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Railway Ticketing System Using Dynamic Seating Allocation within One Train and Across Multiple Trains

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ABSTRACT: While on a train journey, it is common to observe certain vacant seats for various lengths of periods. This occurrence is attributed to the diverse boarding and deboarding points of travelers. Enhancing transportation efficiency and the passenger experience entails capitalizing on these partially unused seats. To achieve this, the paper explores adopting a dynamic seat allocation method, focusing on determining the optimal path of dynamic seats for passengers. This approach not only addresses passenger urgency but also suggests modifications to expedite ticket-checking processes and alleviate the workload of ticket checkers. The paper concludes with a concise analysis and recommendations for seating arrangements following the implementation of dynamic seat allocation.

KEYWORDS: Dynamic Seat Allocation, QR code digitization, Seating arrangement in trains

I. INTRODUCTION

[1] The Indian Railways is the largest rail network in Asia and the world's second-largest railway system managed under a single administration. Encompassing a vast expanse of 68,043 km and servicing 7,308stations, it intricately connects nearly all regions of the country, facilitating the daily transportation of millions of passengers and goods. With a daily ridership of 9.6 million and an annual count of 3.5 billionpassengers, the Indian Railways has implemented various technological innovations, including GPS-based train tracking in the Unreserved Ticketing System (UTS) app, an online reservation systemnamed 'IRCTC Next Generation eTicketing System'.

Despite these advancements, the network is still lagging in handling the masses.With a focus on seat allocation, this paper evaluates existing research and practices in seat management and proposes some changes to them. Beginning with theseat booking system,which comprisestwo components: online platforms&and offline ticket counters. Online platforms while being very informative in aspects of train availability, train schedule, and seat availability lack the adaptive nature of ticket counters and in-train ticket collectors (TC). The online platform's adaptiveness is only showcased in case someone with a booked ticket cancels his/her booking before the train's charting is done (4 hours before the train's journey). In that case, seats become available and are up for allotment to waiting list candidates or if none, shown as available for booking. On the other hand, offline ticket counters and TCs are much more flexible and adept at handling such cancellations even if they are done at the last moment. In-train TCs can see which seats are empty / passenger has not boarded and allocates the seat in real time to the unreserved, general,and ticketless passengers on board. They can further intimate the ticket counters of upcoming stations of such development. Then the ticket counters can sell ticketsforthese seats to any offline customer who wants to go the remaining distance.

Hence, keeping in mind how some travelers with a sense of urgency book multiple consecutive trains in case trains or seats aren't available for their entire route, we designed the solution by merging both services to enable commuters to travel dynamically in the same or different trains, so that theycan be accommodated into those seats to complete their journey if they are up for moving across the train(s).

II. LIST OF ABBREVIATIONS

TC	Ticket collectors/checkers
TTE	Traveling ticket examiner
HHT	Hand-Held terminals
PRS	Passenger Reservation System
DSA	Dynamic Seat Allocation
UTS	Unreserved Ticketing System
PIN	Personal Identification Number
SMS	Short Message Service

III. LITERATURE SURVEY

Singh, et al. [2] This research paper suggests that the reservation process will be facilitated through a dedicated application. After the ticket booking, a QR code is promptly generated, serving as a boarding pass. Before boarding the train, passengers are required to scan the QR code at the designated QR scanner located by the train door. This scanning process confirms the presence of passengers on board. Failure to board within a specified timeframe triggers an alert from the DSA Server, prompting the ticket holder to check the status. In case of cancellation, the DSA server employs a set logic to allocate the vacant seat to waitlisted passengers. Any remaining vacant seats are made available across the railway network for other passengers to book.

The set logic is that the waitlisted passengers are assigned seats on a first-come-first-serve basis. During allocation, priority is given to the first five passengers in the database, with precedence given to those with the longest journey. If no waiting list exists, passengers requiring immediate booking can secure tickets promptly.

Swarup, et al.[3] They proposed a model for the Indian Railway system that introduces a streamlined ticketing and check-in process using QR codes on both counter-generated and e-tickets. These QR codes, containing passenger-specific URLs, serve as personalized identifiers, offering detailed information about each traveler.Train Ticket Examiners (TTEs) use Hand-Held Terminals (HHTs) equipped with anapplication. Passengers present their mobile phones or printed tickets to the TTE's HHT, where the QR code is scanned for check-in. The decoded information from the QR code facilitates access to the Passenger Reservation System (PRS) server, allowing the TTE to cross-verify details with the passenger's ticket and identification proof. Successful verification prompts the TTE to update the DSA server. The DSA server allocates seats on the same set logic as Singh, et al. [2].

Nagolu, et al.[4] To enhance the efficiency of seat arrangements on trains, this research explores the potential adoption of a dynamic seat allocation method. This approach involves determining the most favorable or optimal sequence of dynamic seats for a passenger based on their boarding and deboarding stations. The proposal suggests that by strategically combining available vacant seats, passengers can be accommodated in the train for the duration of their journey. The primary focus of the project revolves around two key metrics: I) Distance, which represents the disparity between the current seat and the subsequent seat where the passenger is to be positioned, and II) Length, which quantifies the maximum extent of consecutive vacant seats. The methodology stipulates that the distance should be minimized, considering the challenge for a passenger to relocate to a seat that is distant from their current position. Simultaneously, the length is maximized to encourage passengers to occupy a single seat for an extended duration if contiguous vacancies are available.

Suda, et al.[5] This paper introduces a quantitative assessment approach for the seating and door configurations in commuter railway cars, focusing on passenger comfort and accessibility. Passenger comfort is defined by analyzing passenger seat selection behaviors, assuming that individuals choose the most comfortable available seat.Based on the evaluations, optimal seat configurations for commuter trains are discussed, and novel seating arrangements are proposed.

It showsthat passengers on the aisle side block passengers from seating on the window side seats. This is demonstrated by the percentage of passenger’s inclination to choose such seats. All of this is backed by thedirectly proportional relationship between getting-off time and sitting capacity, and getting-off time and the number of blocking sites (blocked access to entry/exit).

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IV. PROPOSED MODEL

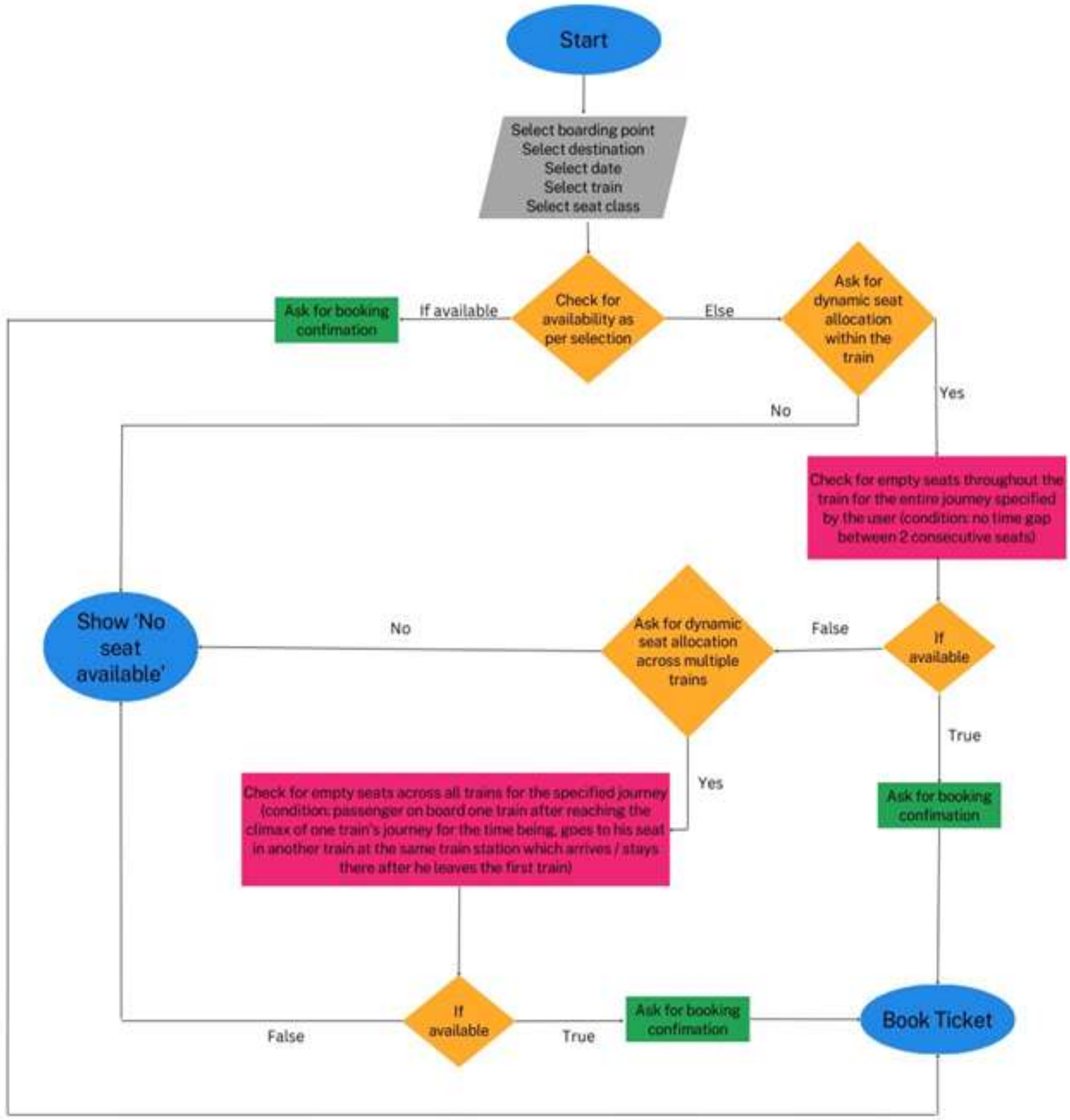

Figure 1: Architecture of the ticketing system

Figure 1 shows the flow of the seat booking process. It begins with the user selecting their boarding point and the starting location of their journey. Following the selection of the boarding point, the user is prompted to choose their destination. After setting the boarding point and destination, the user is then prompted to select the date of travel. With the boarding point, destination, and date in place, the user is prompted to choose a specific train for their journey. Once the user has chosen a train, the system prompts them to select a seat class.

After completing all of the above, the system checks the availability of seats on the selected train for the specified date and seat class. If seats are available, the algorithm proceeds to ask the user for booking, guiding them through the final steps of confirming their reservation.

If no seats are available, the algorithm introduces the concept of dynamic seating. If the user opts for dynamic seating, the algorithm

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explores various possibilities. It first checks for empty seats throughout the selected train for the specified journey, with the condition that there should be no time gap between two consecutive seats. If available, the algorithm prompts the user for booking.

If no seats are found within the selected train, the algorithm provides the option for dynamic seating across trains. In this scenario, the algorithm checks for empty seats across all trains for the specified journey. Here, the condition changes such that the passenger on board one train after reaching the climax of one train's journey for the time being, goes to his seat in another train at the same train station which arrives/stays there after he leaves the first train. If available, the algorithm asks the user to book. However, if no seat is available acrossall possibilities, the algorithm indicates that no train is available for the specified route.

The ticket for such dynamically allocated seats would contain seating information for every segment of the journey.

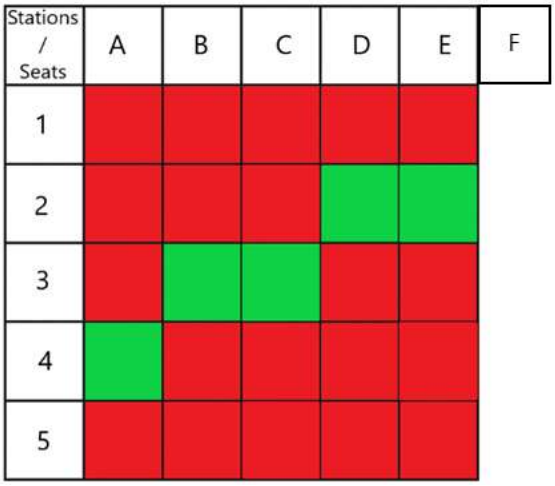

Figure 2: Seating arrangement (red=occupied, green=empty)

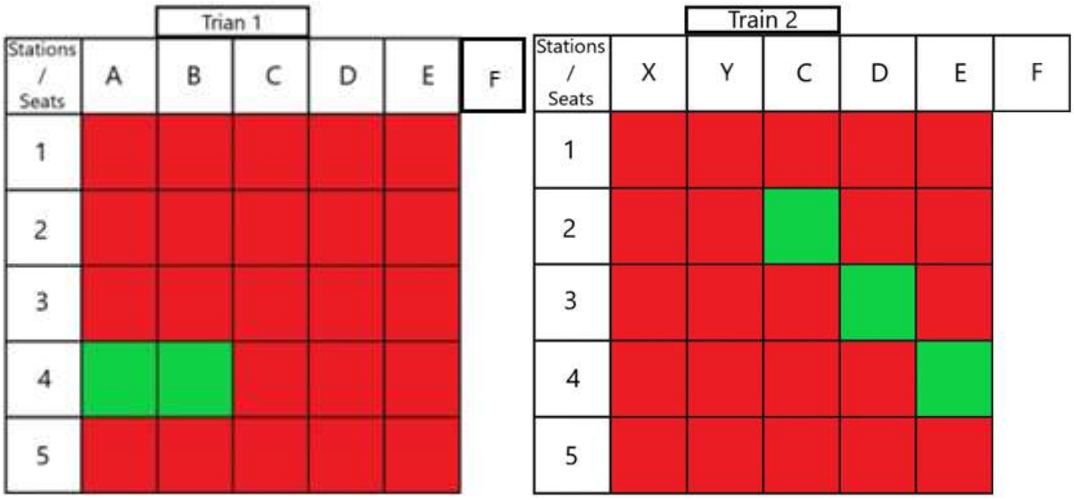

Figure 3: Seating arrangement in train 1 and train 2 (red=occupied, green=empty)

DSA within train:

As shown in Figure 2,seats 1,2,3, & 5 are filled from station A to B; seats 1,2,4, & 5 are filled from station B to C; seats 1,2,4, & 5 are filled from station C to D;seats 1,3, 4, & 5 are filled from station D to E; and seats 1,3, 4, & 5 are filled from station E to F. Some seats are empty in different segments of the route. If a customer is shown this on their online dashboard and agreesto travel in segments (hopping from one seat to another as per availability),they could be accommodated. They could be seated in seat 4 from station A to B, seat 3 from station B to D, and seat 2 from station D to F. This way one more person gets to travel, and all the seats get filled throughout the journey.

In case no seat is empty for a particular segment of the journey then, if the passenger allows it, he can be issued a general ticket and sit in general carriage for that segment, and be reseated in his seat in the upcoming segment.

DSA across multiple trains:

Another solution to the above-mentioned case would be to travel a segment of the journey in one train and continue the remaining in another train with available seats.

As shown in Figure 3,train 1 goes from station A to F,and seats 1, 2, 3, & 5 are filled from station A to B, and seats 1, 2, 4, & 5 are filled from station B to C. Other than these intervals, all 5 seats are filled throughout the rest of the journey

Train 2originating from Xalso travels to F. It has all seats filled from stations X to Y and Y to C, but,only seats 1, 3,4, & 5 are filled from stations C to D; seats 1,2, 4, & 5 are filled from stations D to E; and seats 1,2, 3, & 5 are filled from station E to F. Some seats are empty in different segments of the route in both these trains.

Say by happenstance, both have a common meeting point at station C, where they stay for long enough to facilitate passengers to exchange trains.

If a customer is shown this on their online dashboard and permitstraveling in segmentsin different trains (hopping from one seat to another as per availability across trains), they could be accommodated. They could be seated in seat 4 of train 1 from station A to C. Thentheywould disembark from that train on station C and board train 2 standing at the same station to take a seat at vacant seatnumber 2 from station C to D, seat 3 from station D to E, and seat 4 from station E to Fto reach his destination F.

This is a hypothetical situation that would be rare but possible in the real world. Although some aspects of it might change like, train 1 arriving before train 2 arrives / time to bridge the gap between the trains is inconvenient, then in such cases, information like train schedule, station map, platform number, etc. would be displayed on the online booking platform, so that they could decide if they want to pursue it or not.

In case of delay of the first train or early arrival and departure of the second train, if the passenger on board the first train becomes aware of this via the train schedule (better if the system sends an SMS about such delays), then they must be provided the option to cancel their booking for the second train and book a new ticket on upcoming trains (if available).Otherwise, they must be given a full refund to compensate for being stranded in the middle of the journey.

V. RESULTS AND DISCUSSION

Singh, et al.[2] The author'sconcept of ticket verification at entry pointsvia mounted scanners before entering one’s carriage is deeply flawed. This is because it would create a horde of passengers trying to scan their QR codes at the carriage’s door. This would lead to unnecessary chaos and delays in boarding.

Swarup, et al.[3] Theauthor's idea about QR’s being scanned by TTE’s HHT is not as flawed as the one of door-mountedscanners, but except for it being environment-friendly, is lagging. The reason is that, if the TTE still has to verify everyone’s ticket personally, then digitization does not bear much significance in terms of improving the TTE’s current situation.

Hence, this paper proposes that, upon completion of the final charting, the online ticketing platform provides a pin via SMS to the passenger for their booked seat. That pin be used to confirm the seating of that person only. Here, a QR code could be used but, instead of generating a QR for every passenger, it be printed on the seats. This QR would lead to a portal for marking the boarding of that passenger. A simple prompt would be shown that would ask the passenger for theirPIN. Upon entering the pin, if it is correct (meaning the right passenger is seated) then it would mark his boarding as true. If the pin is incorrect, then it would prompt the passenger to ensure whether his seating is correct or not. This way when a passenger is comfortably seated, theycan scan it and enter theirPIN in a short amount of time. By doing so, their boarding status would be updated on the DSA server (IRCTC Next Generation eTicketing System) without the involvement of TTE. Furthermore, a feature to be added on the online platform, so that seats can be marked as emptied by passengers too upon disembarking mid-journey. This way, the TTE has time to deal with other issues and no crowding would occur.

As for the DSA server, as suggested in [2-4], a device be given to the TTE to view occupied and unoccupied seats. They could verify the empty seats physically and put them up for allotment on the online server (IRCTC Next Generation eTicketing System) during the journey. However, it isproposed that instead of notifying both the physical counter and online ticketing platform, the ticketing counters adopt the online platform. This way they would have access to real-time data on a train's seating information and be able to book tickets for physical customers with much less hassle.

Due to DSA, it is additionallyproposed, that no seat information be provided upon booking, and seat chartingis to be done just before the train starts (seat info can be provided by SMS to passengers). This is so that all the complete journey travelers with fixed seats can be seated in seats that enable segment travelers to move without causing any inconvenience. E.g., window seats, so that continuous boarding and un-boarding of segment travelers doesn't disturb them, while also allowing easy movement for segment ones.Suda, et al.[5]

VI. CONCLUSION

The analysis of the proposed dynamic seat allocation (DSA) system suggests potential improvements in the railway ticketing and seating system. DSA within trains allows passengers to travel in segments, utilizing available seats at different intervals. Meanwhile, DSA across multiple trains presents the possibility of seamlessly transitioning between trains at common stations, maximizing seat utilization. Furthermore, its applications are not limited to railways only, as similar seating arrangements can be practiced in buses too. The discussion emphasizes the importance of real-time seat allocation updates through SMS pins and QR codes, streamlining boarding processes, and minimizing the TTE's involvement. Integrating ticketing counters with online platforms is recommended for improved efficiency, offering real-time data access and simplified ticketing for physical customers. Overall, the proposed DSA system aims to enhance revenue generation, address seating arrangement challenges, and promote adaptability in the railway system.

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