

**CS 340 Group 90 - Project Step 6:**  
*Global High-Speed Rail Infrastructure Database*  
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**URL:** <http://classwork.engr.oregonstate.edu:2181>

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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

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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

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- 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

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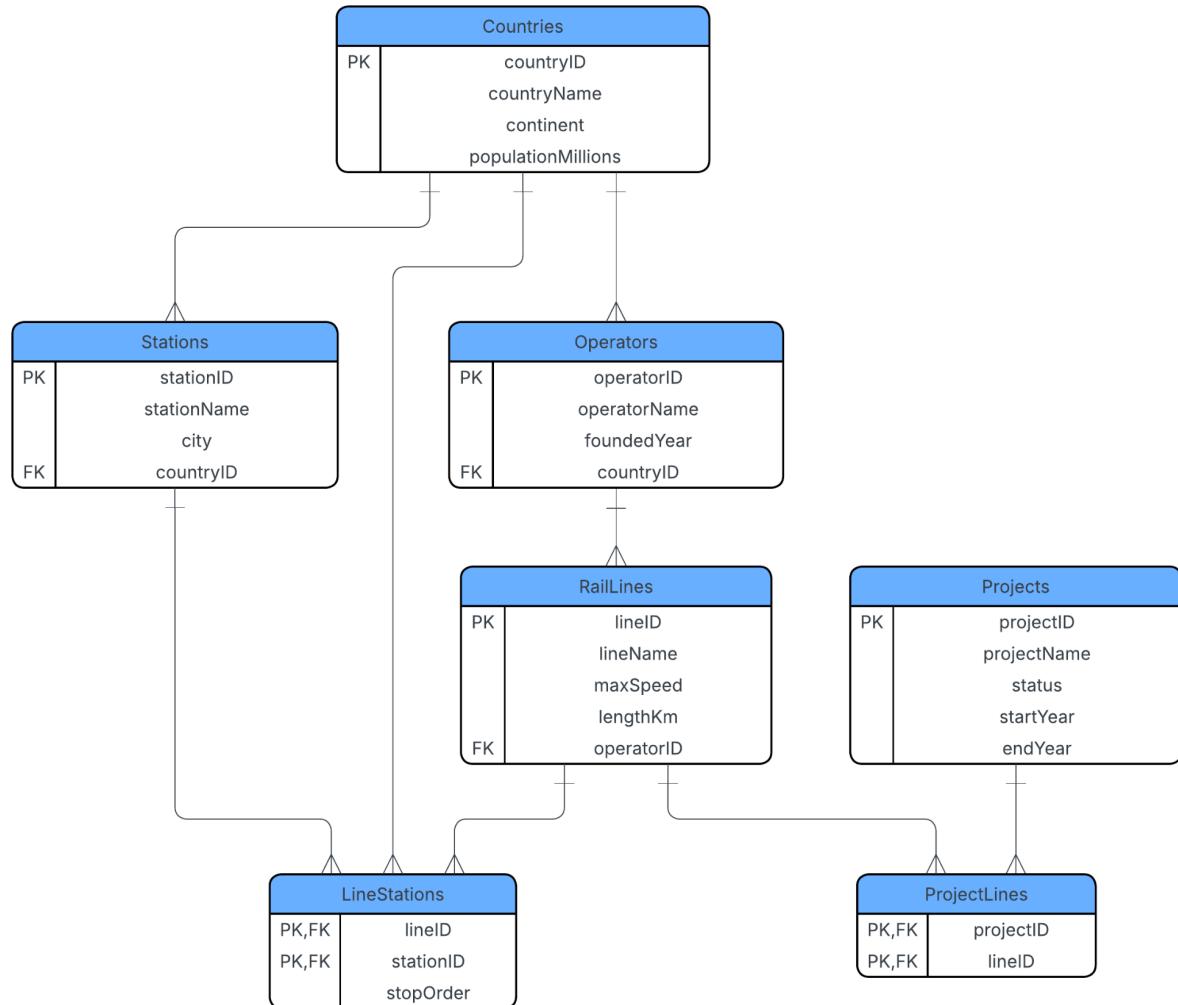


Figure 1. Entity-Relationship Diagram

## Schema Diagram

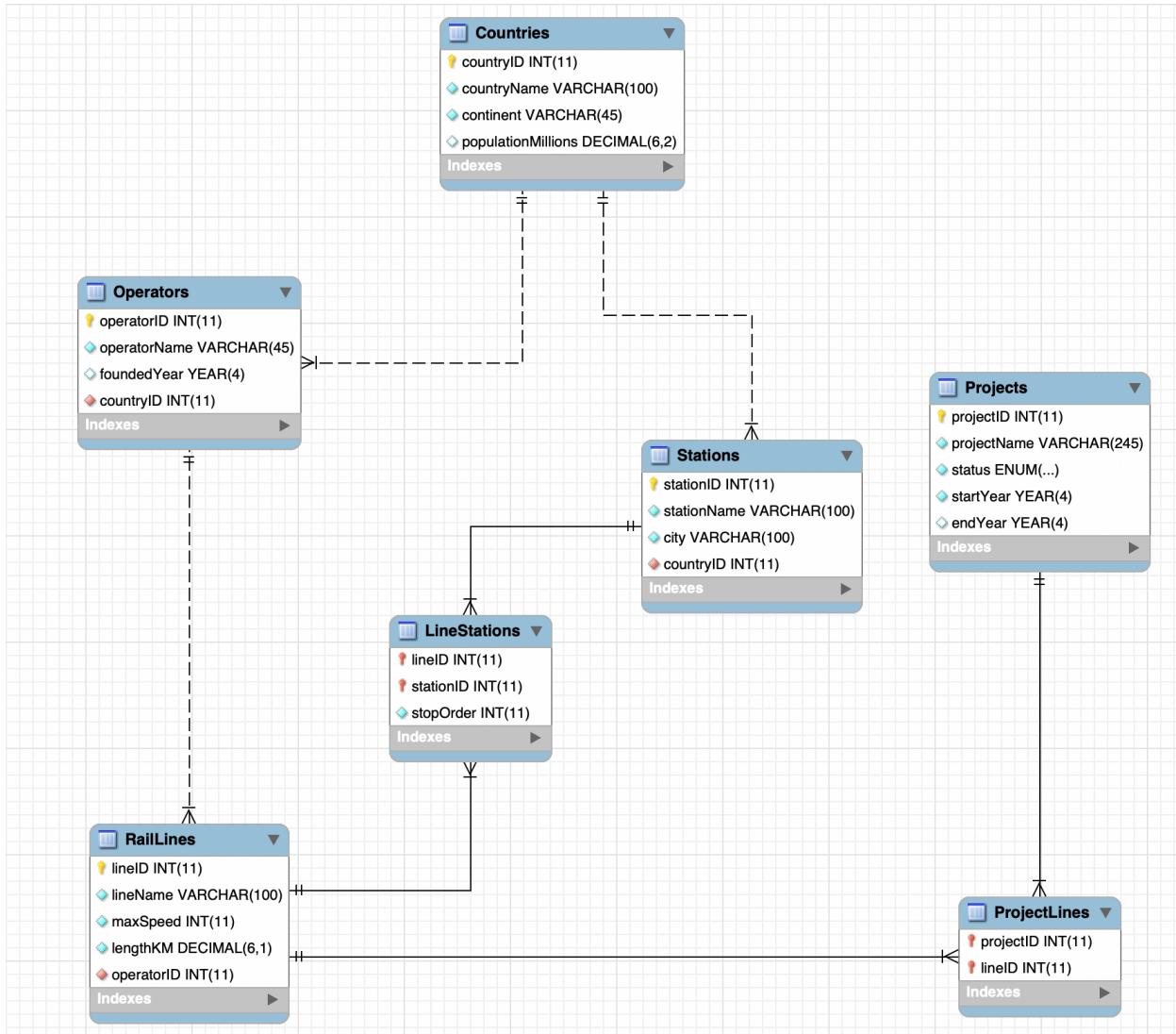


Figure 2. Schema Diagram

## Example Data

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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
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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	

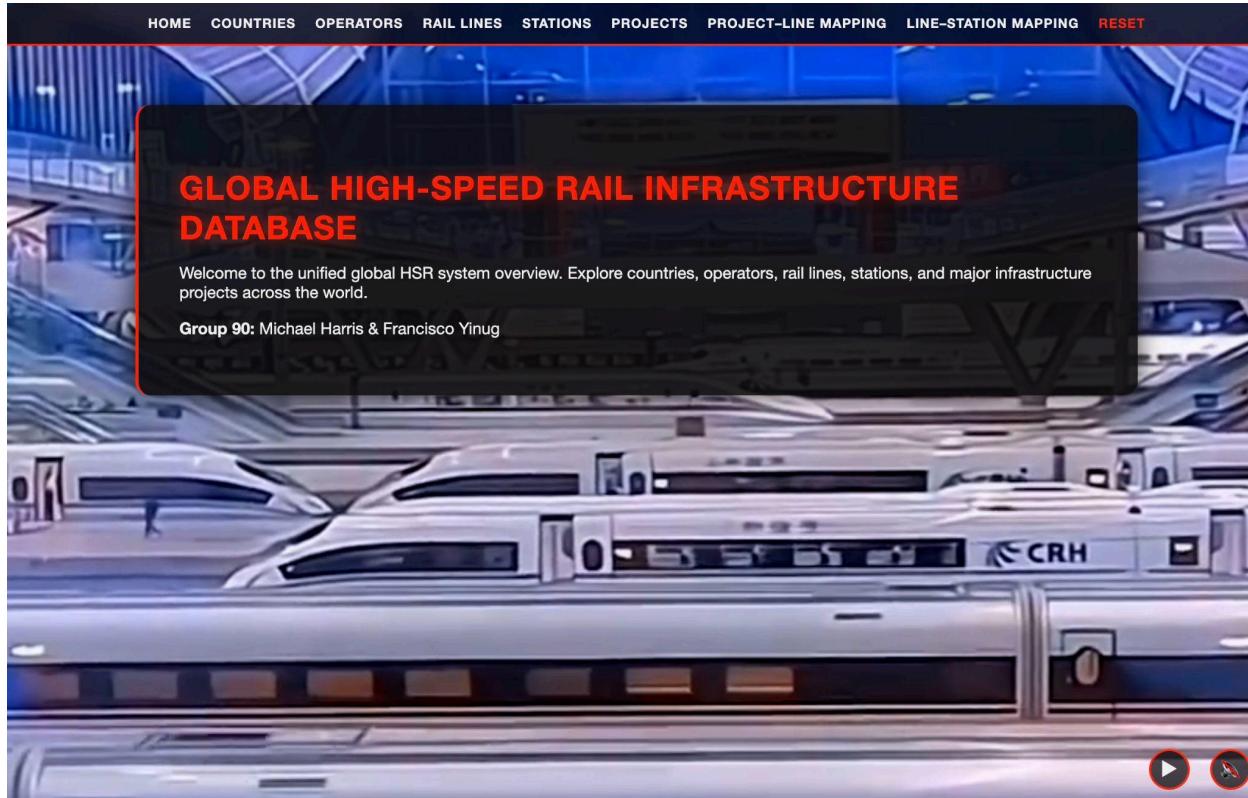
ProjectLines	
projectID	lineID
1	1
2	2
3	3
4	4
5	5
3	1

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

## UI Screenshots

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*Home Page/Navigation Overview*



*READ/DISPLAY Countries Page*

The screenshot shows a table titled "COUNTRIES" with a subtitle "National profiles for each high-speed rail network." The table has columns for ID, Country, Continent, Population, and Edit. The data is as follows:

ID	Country	Continent	Population	Edit
1	Japan	Asia	125.70	<a href="#">Edit</a>
2	France	Europe	67.00	<a href="#">Edit</a>
3	China	Asia	1411.00	<a href="#">Edit</a>
4	Germany	Europe	83.20	<a href="#">Edit</a>
5	Spain	Europe	47.60	<a href="#">Edit</a>

*CREATE/INSERT New Country*

**Add Country**

Country Name:  
USA

Continent:  
North America

Population (millions):  
342.95

**Add**

*UPDATE Country (Prepopulated Form)*

**Update Country**

Select Country:  
3 – China (Asia)

New Country Name:  
China

New Continent:  
Asia

New Population (millions):  
1411.00

**Update**

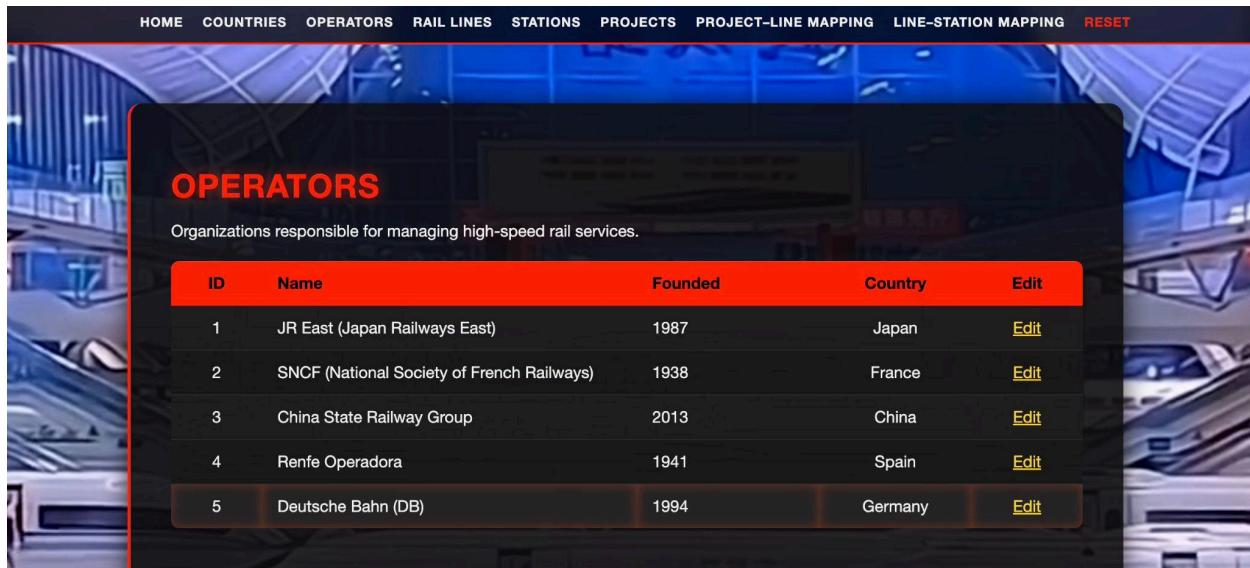
*DELETE Country*

**Delete Country**

Select Country:  
5 – Spain (Europe)

**Delete**

## *READ/DISPLAY Operators Page*



HOME COUNTRIES OPERATORS RAIL LINES STATIONS PROJECTS PROJECT-LINE MAPPING LINE-STATION MAPPING RESET

### OPERATORS

Organizations responsible for managing high-speed rail services.

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

## *CREATE Operator*

### Add Operator

Name:

Founded Year:

Country:

**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*

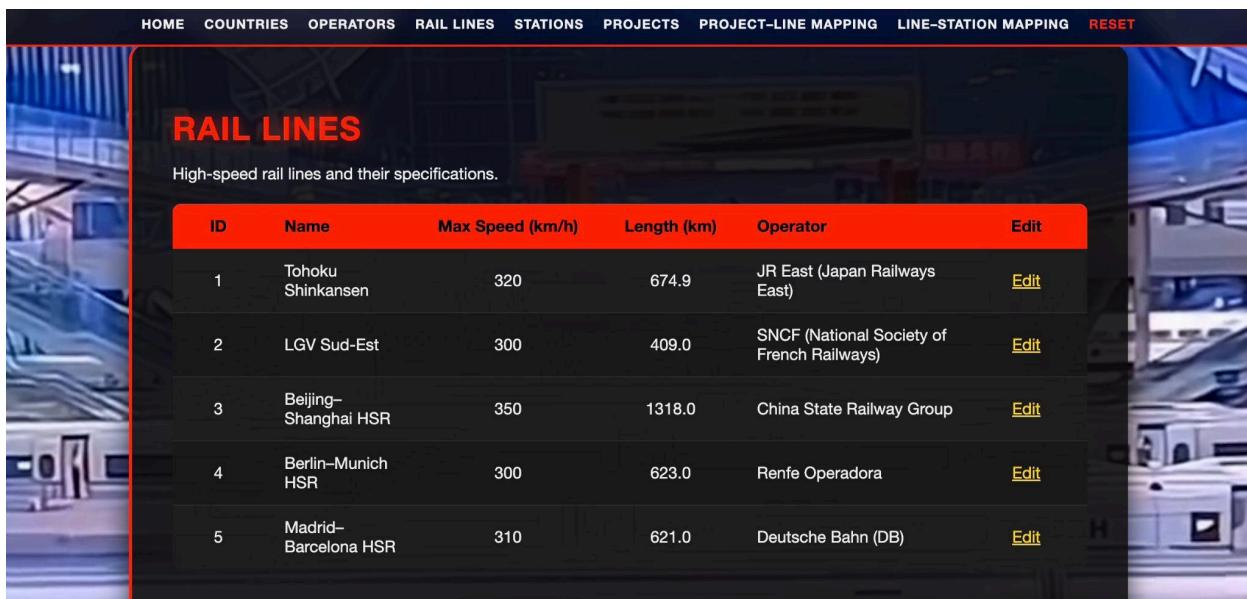
**Delete Operator**

Select Operator:

5 – Deutsche Bahn (DB)

**Delete Operator**

## *READ/DISPLAY Rail Line Page*



HOME COUNTRIES OPERATORS RAIL LINES STATIONS PROJECTS PROJECT-LINE MAPPING LINE-STATION MAPPING RESET

### 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)	<a href="#">Edit</a>
2	LGV Sud-Est	300	409.0	SNCF (National Society of French Railways)	<a href="#">Edit</a>
3	Beijing–Shanghai HSR	350	1318.0	China State Railway Group	<a href="#">Edit</a>
4	Berlin–Munich HSR	300	623.0	Renfe Operadora	<a href="#">Edit</a>
5	Madrid–Barcelona HSR	310	621.0	Deutsche Bahn (DB)	<a href="#">Edit</a>

## *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**

## *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**

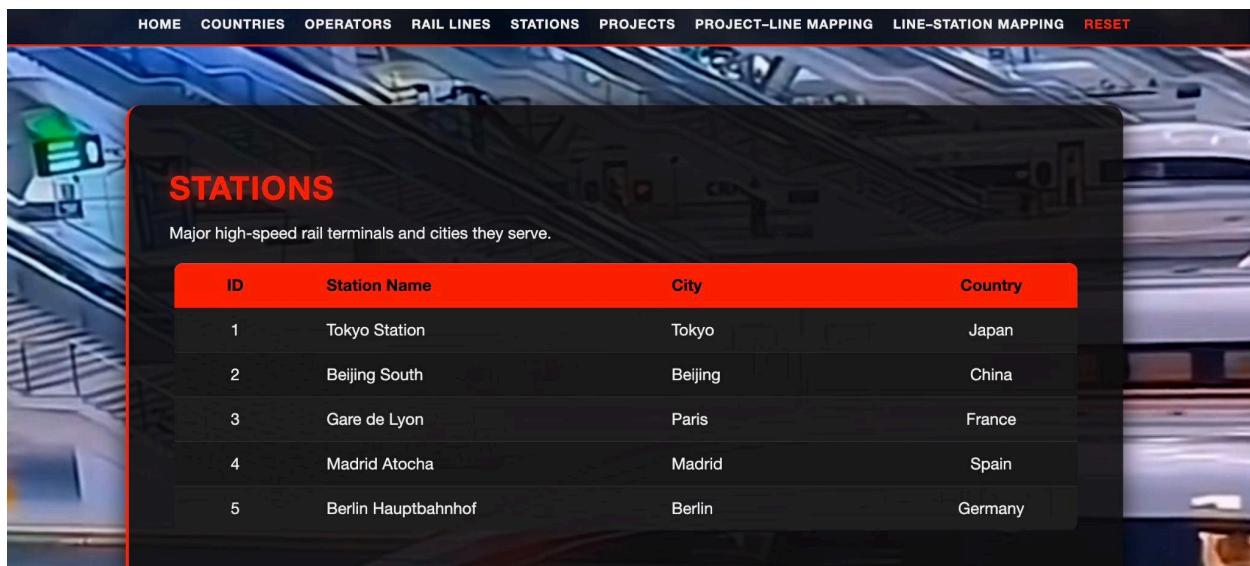
## *DELETE Rail Line*

**Delete Rail Line**

Select Rail Line:  
1 — Tohoku Shinkansen

**Delete Rail Line**

## *READ/DISPLAY Stations Page*



HOME COUNTRIES OPERATORS RAIL LINES STATIONS PROJECTS PROJECT-LINE MAPPING LINE-STATION MAPPING RESET

### STATIONS

Major high-speed rail terminals and cities they serve.

ID	Station Name	City	Country
1	Tokyo Station	Tokyo	Japan
2	Beijing South	Beijing	China
3	Gare de Lyon	Paris	France
4	Madrid Atocha	Madrid	Spain
5	Berlin Hauptbahnhof	Berlin	Germany

## *CREATE Station*

### Add Station

Station Name: Nanjing South

City: Nanjing

Country: 3 – China

**Add Station**

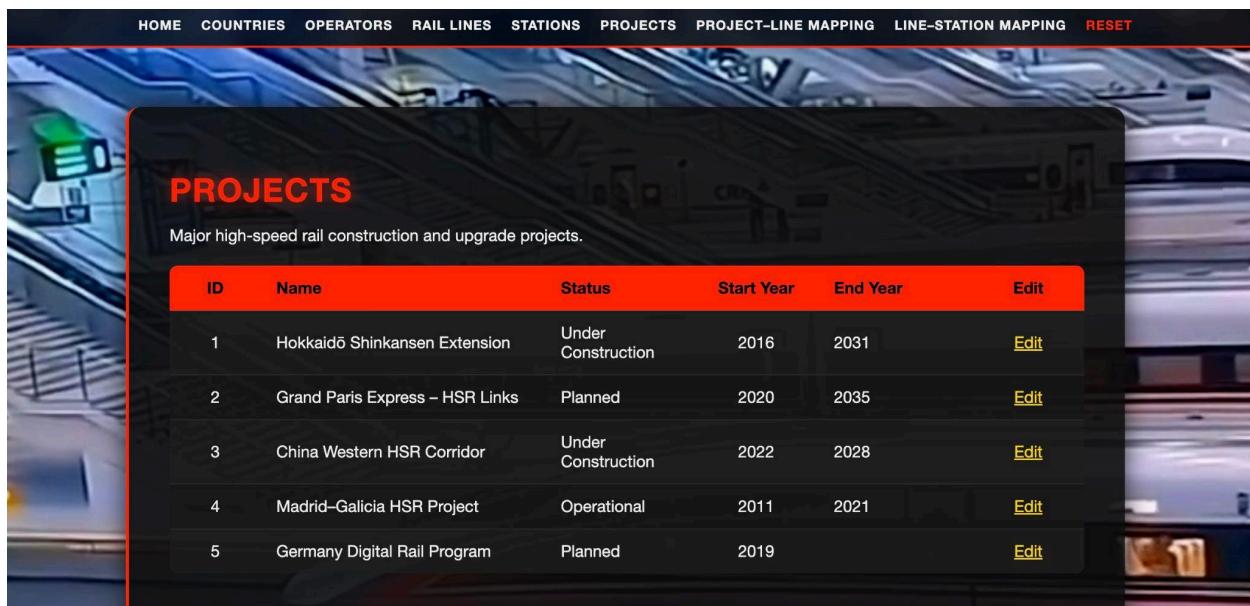
## *DELETE Station*

### Delete Station

Select Station: 1 – Tokyo Station (Tokyo)

**Delete Station**

## *READ/DISPLAY* Projects Page



Major high-speed rail construction and upgrade projects.

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

## *CREATE* Project

### Add Project

Project Name:

Status:

Start Year:

End Year (optional):

**Add Project**

## *UPDATE Project*

**Update Project**

Select Project:  
5 — Germany Digital Rail Program

New Name:  
Germany Digital Rail Program

New Status:  
Operational

New Start Year:  
2025

New End Year:

**Update Project**

## *DELETE Project*

**Delete Project**

Select Project:  
4 — Madrid–Galicia HSR Project

**Delete Project**

## *READ/DISPLAY Project-Line Mapping Page*

The screenshot shows a web-based application for managing rail projects. At the top, a navigation bar includes links for HOME, COUNTRIES, OPERATORS, RAIL LINES, STATIONS, PROJECTS, PROJECT-LINE MAPPING, LINE-STATION MAPPING, and a RESET button. The main content area is titled "PROJECT-LINE MAPPING" in large red capital letters. Below this, a sub-instruction reads "Which rail lines belong to which projects." A table lists six entries, each with a "Edit" link:

Project Name	Line Name	Edit
Hokkaidō Shinkansen Extension	Tohoku Shinkansen	<a href="#">Edit</a>
Grand Paris Express – HSR Links	LGV Sud-Est	<a href="#">Edit</a>
China Western HSR Corridor	Beijing–Shanghai HSR	<a href="#">Edit</a>
Madrid–Galicia HSR Project	Madrid–Barcelona HSR	<a href="#">Edit</a>
Germany Digital Rail Program	Berlin–Munich HSR	<a href="#">Edit</a>

## *INSERT New Project-Line Mapping*

The screenshot shows a modal dialog titled "Add Mapping". It contains two dropdown menus: "Select Project:" with the option "3 — China Western HSR Corridor" selected, and "Select Rail Line:" with the option "4 — Berlin–Munich HSR" selected. At the bottom is a prominent red button labeled "Add Mapping".

## *UPDATE Project-Line Mapping*

**Update Mapping**

**Current Mapping:**  
China Western HSR Corridor — Beijing–Shanghai HSR

**New Project:**  
6 — Brightline (Florida)

**New Line:**  
3 — Beijing–Shanghai HSR

**Update Mapping**

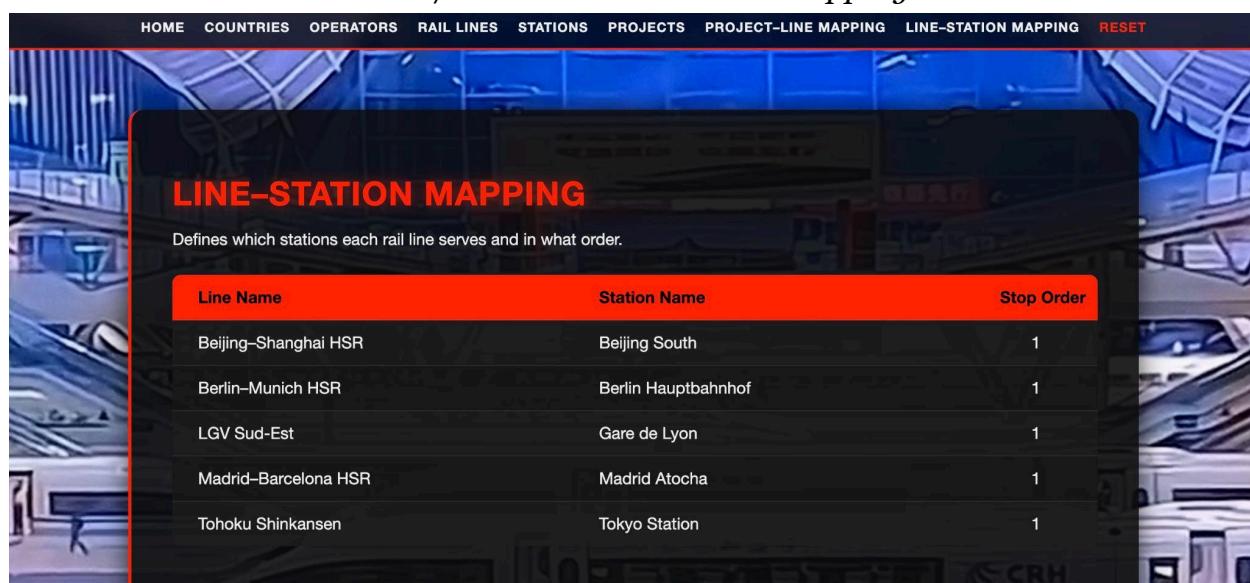
## *DELETE Project-Line Mapping*

**Delete Mapping**

**Select Mapping:**  
Germany Digital Rail Program — Beijing–Shanghai HSR

**Delete Mapping**

## *READ/DISPLAY Line-Station Mapping*



HOME COUNTRIES OPERATORS RAIL LINES STATIONS PROJECTS PROJECT-LINE MAPPING LINE-STATION MAPPING RESET

### LINE-STATION MAPPING

Defines which stations each rail line serves and in what order.

Line Name	Station Name	Stop Order
Beijing–Shanghai HSR	Beijing South	1
Berlin–Munich HSR	Berlin Hauptbahnhof	1
LGV Sud-Est	Gare de Lyon	1
Madrid–Barcelona HSR	Madrid Atocha	1
Tohoku Shinkansen	Tokyo Station	1

*CREATE Line-Station Mapping*

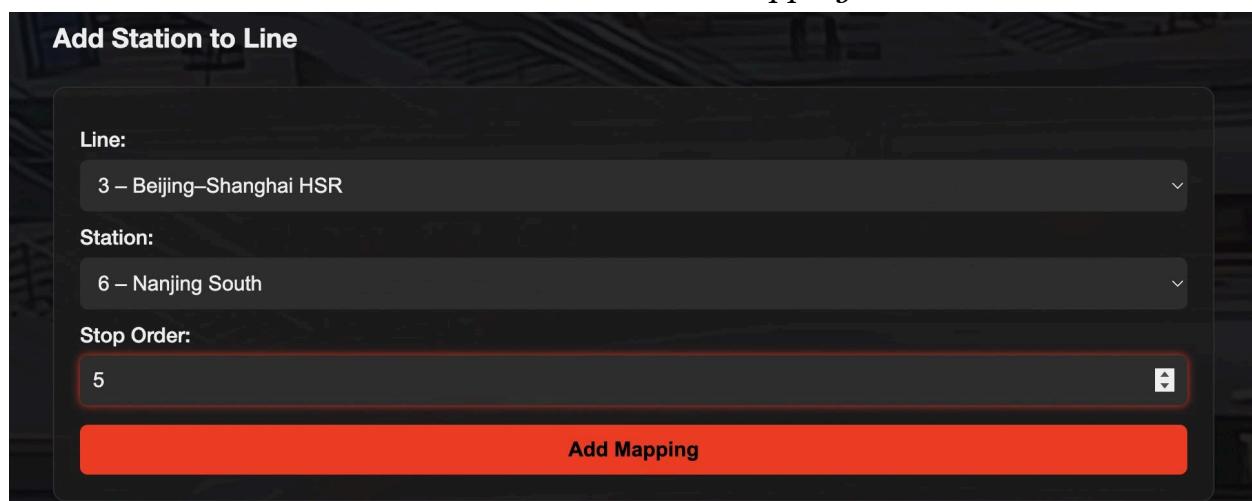
**Add Station to Line**

Line:  
3 – Beijing–Shanghai HSR

Station:  
6 – Nanjing South

Stop Order:  
5

**Add Mapping**



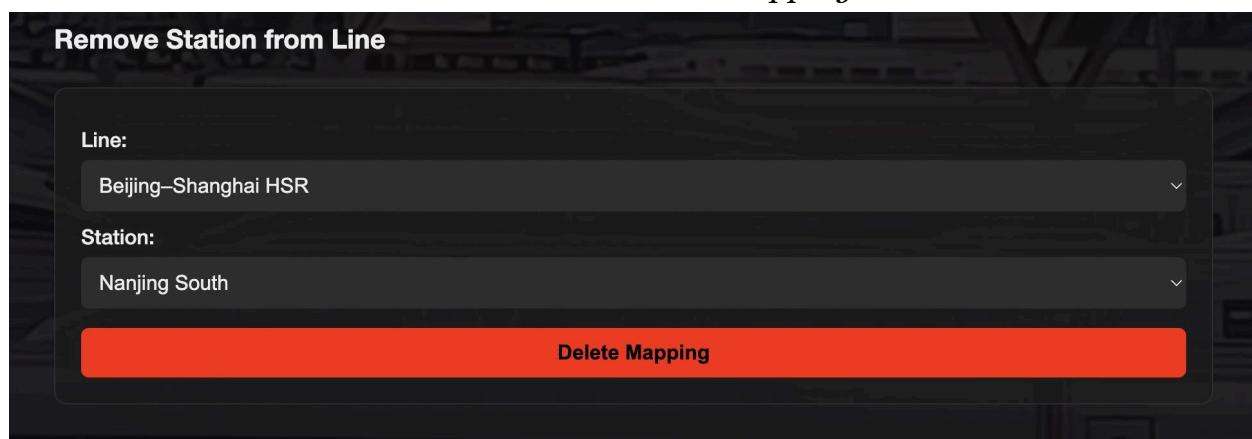
*DELETE Line-Station Mapping*

**Remove Station from Line**

Line:  
Beijing–Shanghai HSR

Station:  
Nanjing South

**Delete Mapping**



*RESET Database To Original State*



## Citations

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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](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/C1lnPccOx7/>

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