

SUGAM IRCTC

A Research Synthesis on Reducing Interaction Friction in Digital Railway Ticket
Booking

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Build What Moves India — OpenAI Hackathon

August 2026

Research synthesis for product development and hackathon submission

Executive Summary

Sugam IRCTC is proposed as a mobile-first, natural-language interface for railway ticket booking. The research question is whether a citizen should have to translate a simple travel intention into a sequence of platform-specific fields, or whether the interface can interpret that intention and guide the citizen through the same underlying service.

This research synthesis combines official IRCTC documentation, peer-reviewed research on railway and e-government user experience, research on conversational interfaces for Indian public services, and recent public reporting on IRCTC usability and infrastructure. The evidence does not establish that every booking failure is caused by interface design; rather, it indicates that usability, interaction quality, accessibility, trust, performance and service reliability all influence the citizen experience.

The resulting product hypothesis is therefore deliberately narrow: use an AI language layer to reduce the translation burden between natural human intent and structured booking parameters, while keeping validation and transaction execution deterministic. The prototype uses synthetic data and simulated service boundaries.

1. Research Objective

The objective of this research is to establish an evidence-based product rationale for Sugam IRCTC. Specifically, the study examines: (1) the interaction complexity of digital railway reservation; (2) evidence concerning usability and accessibility of Indian public-service platforms; (3) whether conversational interaction can reduce user effort; (4) the role AI should play in such a workflow; and (5) the safety and technical boundaries required for a responsible prototype.

2. Research Questions

RQ1: What forms of interaction friction are reported or documented in digital railway and public-service experiences in India?

RQ2: What does existing research suggest about usability, accessibility, mobile readiness and citizen experience in Indian e-government services?

RQ3: Can conversational or natural-language interaction better align a public-service workflow with citizens' mental models?

RQ4: What system architecture allows AI to assist with interpretation without allowing model output to directly control a sensitive transaction?

RQ5: What can be demonstrated safely using synthetic data when live government integration is unavailable or inappropriate?

3. Methodology: Overall Synthesis of Data

This document is a secondary research synthesis rather than a controlled usability experiment. Sources were selected from four evidence groups: (A) official IRCTC documentation describing booking workflows and current Tatkal requirements; (B) peer-reviewed research on IRCTC, e-ticketing and e-government user experience; (C) recent HCI/NLP and public-service chatbot research; and (D) contemporary public reporting and design critiques used only as contextual evidence.

The synthesis does not treat anecdotal complaints as universal facts. Instead, recurring themes are compared across sources: navigation and information density, ease of use, mobile accessibility, language

and digital familiarity, reliability under time pressure, trust, and the potential of conversational interaction. The product concept is then derived from the intersection of these themes.

4. Evidence from Official IRCTC Documentation

IRCTC's Tatkal booking documentation shows that users must provide structured journey inputs including source and destination stations, date and class, and proceed through a multi-stage reservation process. The official Tatkal FAQ also requires users to select the Tatkal quota and check availability before proceeding.

Current IRCTC mobile documentation additionally states that, from 1 July 2025, Aadhaar-authenticated users are required for Tatkal and Premium Tatkal booking, with an authentication flow involving account details, Aadhaar/VID and OTP verification. This is important for Sugam's scope: the prototype must not imply that an AI interface can remove mandatory authentication or government controls.

The evidence supports a narrower product claim: Sugam can simplify how users express and review booking intent, but it cannot legitimately bypass official authentication, availability or transaction rules.

5. Literature Review: Railway and IRCTC User Experience

Recent research directly examining the IRCTC app identifies visibility, interactivity and persistence as important user-experience affordances and reports positive relationships between these factors, perceived quality and user outcomes. The study also identifies gaps in research concerning diverse user groups, transaction performance, error handling and contextual issues such as connectivity.

Earlier research on Indian railway e-ticketing found that perceived usefulness and perceived ease of use influence attitudes and intention to use online railway ticketing. This is directly relevant to Sugam because the proposed intervention is primarily an ease-of-use intervention rather than a replacement for railway inventory or reservation infrastructure.

A separate qualitative study of tourist experiences on IRCTC analyzed online reviews across pre-trip, entrance, payment and post-visit stages and identified improvement areas involving digital performance, customer assistance, payment reliability and service consistency.

6. Literature Review: Indian E-Government Usability

Research on Indian e-government services shows that citizen experience affects adoption, behavior and perceived value. A qualitative study involving Indian citizens concluded that e-government services need to become more competent and satisfactory from the citizen perspective.

A 2021 study examining 164 Indian government websites specifically assessed usability, accessibility and mobile readiness, reinforcing the importance of designing public services for different devices and user capabilities.

Research on Digital India services also emphasizes citizen involvement, empowerment and accessibility. Together, these studies support a key design principle for Sugam: public digital interfaces should minimize unnecessary cognitive and interaction demands, especially where the underlying service is already complex.

7. Literature Review: Conversational Public Services

The strongest conceptual support for Sugam comes from recent HCI/NLP research. A 2025 ACL workshop paper compared a conventional form-based public-service interface with a voice-based conversational prototype for Indian welfare-service access. In a task-based study with 15 low-income participants, the authors reported that conversational interaction and natural-language input better aligned with users' mental models and practices.

Broader research on public-service chatbots similarly identifies potential benefits for access to services, while emphasizing usability and the need for careful evaluation. Research on government chatbots has also identified recurring usability pitfalls, demonstrating that simply adding a chatbot does not automatically create a good public-service experience.

This distinction is central to Sugam: the goal is not to build a chatbot for its own sake. The goal is to use natural language as an interaction layer for a concrete, high-friction citizen journey.

8. Synthesis of Findings

Across the literature, five themes recur.

First, usability matters because perceived ease of use influences adoption of online railway services.

Second, public-service interfaces must account for heterogeneous users, including differences in digital familiarity, language, device and accessibility needs.

Third, railway-booking UX is not purely a visual-design problem. Reliability, transaction performance, payment behavior and error handling affect the end-to-end experience.

Fourth, conversational interfaces can reduce the distance between users' natural mental models and structured digital-service forms, particularly for emergent or less digitally experienced users.

Fifth, conversational AI introduces its own risks. A model can misinterpret dates, stations, passenger details or ambiguous language. Therefore, the appropriate architecture is not AI-controlled booking; it is AI-assisted intent interpretation followed by deterministic validation and execution.

9. Identified Research Gap

The reviewed literature provides evidence on railway-app UX, e-government usability and conversational public-service interfaces, but there is a clear product-design gap at their intersection.

Existing railway UX research largely evaluates conventional app affordances, satisfaction and service quality. Conversational public-service research demonstrates the potential of natural-language interaction, but is not focused specifically on time-sensitive railway reservation. This creates an opportunity to explore a focused architecture in which natural-language intent is translated into a railway-booking schema and then processed through deterministic application logic.

Sugam IRCTC is positioned as a prototype exploration of this intersection, not as proof that conversational AI improves live railway booking performance.

10. Product Hypothesis

If citizens can express a railway-booking request in natural language, and the system converts that request into a transparent, validated booking intent before executing the workflow, then the number of manual translation steps required from the citizen should decrease.

The hypothesis can be represented as:

Natural citizen intent → AI-assisted interpretation → Structured booking intent → User confirmation → Deterministic validation → Booking workflow → Confirmation

The AI component should therefore reduce interaction friction without becoming the authority for railway availability, identity, payment or reservation state.

11. Proposed System Architecture

Sugam IRCTC uses five logical layers:

1. Citizen Interface — mobile-first text and voice-derived input. 2. Natural-Language Understanding — OpenAI gpt-4o-mini extracts booking entities. 3. Structured Intent Layer — a constrained JSON schema represents source, destination, date, quota, class and passengers. 4. Validation and Workflow Layer — deterministic code validates fields and controls state transitions. 5. Mock Service Layer — synthetic train inventory, availability, seat allocation, payment and PNR generation demonstrate the complete journey safely.

The architectural principle is separation of concerns: the model interprets language; application code decides whether the resulting data is valid and what action is allowed.

12. OpenAI's Role

OpenAI's gpt-4o-mini is used as a backend language-understanding component. It converts flexible English or Hinglish requests into structured data that the application can consume. The model is therefore part of the execution path, but it is not the transaction authority.

A production implementation should combine structured outputs/schema enforcement with independent validation. For example, a model-derived station code should be checked against an authoritative station dataset, and a date or passenger attribute should be validated by application logic before proceeding.

13. Safety, Privacy and System Boundaries

The prototype deliberately does not access, test, reverse-engineer or interfere with production IRCTC or other government systems. All train inventory, availability, passenger records, seat allocation, PNR generation and payment behavior are synthetic or simulated.

No real Aadhaar numbers, passwords, OTPs, payment credentials or production booking accounts are required. The prototype therefore demonstrates the citizen journey without creating real reservations or processing real financial transactions.

This boundary is consistent with the hackathon's requirement to use mock data and simulated dependencies where production access would be unsafe or unavailable.

14. Limitations of the Research

This synthesis has important limitations. Most sources evaluate general e-government or railway-app usability rather than the exact Sugam workflow. Evidence from design critiques and news reports is contextual and should not be treated as equivalent to peer-reviewed experimental evidence. The proposed natural-language workflow has not yet been validated through a controlled study with a representative Indian passenger population.

Accordingly, the next stage of the project should include task-based usability testing, error-rate measurement, task-completion time, clarification frequency, user confidence and comparison against a

conventional booking flow. These measures would allow the product hypothesis to be tested rather than assumed.

15. Evaluation Framework for Sugam IRCTC

To make the project research-grade, the prototype should eventually be evaluated using measurable outcomes:

- Task completion rate — percentage of users who successfully reach simulated confirmation.
- Time on task — time required to express and complete a booking.
- Interaction count — number of manual screens/fields/actions required.
- Clarification rate — percentage of requests requiring additional questions.
- Extraction accuracy — correctness of station, date, class, quota and passenger fields.
- Error recovery — ability to correct an incorrectly interpreted request.
- User-reported ease of use — perceived simplicity and confidence.
- Accessibility observations — performance across mobile, voice and different levels of digital familiarity.

These metrics align the product with the hackathon's emphasis on working builds, usability, product thinking and end-to-end execution.

16. Expected Contribution

Sugam IRCTC contributes a focused design pattern for public digital infrastructure: use conversational AI as an interpretation layer while preserving deterministic control over sensitive service operations.

The broader proposition is not that every government service should become a chatbot. Instead, services with complex forms, structured fields and clear user intent may benefit from an intent-first interface that translates citizen language into validated application state.

For railway booking, this could mean that a citizen describes the journey in their own words while the system handles the translation into the structured vocabulary required by the service.

17. Conclusion

The overall evidence suggests that Sugam IRCTC addresses a legitimate product problem: the gap between simple citizen intent and complex digital-service interaction. Research on IRCTC and Indian e-government services highlights the importance of usability, accessibility, interactivity, reliability and citizen experience. Recent HCI/NLP research provides evidence that conversational interaction can better align certain public-service workflows with users' mental models.

The project therefore proposes a deliberately bounded solution. OpenAI is used to interpret natural language; deterministic software validates and executes the workflow; synthetic services provide safe end-to-end demonstration. The resulting prototype can be evaluated as a citizen-experience intervention rather than as an attempt to replace or bypass railway infrastructure.

Sugam IRCTC's central design principle is:

“Let citizens describe the outcome they want; let the system handle the translation into structured service actions.”

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