

Design and Implementation of a Spatial Database

A structured spatial database design that optimises geo spatial data storage, querying and interoperability with the use of POSTGIS

Introduction

The project was designed for an events company for their annual festival to ensure organisation and proper service delivery to their clientele.

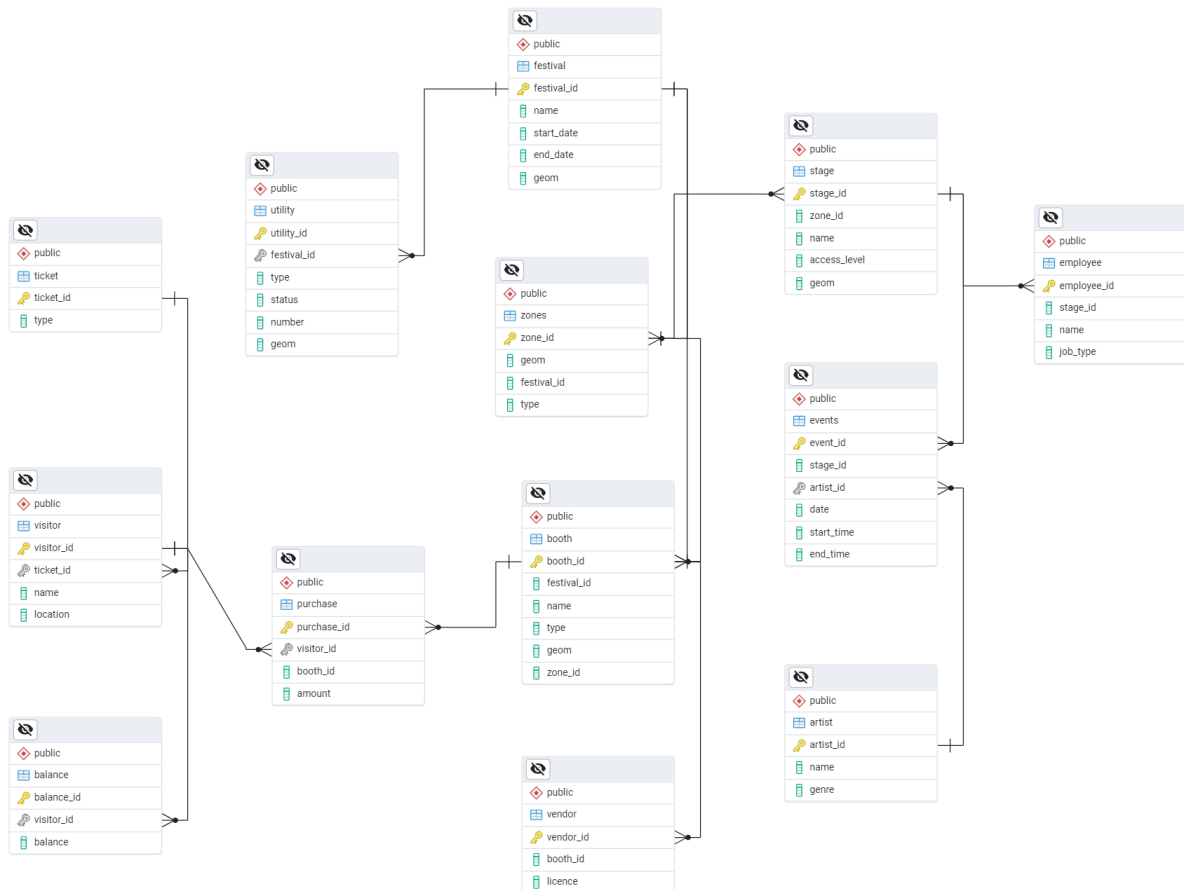
It leveraged WebGis to support a mobile application interface that provided clients with real-time information and streamline organisers workflows. The information included locating stages, guiding artists to respective stages, locating wash rooms among other amenities.

Objectives

- Serve as a database backend to organise the booths, roller coasters, tents etc. (Positions, opening times) as well as other facilities (garbage bins, toilets etc)
- User-specific, dynamic queries that return which events take place or facilities that are close to the current visitor's position.
- User-specific and dynamic queries about the festival (digital maps, lists of events etc

ER diagram

The ER diagram illustrates the main entities in the database design and their relationships.



Summary of Tables

- Festival – Central entity that links all other tables, storing details about the festival's name, location, and dates.
- Event Zones – Defines areas within the festival (e.g., food, medical, event zones), linking to stages, booths, and utilities.
- Stage – Stores details of festival stages, defining location, access level, and zone affiliation.
- Event – Links artists to stages, recording performance time slots and locations.
- Artist – Stores artist details, linked to events and stages.
- Booth – Represents vendor booths, specifying type, location, and zone.
- Vendor – Links vendors to booths.
- Utility – Stores details about facilities (e.g., toilets, medical points, garbage bins), linked to zones and festival areas.

- Employees – Stores festival staff information, linking them to stages and assigned roles.
- Visitor – Tracks festival attendees, linking them to ticket types.
- Visitor Balance – Monitors a visitor's remaining balance on their digital festival band.
- Ticket – Stores ticket types (VIP, General Admission), defining visitor access levels.
- Purchase – Tracks visitor purchases at booths, recording transaction amounts.

Database definition

Spatial tables including utilities, booths, stages, zones and the festival grounds, were created using QGIS and the shapefiles were then imported into a PostGIS database



Non-spatial tables were defined in Postgres including events, artists, visitors employees , tickets etc

The database is normalized to Third Normal Form (3NF) to eliminate redundancy by having each table has a primary key that uniquely identifies records and all other attributes dependent on the full primary key and not the other non-primary keys.

Sample data was then inserted into the database for the corresponding tables.

```
--- Adding sample data to the table
--- 1. event table
INSERT INTO events (event_id, stage_id, artist_id, date, start_time, end_time)
VALUES
  (1, 1, 1, '2025-07-09', '18:00', '19:30'),
  (2, 1, 2, '2025-07-10', '20:00', '21:30'),
  (3, 2, 3, '2025-07-09', '17:00', '18:30'),
  (4, 2, 4, '2025-07-10', '19:00', '20:30'),
  (5, 3, 5, '2025-07-09', '18:00', '19:30'),
  (6, 3, 6, '2025-07-10', '20:00', '21:30'),
  (7, 4, 7, '2025-07-09', '17:00', '18:30'),
  (8, 4, 8, '2025-07-10', '19:00', '20:30'),
```

Database Access and control (Role based access)

For database security, different roles were created for festival employees and visitors providing different levels of access. Each role has specific permissions granted based on their responsibilities. The roles included:

1. Visitor: Limited access to personal data and location tables only to view.
2. Stage Manager: full access to events table and limited access to stage and artist.
3. Vendor Coordinator: full access to vendor table and limited access to purchase and booth data.
4. Ticketing staff: limited access to ticket and visitor table
5. Security staff: limited access to stage, artist and events tables

```
--- Access control
--- create roles for individuals to access database
CREATE ROLE visitor WITH LOGIN PASSWORD 'ticket_id' VALID UNTIL '2025-07-11';
CREATE ROLE stage_manager WITH LOGIN PASSWORD 'M4u=ct)HB8Em';
CREATE ROLE vendor_coordinator WITH LOGIN PASSWORD 'u+}zmEn-P8`?sb';
CREATE ROLE ticketing_staff WITH LOGIN PASSWORD 'e2H-mtS+Fs(q' VALID UNTIL '2025-07-11';
CREATE ROLE security_staff WITH LOGIN PASSWORD 'ZL~hB+.E5GJ9/' VALID UNTIL '2025-07-11';

--- visitor access
GRANT SELECT ON
  festival, zones, stage,events, artist, vendor, booth, utility
TO visitor;
```

Database Manipulation (Queries)

1. List of events on the second day of the festival. What are the events that are taking place on the second day of the festival including which stage and artists will perform?

```
--- Database Manipulation
--- 1. list of events plus artist and stage they perform at on a specific date i.e. 2nd day of the festival
SELECT
    e.date,
    e.start_time,
    e.end_time,
    s.name AS stage_name,
    a.name AS artist_name
FROM events e
JOIN stage s ON e.stage_id = s.stage_id
JOIN artist a ON e.artist_id = a.artist_id
WHERE e.date = '2025-07-10';
```

Results:

Execute

4 rows, 0.001 seconds

Create a view

Clear

	artist_name	date	start_time	end_time	stage_name
1	Felo le tee	2025-07-09	17:00:00	18:30:00	A-Z stage2
2	The therapist	2025-07-10	19:00:00	20:30:00	A-Z stage2
3	Dj maphorisa	2025-07-09	18:00:00	19:30:00	Sky view
4	Dj grauchi	2025-07-10	20:00:00	21:30:00	Sky view

2. What are the utilities near a festival goer? *Assumption for this query is that the location of the festival goer is from a specific zone, ideally it should be the real time location of the visitor.*

Query 2 result

Execute

4 rows, 0.001 seconds

Create a view

Clear

	artist_name	date	start_time	end_time	stage_name
1	Felo le tee	2025-07-09	17:00:00	18:30:00	A-Z stage2
2	The therapist	2025-07-10	19:00:00	20:30:00	A-Z stage2
3	Dj maphorisa	2025-07-09	18:00:00	19:30:00	Sky view
4	Dj grauchi	2025-07-10	20:00:00	21:30:00	Sky view

3. Identify the access level visitor has based on ticket type. Which stages / events does a festival have access to? *Example below is with one festival goer*

	artist_name	date	start_time	end_time	stage_name
1	Burna Boy	2025-07-09	18:00:00	19:30:00	Main stage
2	Tems	2025-07-10	20:00:00	21:30:00	Main stage
3	Amaarae	2025-07-09	17:00:00	18:30:00	A-Z stage1
4	Dexta Daps	2025-07-10	19:00:00	20:30:00	A-Z stage1
5	Uncle Waffles	2025-07-09	18:00:00	19:30:00	Amapiano stage
6	Scorpion kings	2025-07-10	20:00:00	21:30:00	Amapiano stage

Query 3 result for a VIP ticket holder