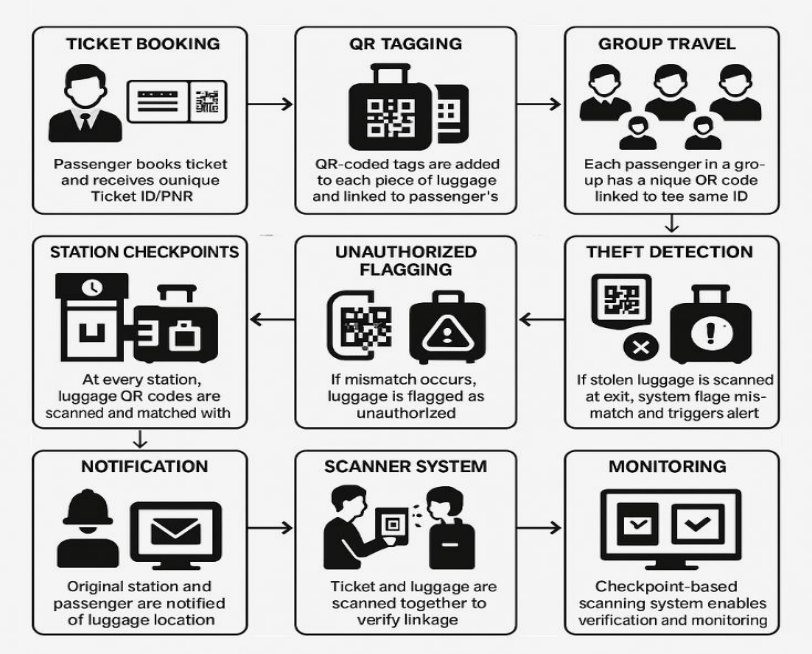

Fig 1 QR Code Tagging

Fig. 1 illustrates the technical workflow of a QR-coded luggage tracking system integrated with passenger ticketing. Upon booking, each passenger receives a unique Ticket ID/PNR, which is digitally linked to QR-coded tags affixed to their luggage.

2.2 Zone-based boarding

- To reduce platform congestion and overcrowding during boarding, passengers will board the train according to designated zone numbers printed on their tickets. Those with confirmed ticket status (PNR: CNF), including Tatkal passengers with reserved seats, will be assigned to Zone 1 and given priority boarding [13]. Remaining passengers will board in subsequent zones in a staggered manner to ensure smoother, safer, and more organized entry.
- Passengers will queue according to their assigned zone number, and once their zone number is being called, passengers will board the train in an orderly manner. Before entry, both their ticket and luggage QR code will be scanned to verify identity and baggage ownership.

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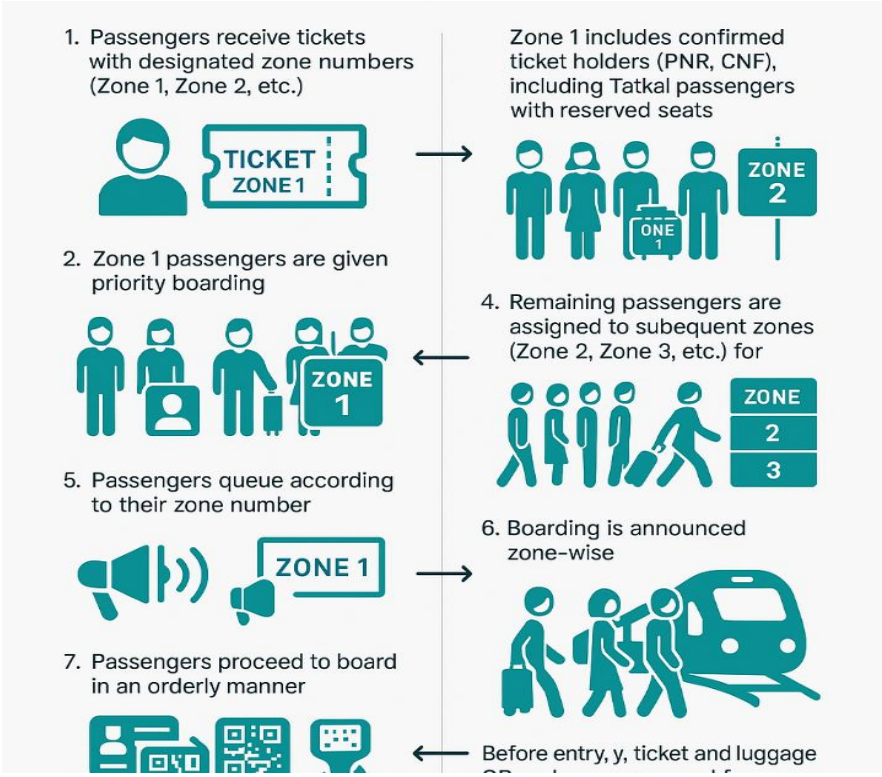

Fig 2. Zone base boarding

Fig. 2 provides a visual representation of how ticket-linked QR codes enhance luggage security by enabling verification and theft prevention across station checkpoints.

III. CONCLUSION

Indian Railways continues to serve as the backbone of public transportation in India, yet it faces persistent challenges related to crowd management, passenger safety, and luggage security especially at high-traffic stations. This research presents a scalable, inclusive solution built around zone-based boarding and QR-coded luggage identification. Integrating QR codes on both tickets and luggage, combined with structured, zone-based boarding, can significantly enhance security, reduce congestion, and improve the overall passenger experience on Indian Railways. Its inclusive design ensures accessibility for both smartphone and non-smartphone users, making it adaptable across diverse passenger usage.

Ultimately, this approach moves Indian Railways toward a more human-centred, secure, and digitally empowered future where crowd control, security, and passenger experience are no longer compromised by scale or complexity especially for high numbered stations.

Although this may imply greatly in some situations, it is important to note that zone-based boarding would not be the most effective in extremely busy stations where trains arrive in every five minutes with limited infrastructure. Passengers who do not own a cell phone or a mobile phone may have to compromise with QR code systems.

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