CS 340 Group 90 - Project Step 6:
Global High-Speed Rail Infrastructure Database
Michael Harris & Francisco Yinug

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Executive Summary

We began with a clear plan and a chosen topic, but the real complexity of the project became apparent once we started implementing the database and CRUD workflows. The many-to-many relationships pushed us to redesign parts of the schema, add CASCADE rules, and treat the intersection tables as central to maintaining integrity rather than secondary structures.

Stored procedures also grew beyond simple inserts and updates. Preventing duplicate mappings, validating inputs, and producing meaningful error messages became essential, and those requirements reshaped how the UI needed to interact with the database.

The UI evolved through iteration and especially through Step 5 peer feedback. We added Edit buttons, prepopulated update forms, replaced raw foreign key IDs with readable labels, and corrected the Line–Station delete workflow so that only valid mappings appear. These changes made the interface more intuitive and more aligned with the underlying data model.

AI tools were used for debugging, documentation support, and CSS troubleshooting. All schema design, SQL logic, stored procedures, and application code were created by us unless noted otherwise.

Overall, the project improved through continuous refinement. Each stage revealed issues we couldn't fully anticipate upfront, and addressing them led to a stable, cohesive, and fully functional final application.

Project Overview

The International Union of Railways (UIC) reports that as of 2024 more than 56,000 kilometers of high-speed rail (HSR) lines are in operation worldwide, with another 20,000 kilometers under construction across 26 countries. Together these networks serve hundreds of stations and move tens of millions of passengers daily, yet much of this information remains scattered across operator sites and government portals. This web-based database will unify global HSR data into one relational system. It will record countries, operators, rail lines, stations, and projects, capturing how lines connect multiple stations and how development projects span multiple lines. The prototype will manage roughly 20 operators, 100 lines, 300 stations, and 30 projects.

Database Outline

- Stations: the details about a particular station and where it is
    - stationID INT: PK, NOT NULL, AUTO INCREMENT
    - stationName VARCHAR(100): NOT NULL
    - city VARCHAR(100): NOT NULL
    - countryID INT: foreign key from Countries, NOT NULL

        Relationship: a 1:M relationship between Countries and Stations is implemented with countryID as a foreign key inside Stations

- Countries: name and population of a particular country
    - countryID INT: PK, NOT NULL, AUTO INCREMENT
    - countryName VARCHAR(100): NOT NULL, UNIQUE
    - continent VARCHAR(45): NOT NULL
    - populationMillions DECIMAL(6,2)

        Relationships:

        - a 1:M relationship between Countries and Operators is implemented with countryID as a foreign key inside Operators
        - a 1:M relationship between Countries and Stations is implemented with countryID as a foreign key inside Stations

- Operators: the details about a particular train operator and where they are

- ○ operatorID INT: PK, NOT NULL, AUTO INCREMENT
- ○ operatorName VARCHAR(45): NOT NULL, UNIQUE
- ○ foundedYear YEAR: (default NULL)
- ○ countryID INT: foreign key from Countries, NOT NULL

  Relationship: a 1:M relationship between Operators and RailLines is implemented with operatorID as a foreign key inside RailLines

- RailLines: details about a particular rail line such as how long one is
  - ○ lineID INT: PK, NOT NULL, AUTO INCREMENT
  - ○ lineName VARCHAR(100): NOT NULL, UNIQUE
  - ○ maxSpeed INT: NOT NULL
  - ○ lengthKM DECIMAL(6,1): NOT NULL
  - ○ operatorID INT: foreign key from Operators, NOT NULL

    Relationships:

    - ■ a 1:M relationship between Operators and RailLines is implemented with operatorID as a foreign key inside RailLines
    - ■ a 1:M relationship between RailLines and LineStations is implemented with lineID as a foreign key inside LineStations
    - ■ a M:N relationship between RailLines and Projects is implemented through the junction table ProjectLines, which contains lineID and projectID as foreign keys

- Projects: the name of a project and when it began and ended.
  - ○ projectID INT: PK, NOT NULL, AUTO INCREMENT
  - ○ projectName VARCHAR(245): NOT NULL
  - ○ status ENUM('Planned', 'Under Construction', 'Operational', 'Cancelled'): NOT NULL
  - ○ startYear YEAR: NOT NULL
  - ○ endYear YEAR: (default NULL)

    Relationships:

    - ■ a 1:M relationship between Projects and ProjectLines is implemented with projectID as a foreign key inside ProjectLines
    - ■ a M:N relationship between Projects and RailLines is implemented through the ProjectLines junction table

- ProjectLines: a junction table showing which rail lines belong to which projects
  - ○ projectID INT: foreign key from Projects, NOT NULL

- ○ lineID INT: foreign key from RailLines, NOT NULL
- ○ Composite Primary Key: (projectID, lineID)

  Relationship: a M:N relationship between Projects and RailLines is implemented through ProjectLines

- ● LineStations: a junction table that details which station each line serves and in what order
  - ○ lineID INT: foreign key from RailLines, NOT NULL
  - ○ stationID INT: foreign key from Stations, NOT NULL
  - ○ stopOrder INT: NOT NULL
  - ○ Composite Primary Key: (lineID, stationID)

    Relationship: a M:N relationship between RailLines and Stations is implemented through LineStations

Entity-Relationship Diagram
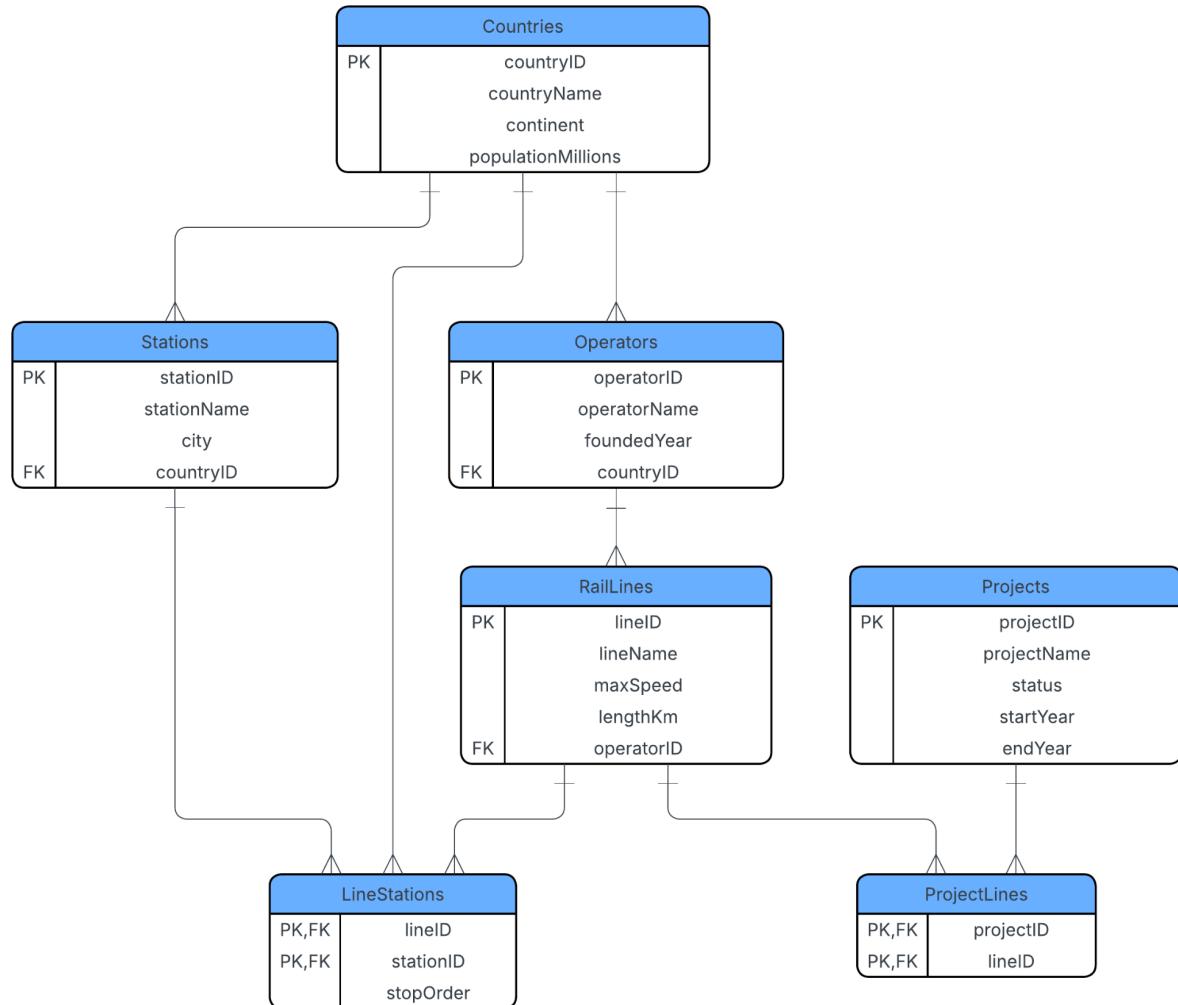
Figure 1. Entity–Relationship Diagram

Schema Diagram
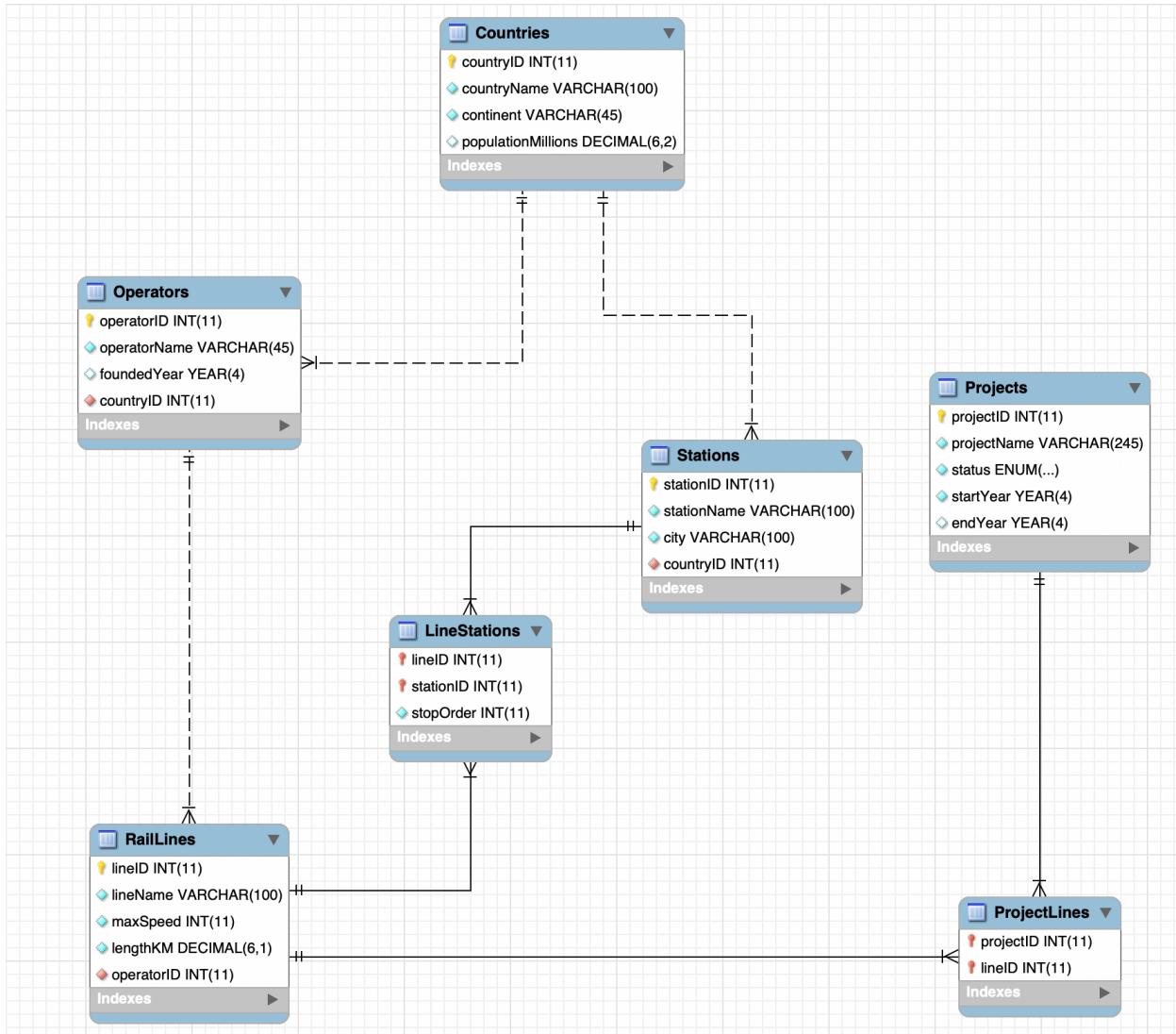
Figure 2. Schema Diagram

Example Data

Countries

countryID	countryName	continent	populationMillions
1	Japan	Asia	125.1
2	France	Europe	68.4
3	China	Asia	1412
4	Spain	Europe	47.6
5	Germany	Europe	83.2

Operators

operatorID	operatorName	foundedYear	countryID
1	JR East (Japan Railways East)	1987	1
2	SNCF (National Society of French Railways)	1938	2
3	China State Railway Group	2013	3
4	Renfe Operadora	1941	4
5	Deutsche Bahn (DB)	1994	5

RailLines

lineID	lineName	maxSpeed (km/h)	lengthKm	operatorID
1	Tōhoku Shinkansen	320	674.9	1
2	LGV Sud-Est	300	409	2
3	Beijing–Shanghai HSR	350	1318	3
4	Madrid–Barcelona AVE	310	621	4
5	ICE Sprinter Berlin–Munich	300	623	5

Stations

stationID	stationName	city	countryID
1	Tokyo Station	Tokyo	1
2	Sendai Station	Sendai	1
3	Gare de Lyon	Paris	2
4	Beijing South	Beijing	3
5	Madrid Atocha	Madrid	4

| 6 | Berlin Hbf | Berlin | 5 |

Projects

projectID	projectName	status	startYear	endYear
1	Hokkaidō Shinkansen Extension	Under Construction	2016	2031
2	Grand Paris Express – HSR Links	Planned	2020	2035
3	China Western HSR Corridor	Under Construction	2022	2028
4	Madrid–Galicia HSR Project	Operational	2011	2021
5	Germany Digital Rail Program	Planned	2019	
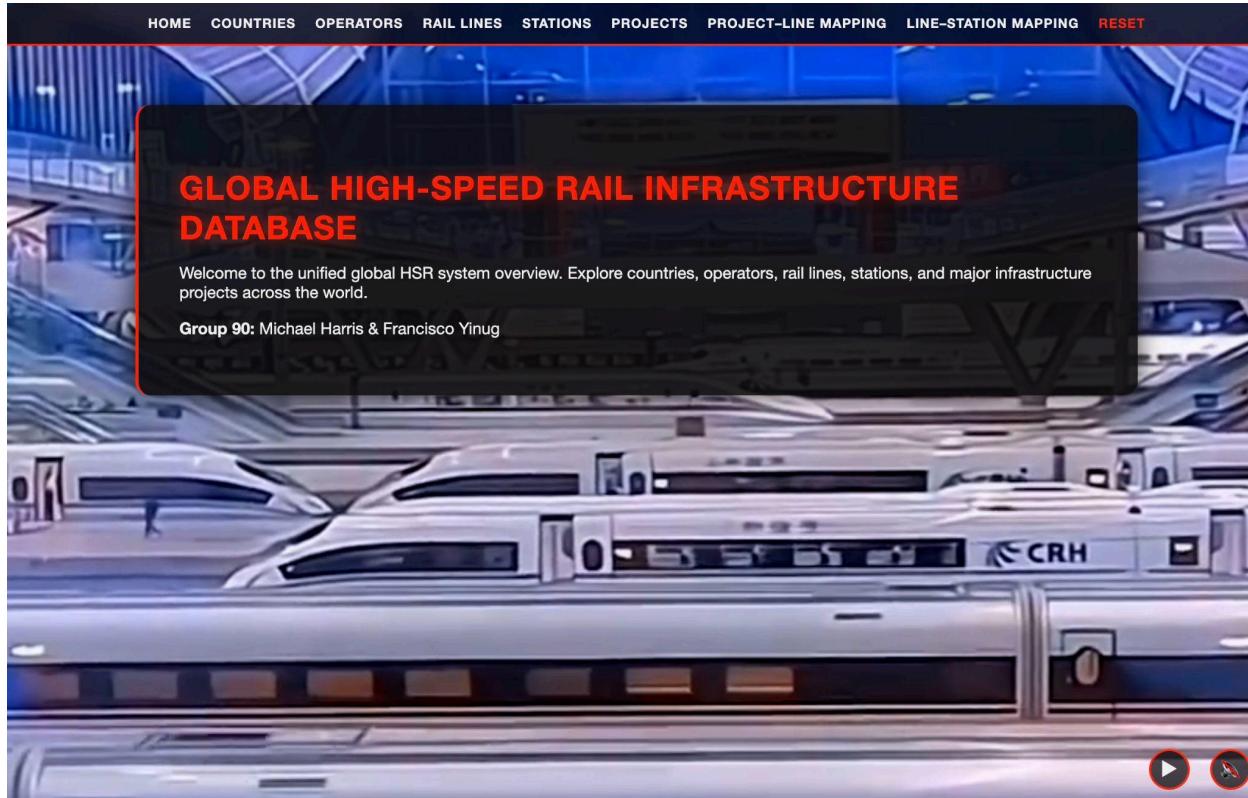
ProjectLines

projectID	lineID
1	1
2	2
3	3
4	4
5	5
3	1

LineStations

lineID	stationID	stopOrder
1	1	1
1	2	2
2	3	1
3	4	1
4	5	1
5	6	1

UI Screenshots

Home Page/Navigation Overview

READ/DISPLAY Countries Page

CREATE/INSERT New Country

UPDATE Country (Prepopulated Form)
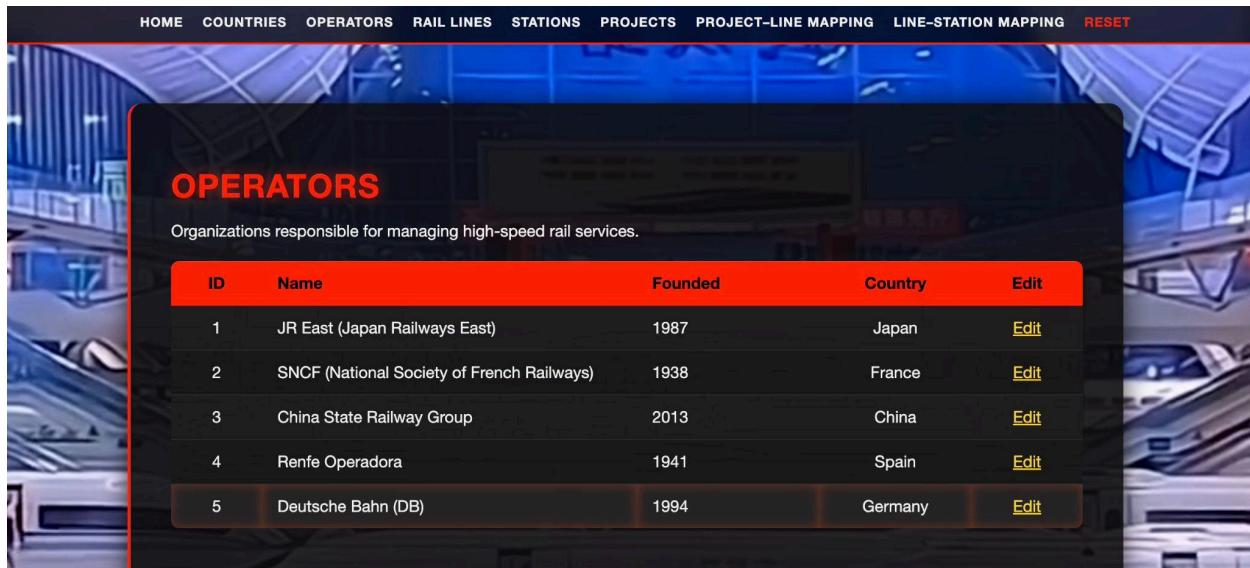
DELETE Country

READ/DISPLAY Operators Page

OPERATORS

Organizations responsible for managing high-speed rail services.

ID	Name	Founded	Country	Edit
1	JR East (Japan Railways East)	1987	Japan	Edit
2	SNCF (National Society of French Railways)	1938	France	Edit
3	China State Railway Group	2013	China	Edit
4	Renfe Operadora	1941	Spain	Edit
5	Deutsche Bahn (DB)	1994	Germany	Edit

CREATE Operator

Add Operator

Name:

Amtrak Hartford Line

Founded Year:

2018

Country:

6 – USA

Add Operator

UPDATE Operator

Update Operator

Select Operator:

1 — JR East (Japan Railways East)

New Name:

Toei Line

New Founded Year:

1987

New Country:

1 — Japan

Update Operator

DELETE Operator
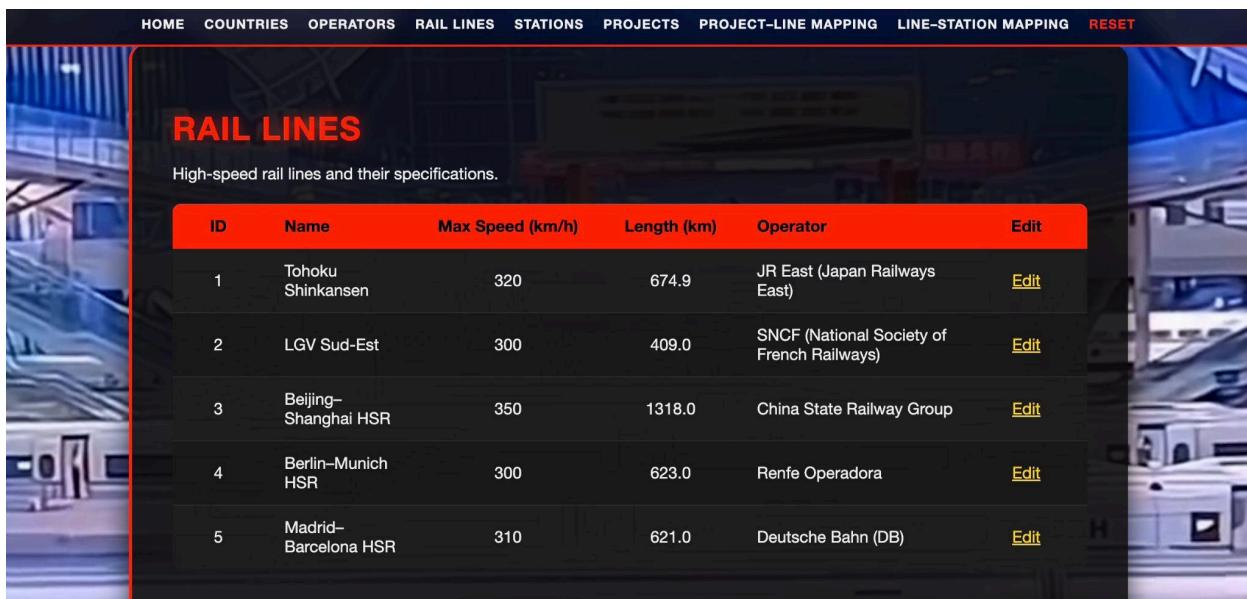
Delete Operator

Select Operator:

5 – Deutsche Bahn (DB)

Delete Operator

READ/DISPLAY Rail Line Page

RAIL LINES

High-speed rail lines and their specifications.

ID	Name	Max Speed (km/h)	Length (km)	Operator	Edit
1	Tohoku Shinkansen	320	674.9	JR East (Japan Railways East)	Edit
2	LGV Sud-Est	300	409.0	SNCF (National Society of French Railways)	Edit
3	Beijing–Shanghai HSR	350	1318.0	China State Railway Group	Edit
4	Berlin–Munich HSR	300	623.0	Renfe Operadora	Edit
5	Madrid–Barcelona HSR	310	621.0	Deutsche Bahn (DB)	Edit

CREATE Rail Line

Add Rail Line

Line Name:

Toei Line

Max Speed (km/h):

400

Length (km):

500

Operator:

1 – JR East (Japan Railways East)

Add Rail Line

13

UPDATE Rail Line

Update Rail Line

Select Rail Line:

2 — LGV Sud-Est

New Name:

LGV Sud-Est

New Max Speed (km/h):

300

New Length (km):

409.0

New Operator:

4 — Renfe Operadora

Update Rail Line
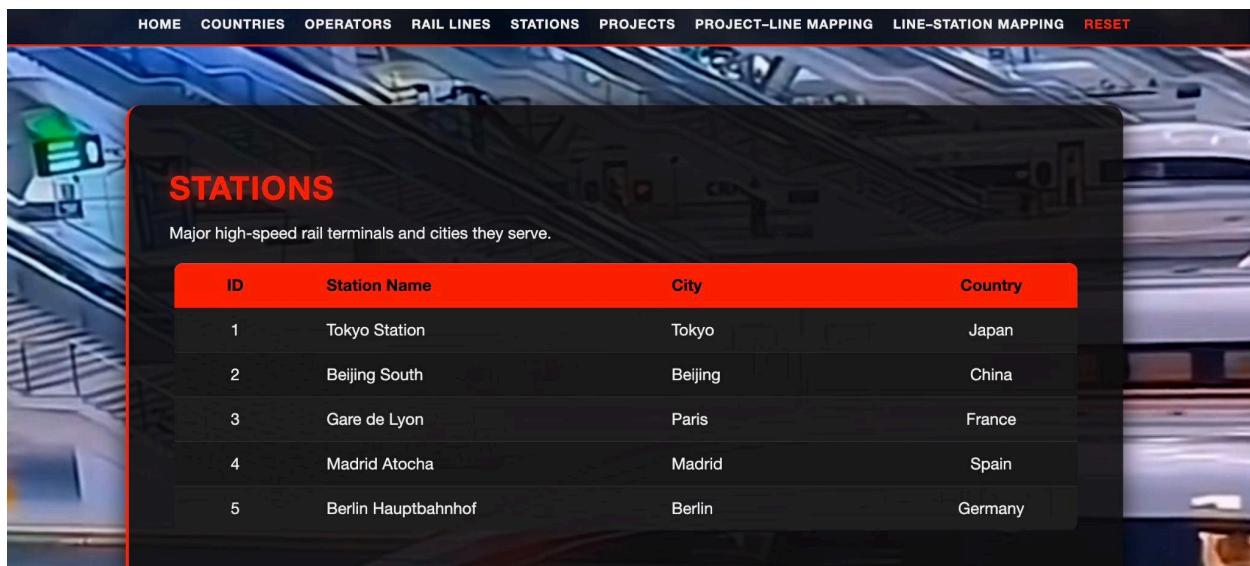
DELETE Rail Line

Delete Rail Line

Select Rail Line:

1 – Tohoku Shinkansen

Delete Rail Line

READ/DISPLAY Stations Page
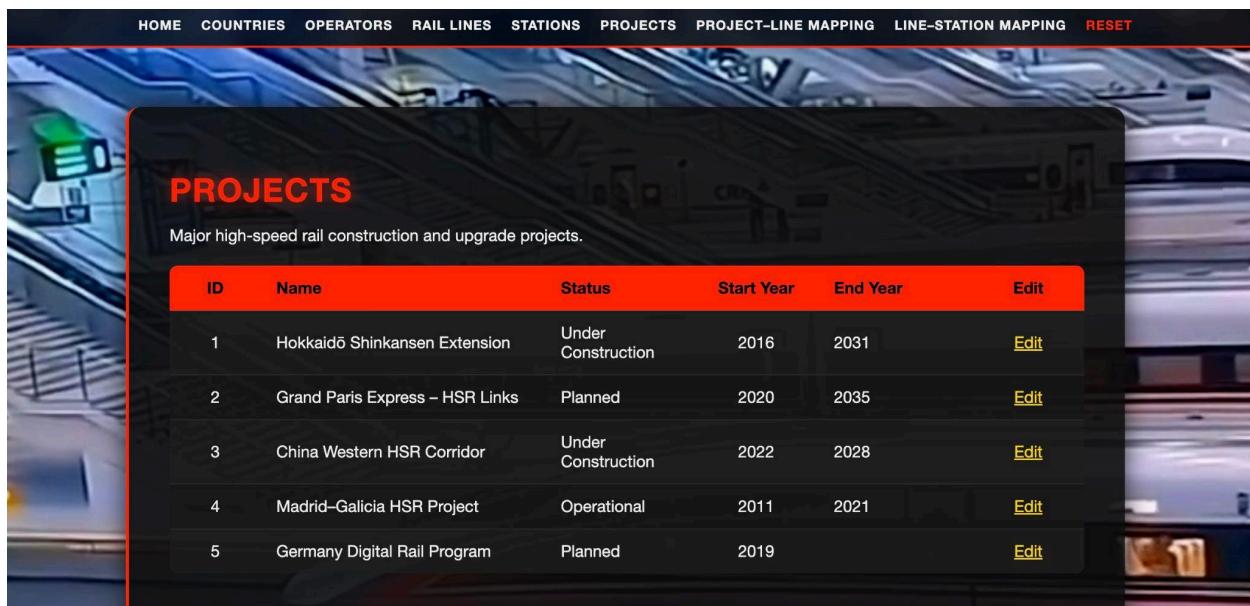
CREATE Station

DELETE Station

READ/DISPLAY Projects Page

PROJECTS

Major high-speed rail construction and upgrade projects.

ID	Name	Status	Start Year	End Year	Edit
1	Hokkaidō Shinkansen Extension	Under Construction	2016	2031	Edit
2	Grand Paris Express – HSR Links	Planned	2020	2035	Edit
3	China Western HSR Corridor	Under Construction	2022	2028	Edit
4	Madrid–Galicia HSR Project	Operational	2011	2021	Edit
5	Germany Digital Rail Program	Planned	2019		Edit

CREATE Project

Add Project

Project Name:

Brightline (Florida)

Status:

Operational

Start Year:

2012

End Year (optional):

Add Project

UPDATE Project

DELETE Project

READ/DISPLAY Project-Line Mapping Page

INSERT New Project-Line Mapping
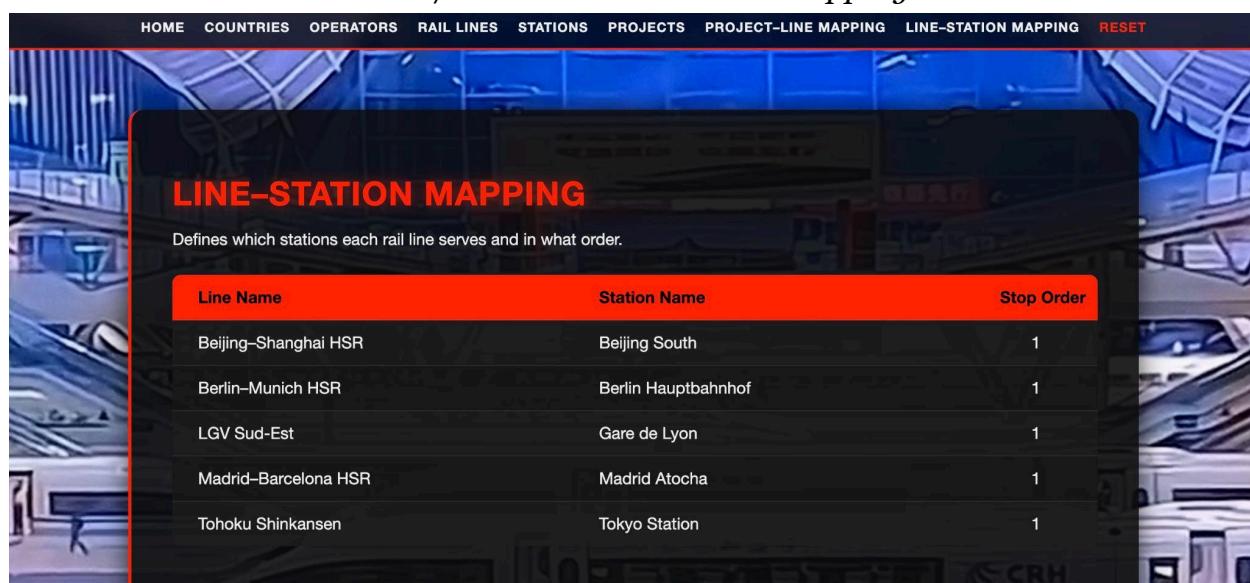
UPDATE Project-Line Mapping

DELETE Project-Line Mapping

READ/DISPLAY Line-Station Mapping

CREATE Line-Station Mapping
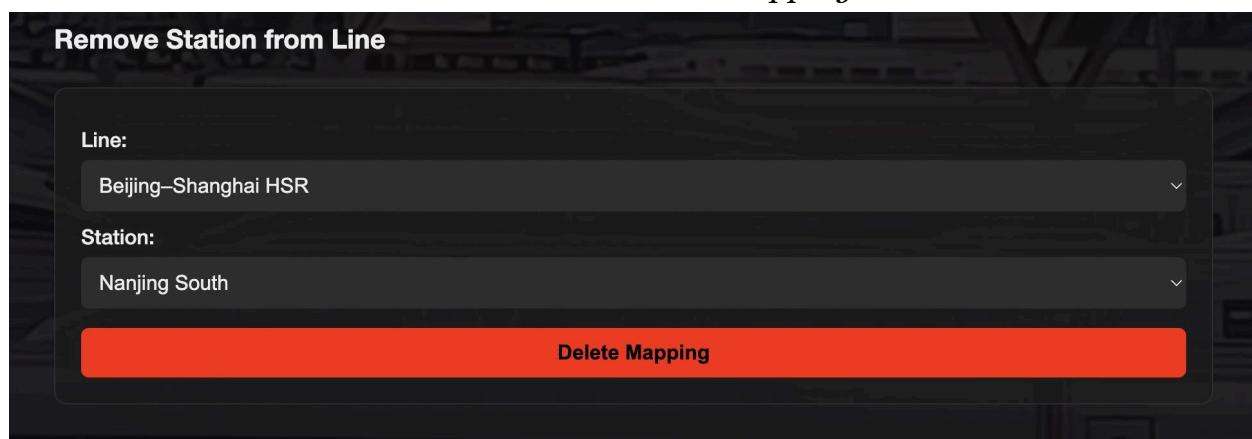
DELETE Line-Station Mapping

RESET Database To Original State

Citations

International Union of Railways. (2024). UIC High-Speed Rail Atlas 2024 (6th ed.) [PDF]. Paris, France: UIC. Retrieved from https://uic.org/IMG/pdf/uic_high-speed_atlas_2024.pdf

We used ChatGPT (OpenAI, 2025) to help compile representative example data for our database tables. We asked:
"Can you provide realistic example data for countries, operators, rail lines, stations, and high-speed rail projects based on actual global HSR systems?"

We also asked ChatGPT (OpenAI, 2025) to help us set up a website. We asked: *"Can you provide guidance on how to begin developing our CS340 project website using Node.js with the Handlebars templating engine, and whether this framework is the most appropriate choice for our implementation?"*

china.travels. (2024, January 2). *High-speed train video in China* [Video]. Instagram. https://www.instagram.com/reel/C1lnPcc0OX7/

Favicon and icon assets were purchased with full commercial rights and are owned by the project team.

Claude (Anthropic, 2025) was used to assist with:

- CSS table layout debugging and spacing refinements
- JavaScript form-interaction troubleshooting
- Structuring and editing the README documentation
- Refining wording of technical descriptions and non-functional explanations