KATHMANDU UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF GEOMATICS ENGINEERING

Final Report on

Determining Shortest Route

Using pgRouting, PostGIS, PostgreSQL and QGIS

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ABSTRACT

This project studies the application of pgRouting, an open-source extension for PostgreSQL, in determining the shortest route between Jadibuti, Kathmandu and Kathmandu University. Utilizing OpenStreetMap (OSM) data and the spatial capabilities of PostGIS, the project demonstrates a comprehensive workflow that includes data preparation, route calculation, and visualization. The process begins with importing OSM data using osm2po, and then identifying the nearest nodes to the origin and destination points. pgRouting's Dijkstra algorithm is employed to compute the shortest path, and the results are visualized using QGIS. The report discusses the integration of these tools and the methodology used in determining the shortest path. The findings highlight the effectiveness of pgRouting for route optimization and its potential applications in time management and transportation management. This project shows the real world application of PostgreSQL and QGIS.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ABBREVIATIONS

DB	Database
GIS	Geographic Information System
OSM	Open Street Mapping
SQL	Structured Query Language

1 Introduction

In the realm of geographic information systems (GIS) and spatial analysis, the ability to determine the shortest route between two points on a map is a fundamental and widely applicable task. This task, known as routing, has numerous practical applications in fields such as transportation planning, logistics, emergency response, and urban development(Chadha & Garg, 2019). One of the key tools that facilitate routing analysis is pgRouting, an open-source extension of the PostgreSQL database system. pgRouting enhances PostgreSQL with advanced routing functionalities, allowing users to perform complex routing calculations directly within the database environment. This integration is particularly powerful when combined with PostGIS, a spatial database extender for PostgreSQL, which provides the necessary spatial data management capabilities.

pgRouting offers a range of routing algorithms, including the well-known Dijkstra and A* (A-star) algorithms, which are designed to find the shortest path between two points on a graph. These algorithms take into account various factors such as edge weights (e.g., distance, travel time) and constraints (e.g., one-way streets, turn restrictions) to determine the optimal route(Pritee & R.D., 2017). The ability to handle such factors makes pgRouting suitable for a wide range of routing scenarios, from simple point-to-point routing to more complex multi-stop and time-dependent routing. This flexibility is further enhanced by the extensibility of pgRouting, which allows users to customize and extend its functionalities to suit their specific needs.

In addition to its routing capabilities, pgRouting also offers powerful network analysis tools that enable users to analyze and visualize spatial data in meaningful ways(Sankepally & Rajan, 2018). For example, pgRouting can be used to analyze the connectivity of road networks, identify critical paths or nodes in a network, and simulate the impact of changes to the network infrastructure. These capabilities make pgRouting a valuable tool for decision-making in various industries, including transportation, logistics, and urban planning.

This project aims to demonstrate the practical application of pgRouting in determining the shortest route between two points on a map. Using a real-world scenario of calculating the shortest route, the step-by-step process of preparing the data, performing the routing analysis, and visualizing the results is illustrated in this project. Through this project, the power and versatility of pgRouting as a tool for spatial analysis and routing is shown. Further exploration and utilization of this technology can be done in diverse applications.

2 OBJECTIVES

2.1 Primary Objectives

The primary objective of this project is to determine the shortest route between Kathmandu University and Jadibuti, Kathmandu using pgrouting.

2.2 Secondary Objectives

The secondary objectives are:

- To use OSM, QGIS, PostgreSQL, and PostGIS to solve real-world problems.
- To deepen the understanding of spatial database and their functionalities.
- To visualize spatial data and develop practical GIS skills.

3 METHODOLOGY

3.1 Study area

The study area encompasses the route between Jadibuti, Kathmandu and Kathmandu University, Kavrepalanchok located in Bagmati province of Nepal. The specific coordinates for the starting point (Jadibuti, Kathmandu) are 27.6727° N, 85.35125° E, and the ending point (Kathmandu University) is 27.6194° N, 85.53877° E.

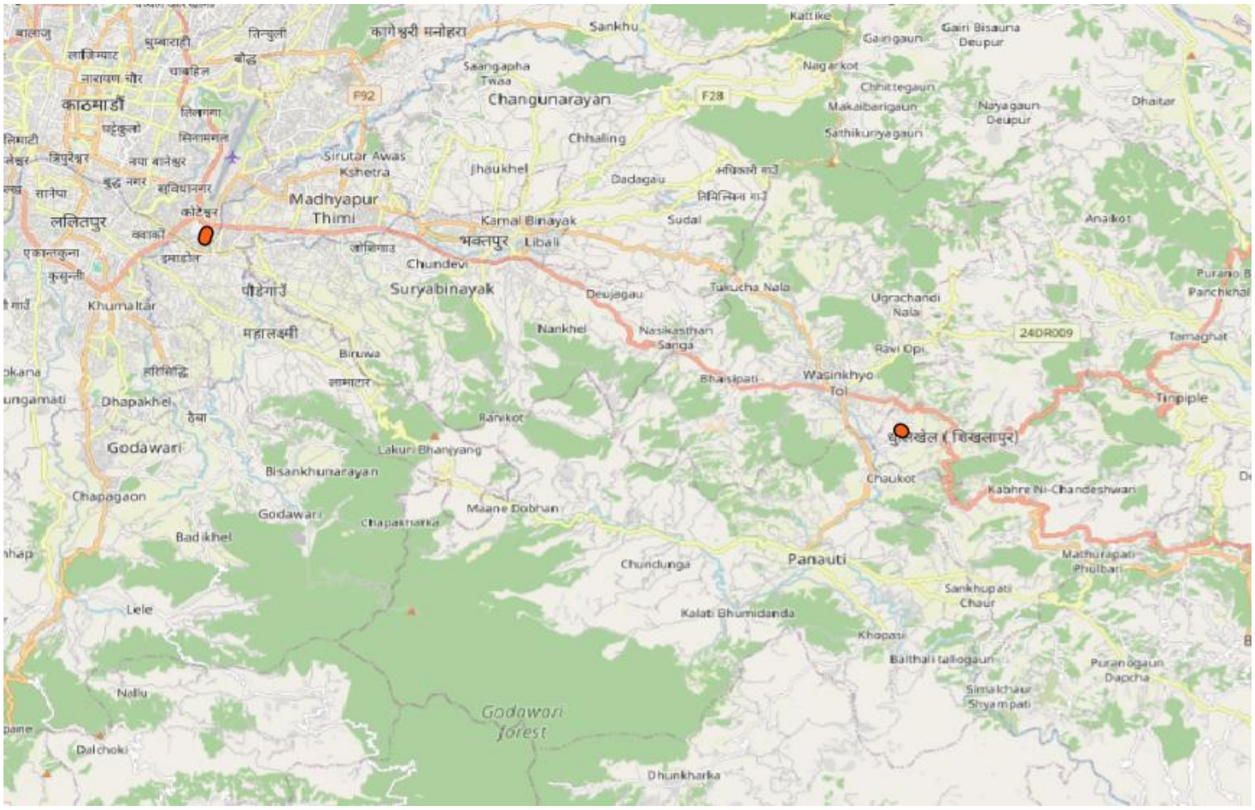

Figure 1: Study Area

3.2 Materials Used

3.2.1 Data used

OSM data for Nepal, which includes detailed information about the road network and other relevant geographic features was downloaded online.

3.2.2 Software used

The softwares used for this project are:

- PostgreSQL: A powerful relational database management system used for storing and managing spatial data.
- PostGIS: An extension of PostgreSQL that adds support for geographic objects, enabling spatial queries and analysis.
- pgRouting: An extension of PostGIS that provides routing and network analysis capabilities.

- QGIS: An open-source geographic information system used for data visualization, spatial analysis, and map creation.

3.3 Work Flow

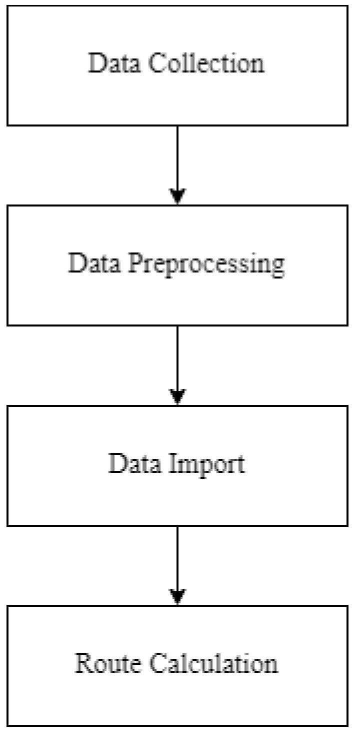

Figure 2: Project Workflow

The step-by-step explanation of each process is as follows:

3.3.1 Data Collection

OSM data for Nepal was downloaded through the link https://download.geofabrik.de/asia.html in .pbf format.

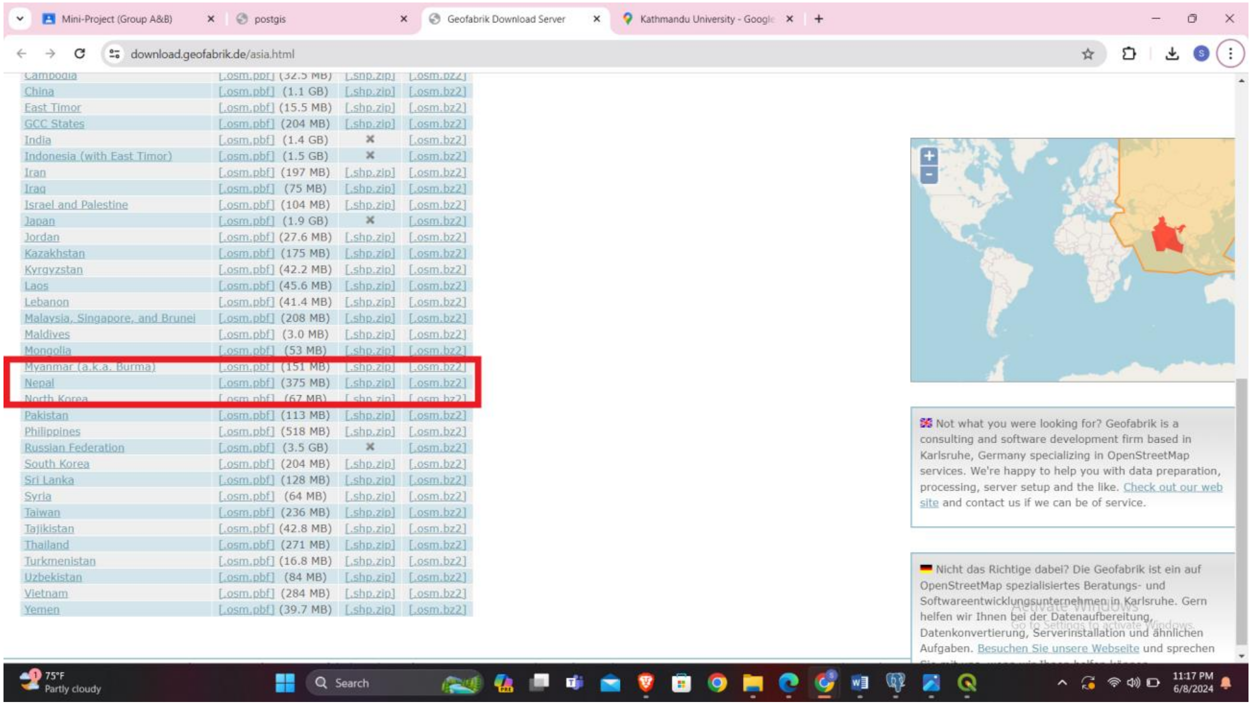

Figure 3: Downloading OSM data for Nepal

3.3.2 Data Preprocessing

The OSM data of Nepal was converted to usable form using command prompt and osm2po. osm2po is a powerful tool designed to convert OpenStreetMap (OSM) data into a format that can be used for routing and network analysis in PostgreSQL with PostGIS and pgRouting.

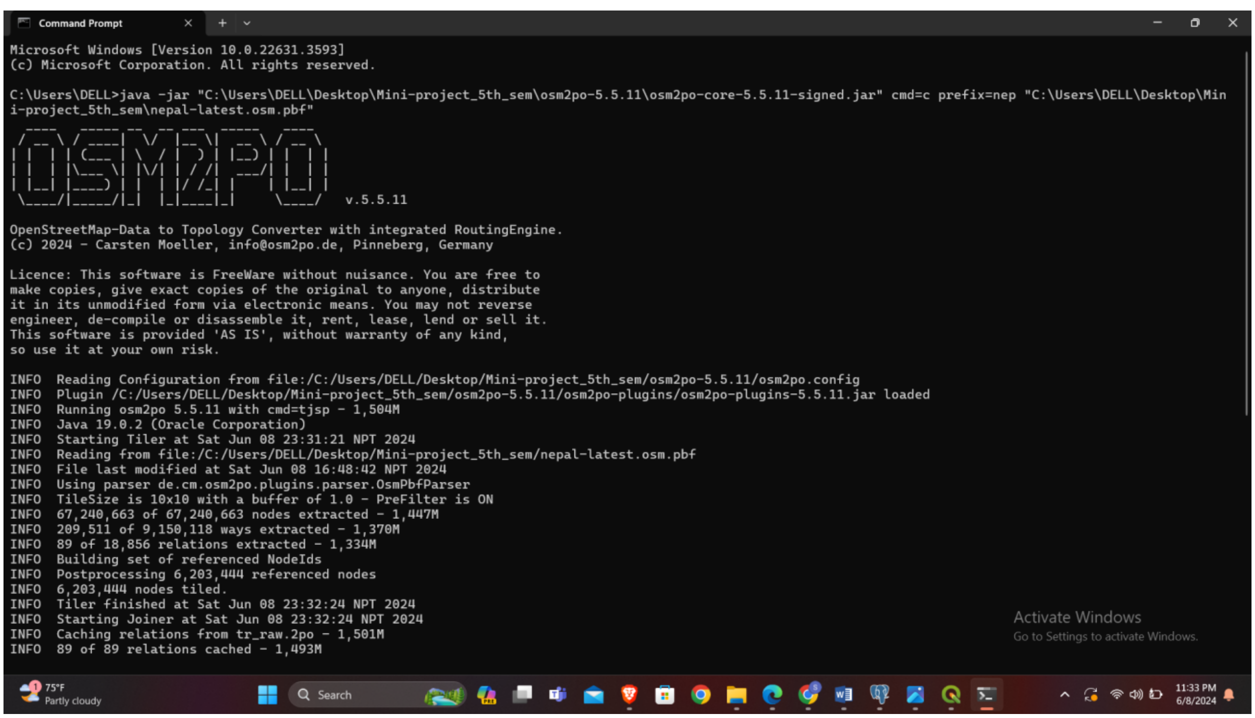

Figure 4: Preprocessing OSM data

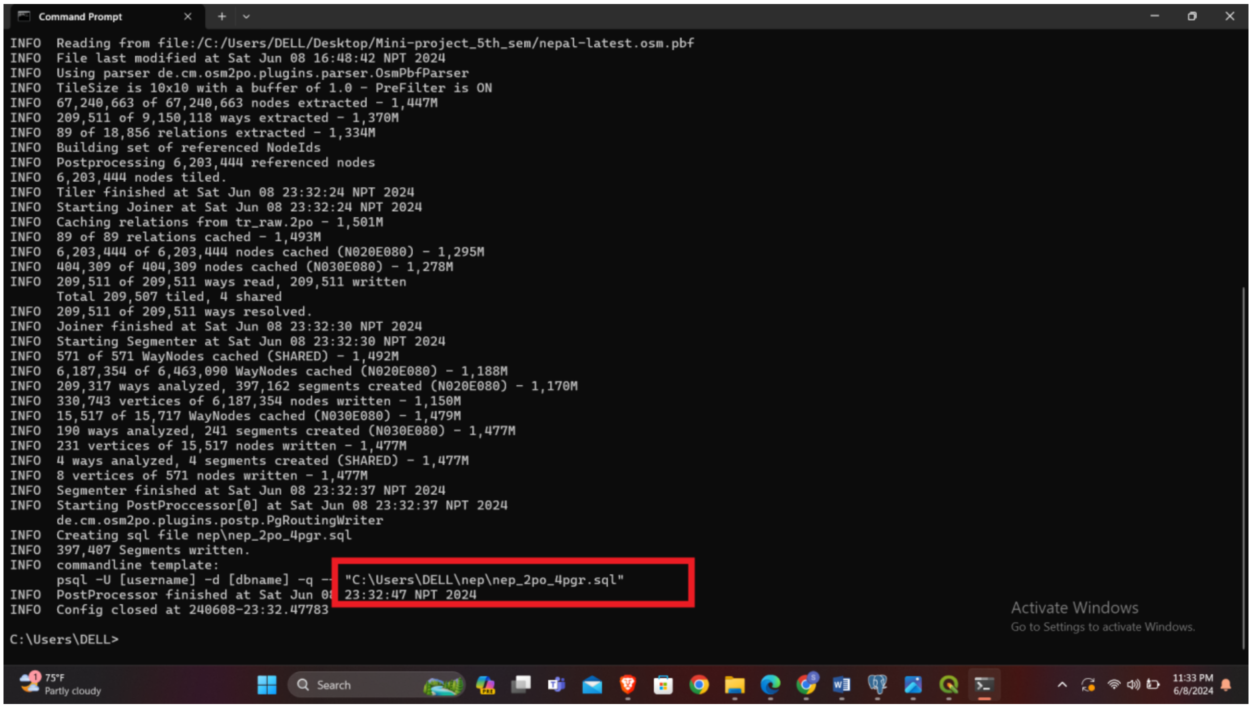

Figure 5: Navigating converted data

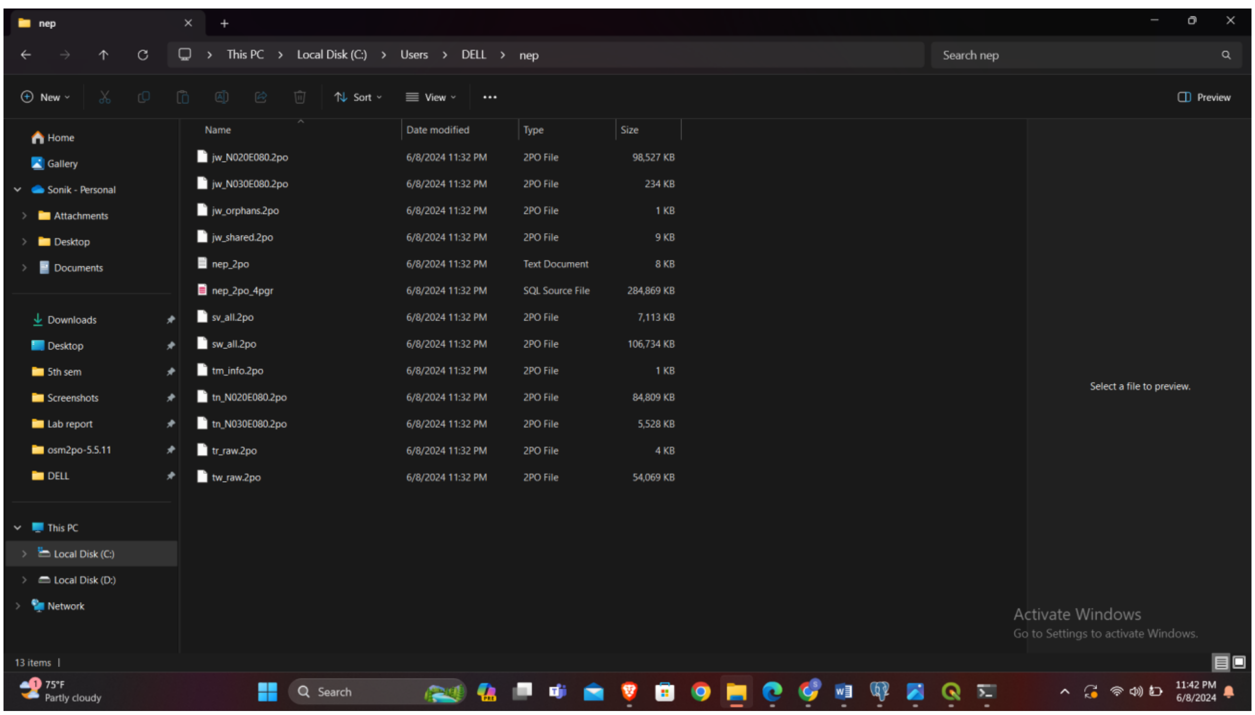

Figure 6: Opening converted data

3.3.3 Data Import

To import data from OSM to PostgreSQL, first of all a new database named “pgrouting” was created. Then two extensions “postgis” and “pgrouting” was created.

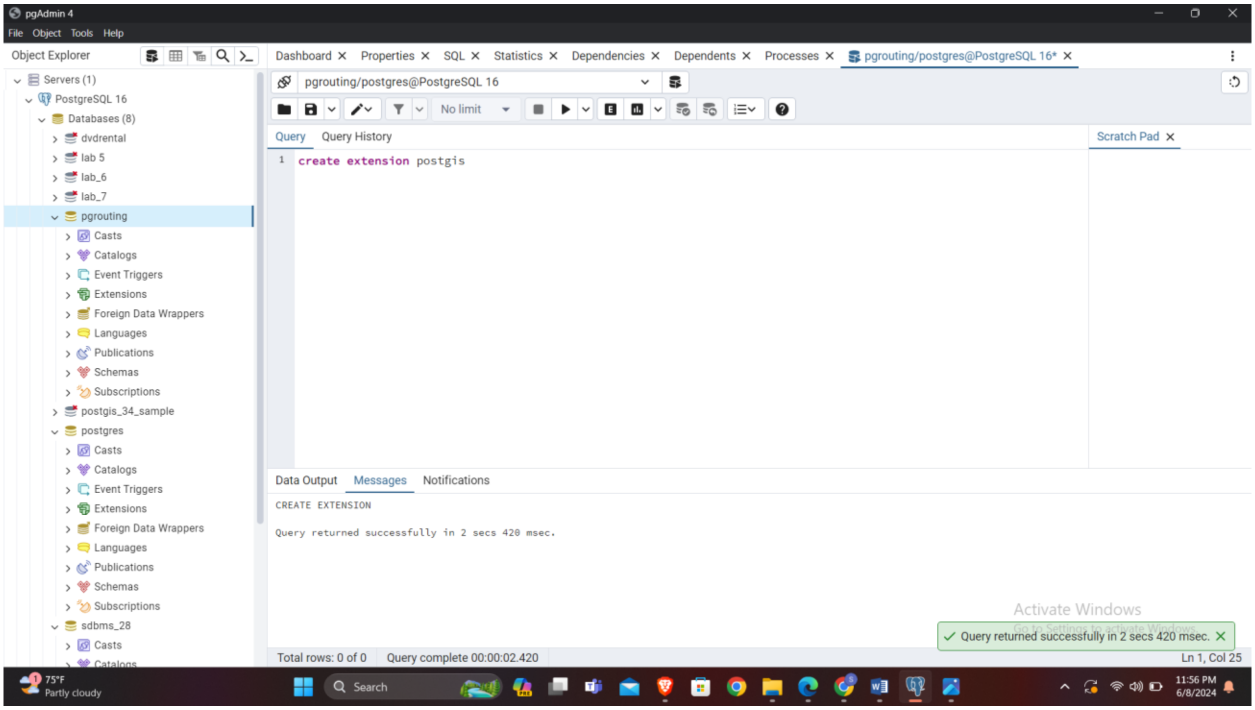

Figure 7: Creating extension "postgis"

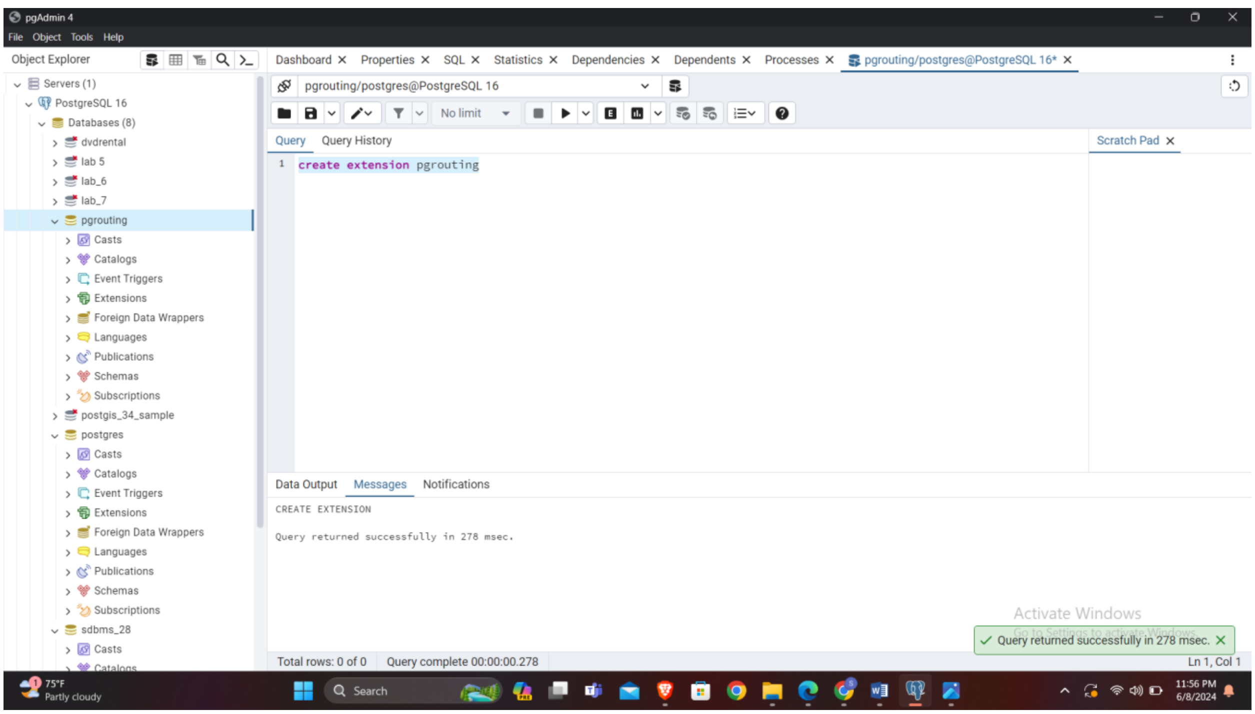

Figure 8: Creating extension "pgrouting"

Then, the SQL file of converted OSM data was run in pgadmin to create and insert data into table.

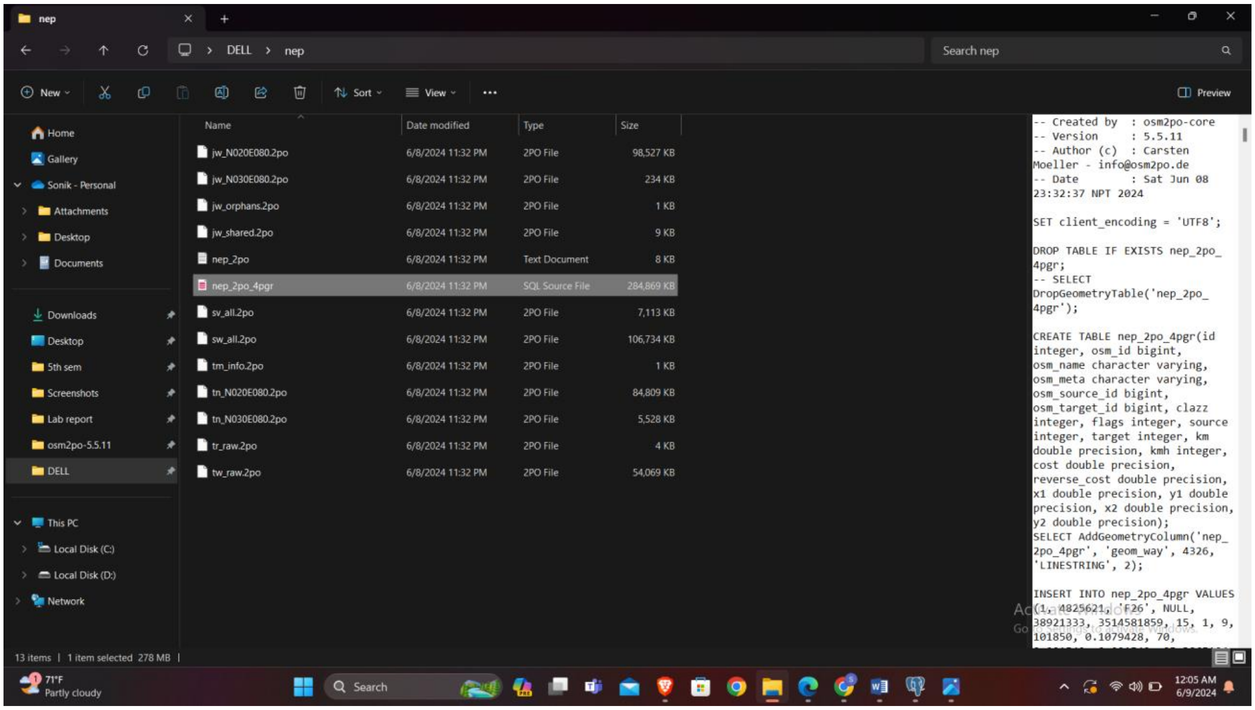

Figure 9: Navigating SQL file of OSM data

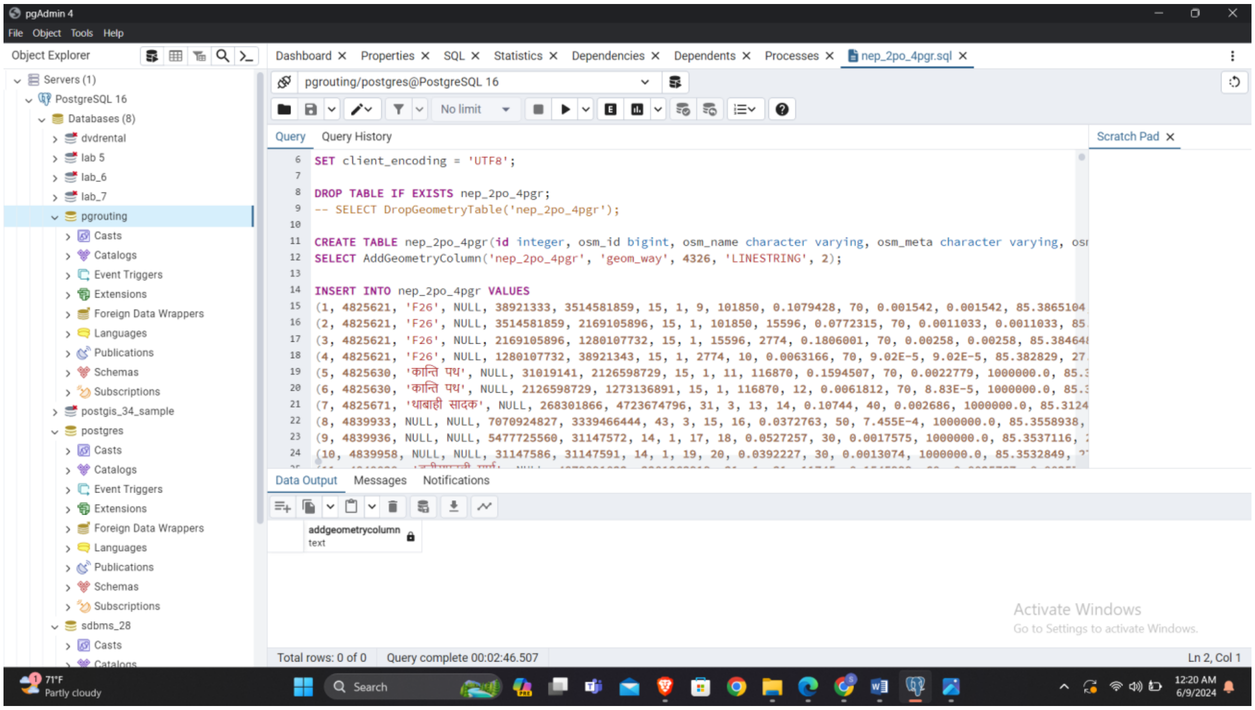

Figure 10: Creating a table and inserting data

Simple query was used to visualize the table:

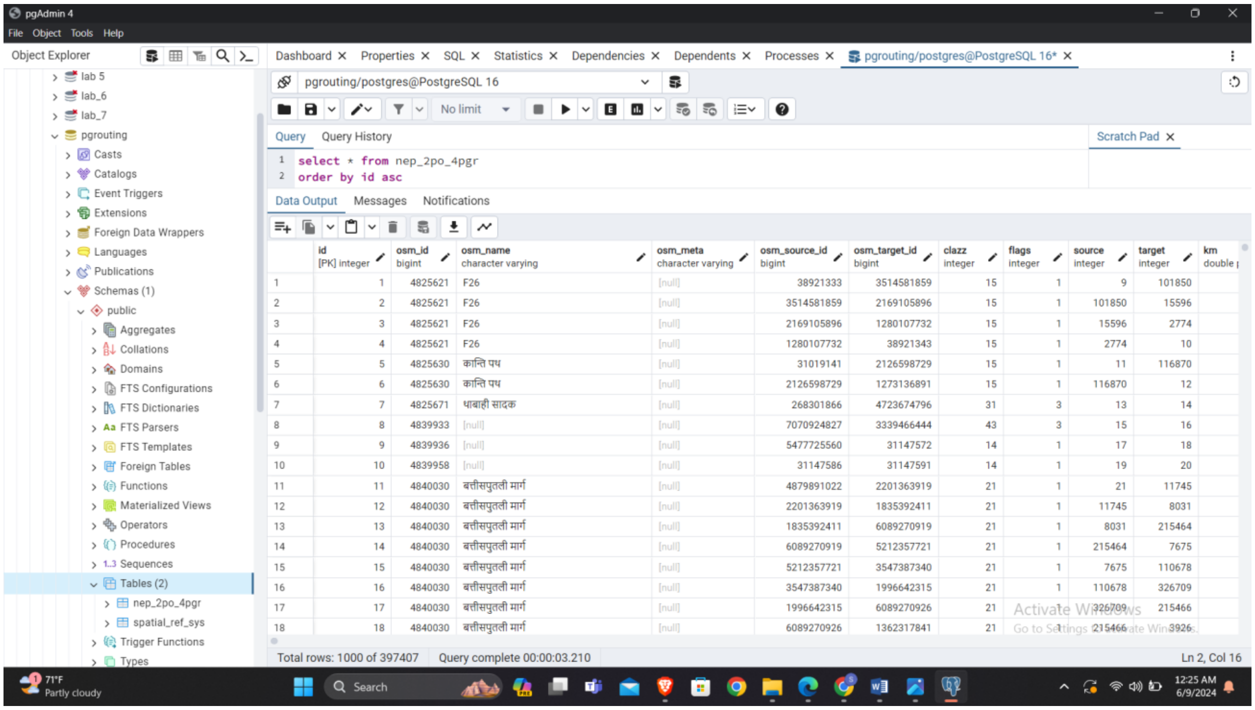

Figure 11: Visualizing the table

The data was also visualized through a geometry viewer.

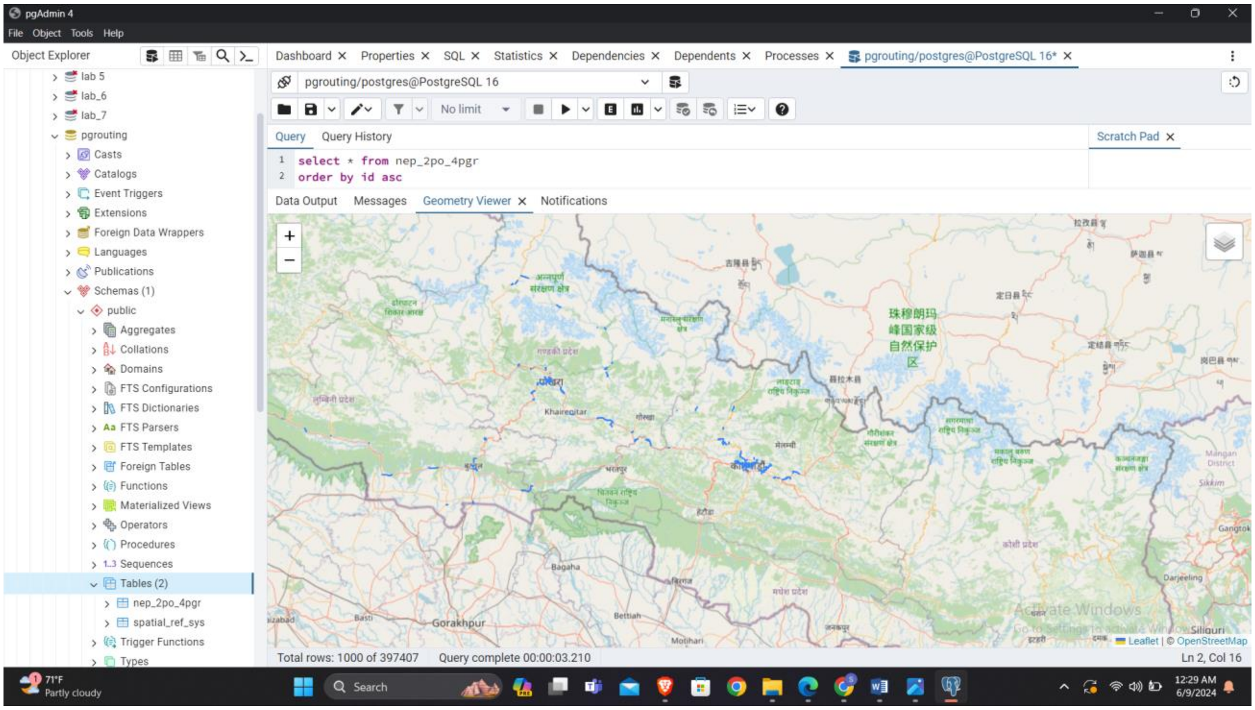

Figure 12: Visualizing data from geometry viewer

3.3.4 Route Calculation

For calculating the route the origin was selected as Jadibuti (27.6727° N, 85.35125° E) and the destination was selected as Kathmandu University (27.6194° N, 85.53877° E).

First of all, database was connected with PostgreSQL using a username and password. The OSM data of routes was loaded in QGIS. After that base map was added.

In QGIS DB manager, query was executed to determine the shortest route using pgrouting and three layers i.e. starting point, ending point and shortest route was added to QGIS.

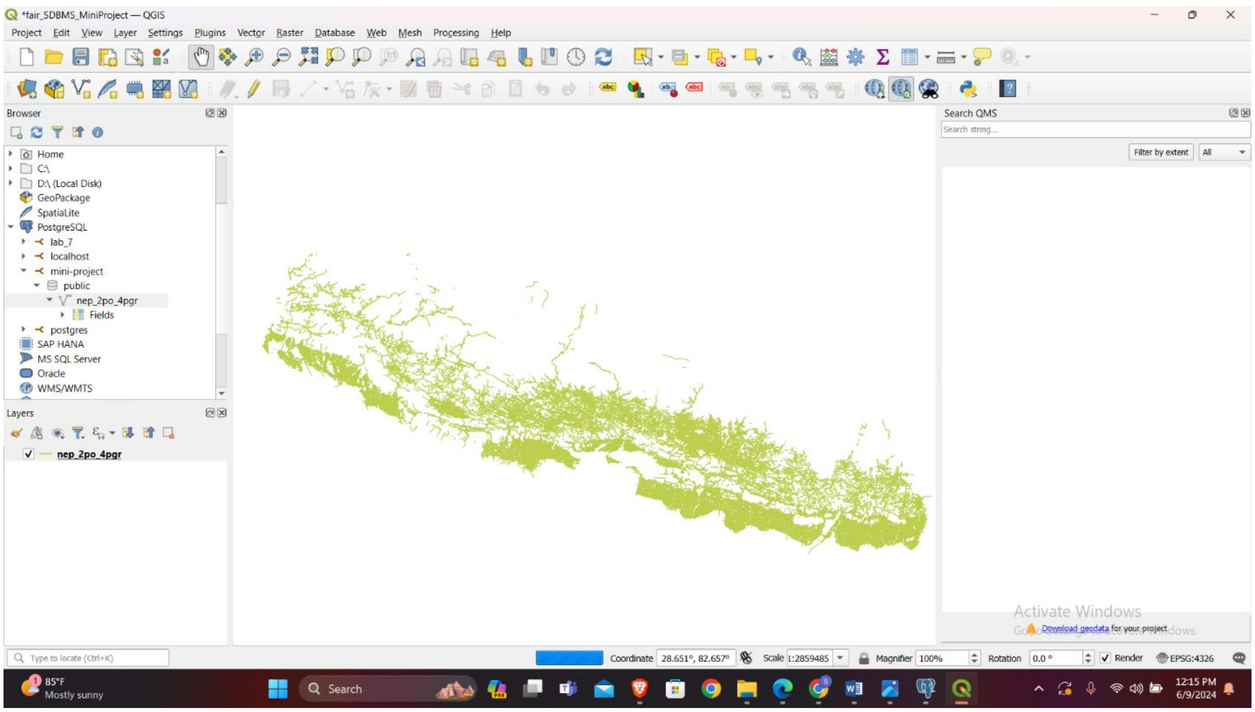

Figure 13: Adding OSM data of routes as layer

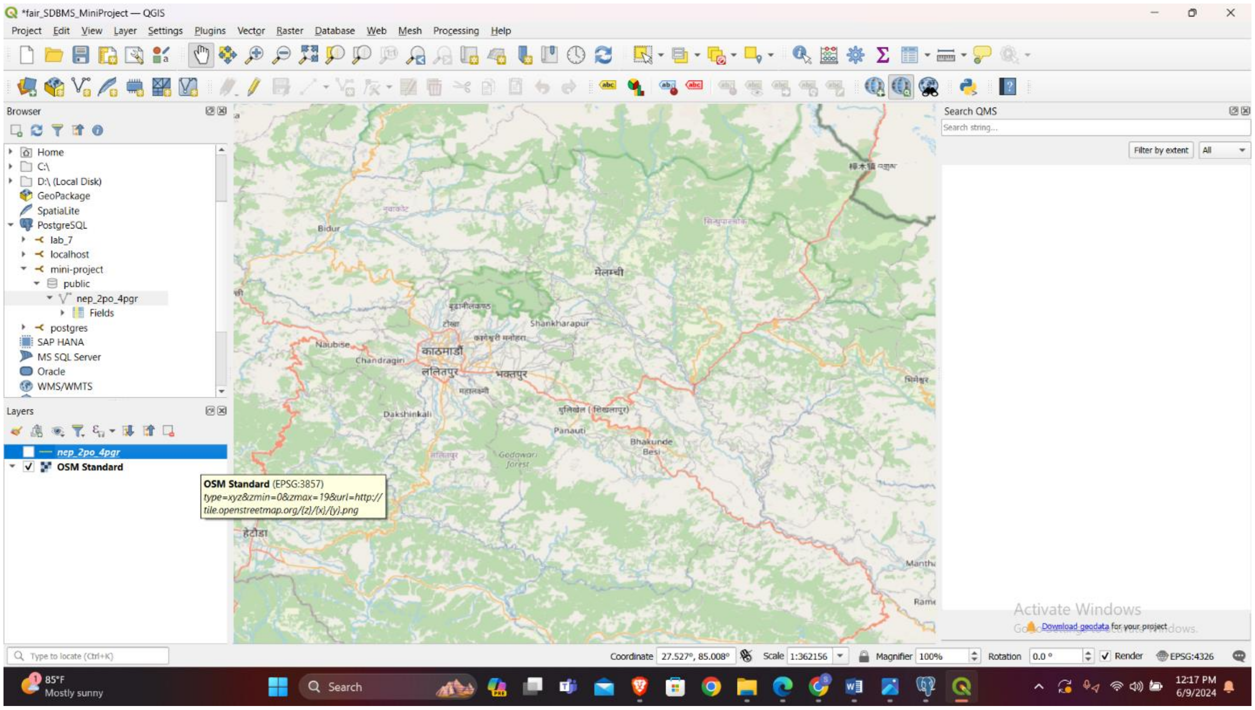

Figure 14: Adding basemap

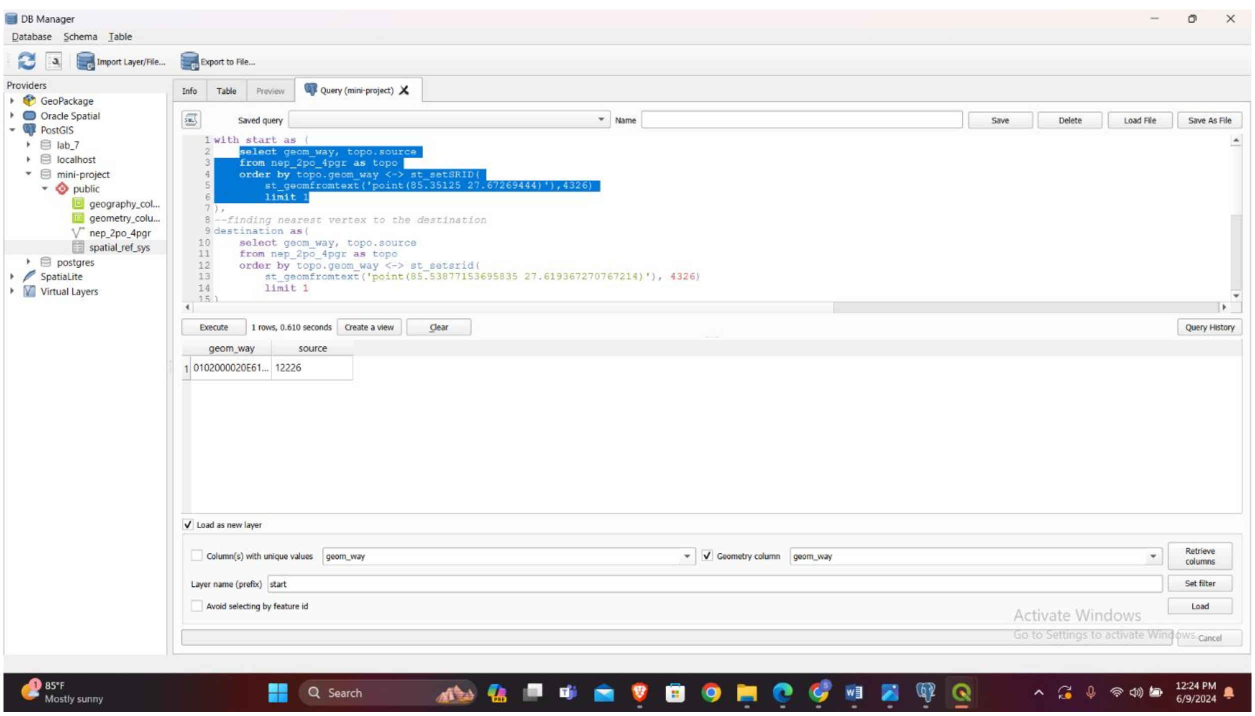

Figure 15: Executing query for start point

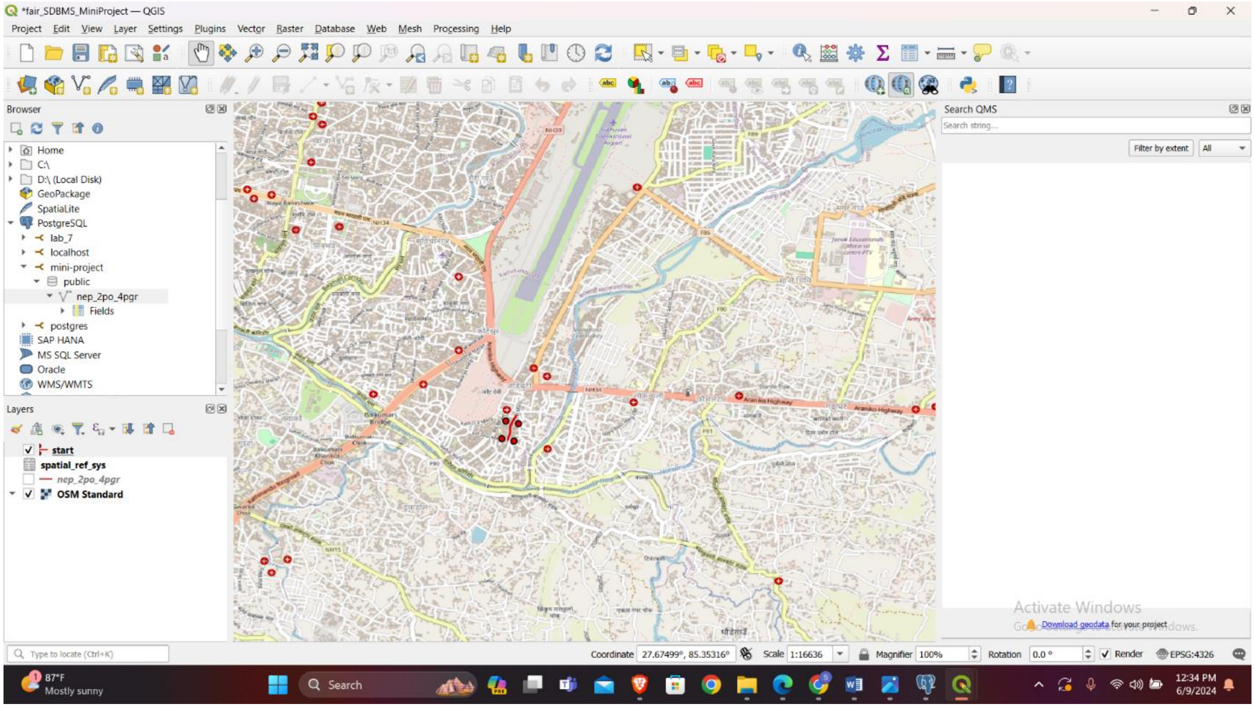

Figure 16: Loading layer with starting point

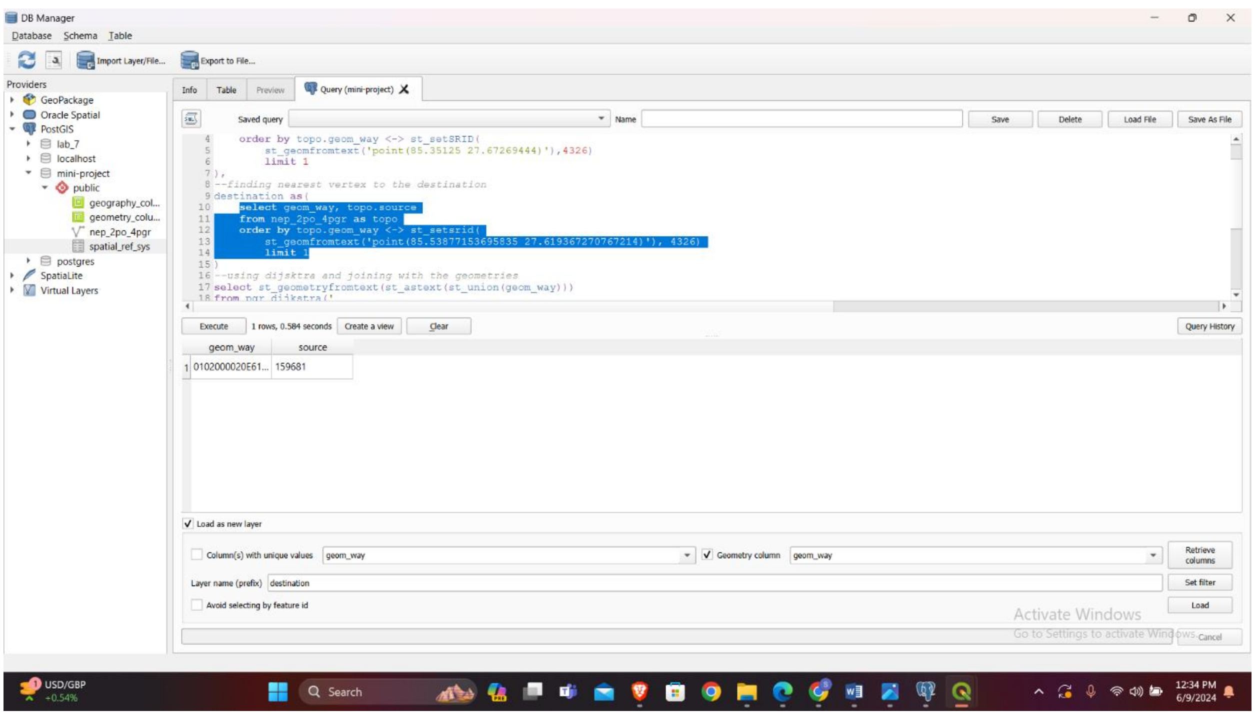

Figure 17: Executing query for destination point

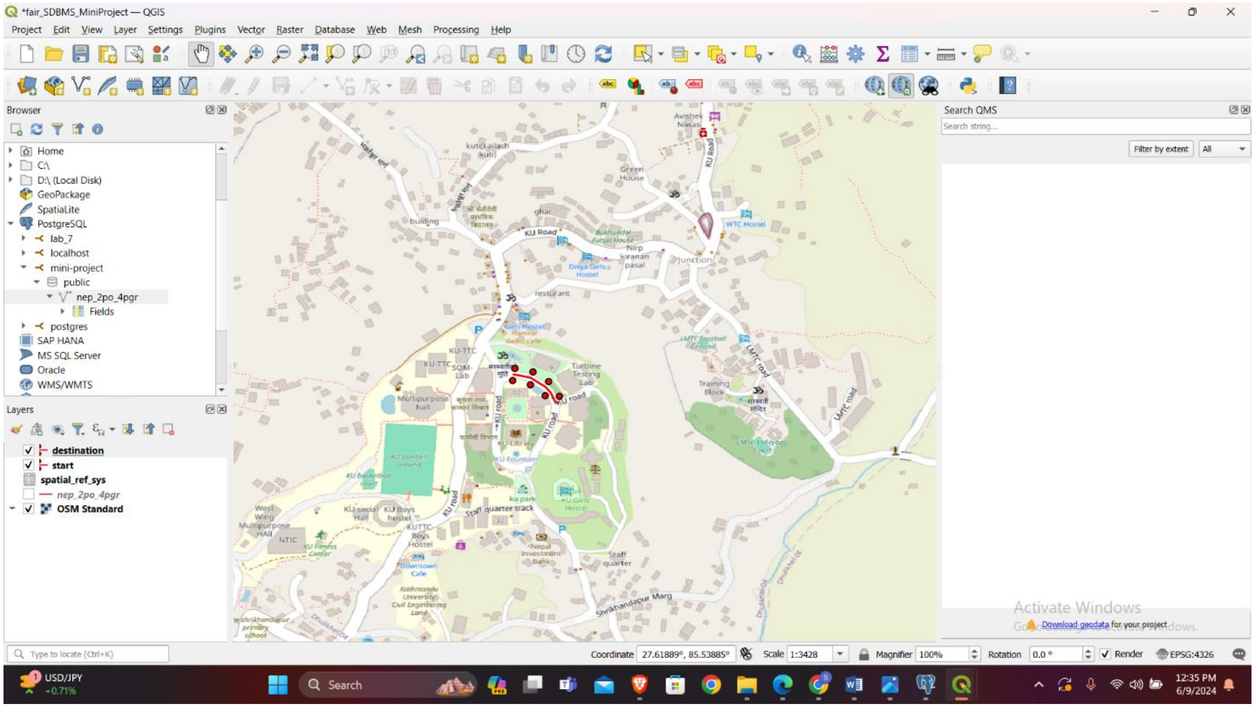

Figure 18: Loading layer with destination point

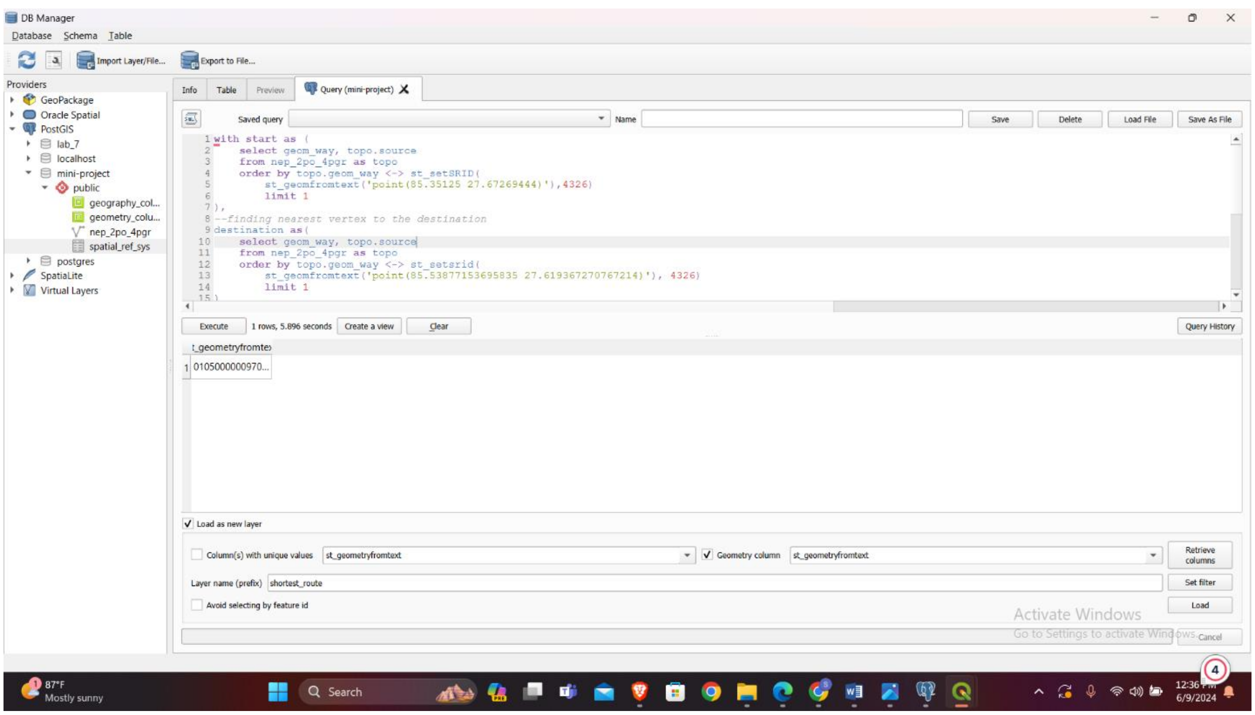

Figure 19: Executing query to find the shortest route

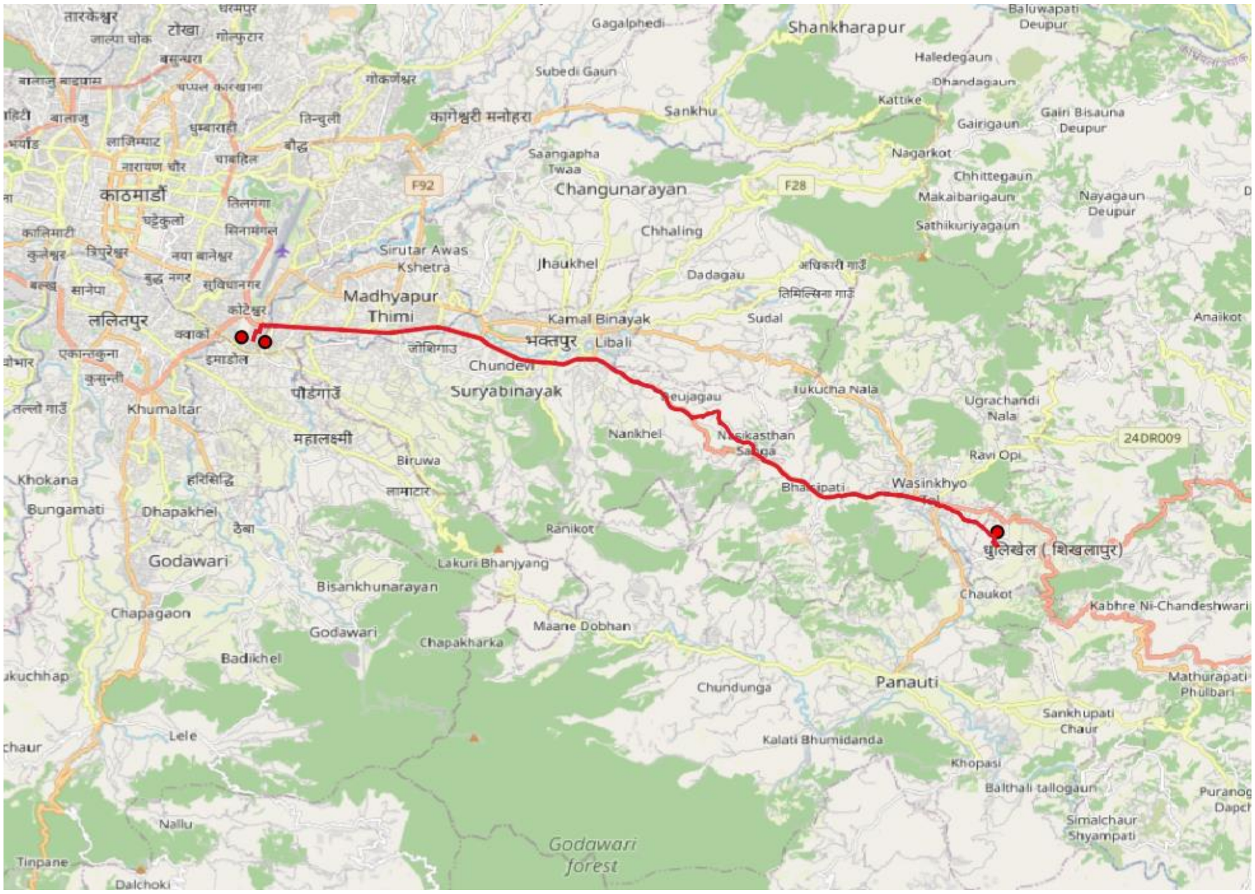

Figure 20: Shortest route visualization

4 RESULTS AND DISCUSSION

The shortest route between Jadibuti and Kathmandu University was determined using pgRouting. In the map below green dots represent Jadibuti, Kathmandu area and black dot represents Kathmandu University. The pink lines are the routes present in the area of map. The red line represents the shortest route between origin (Jadibuti) and destination (Kathmandu University).

The integration of OSM data with PostgreSQL, PostGIS, and pgRouting proved to be effective for routing purposes. The tools worked seamlessly together, enabling efficient route calculation. QGIS was used to visualize the calculated route.

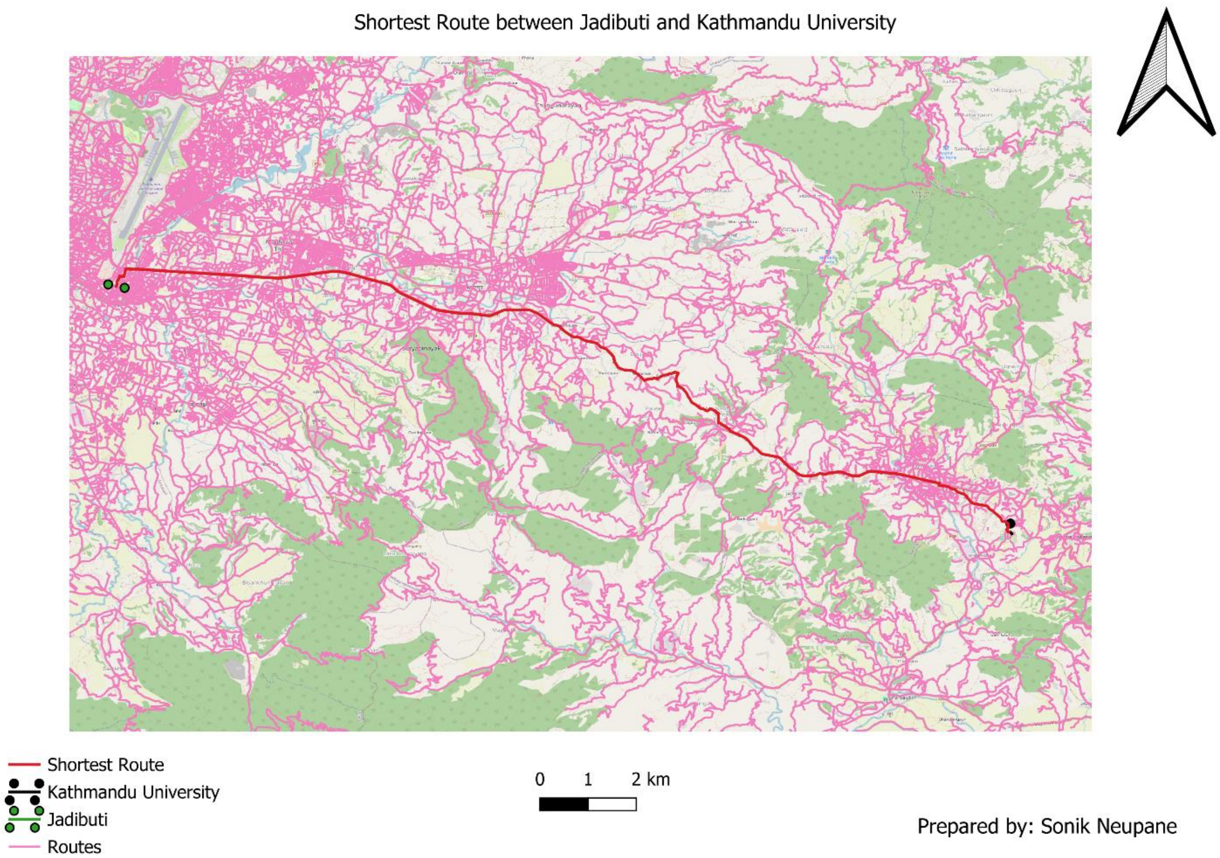

Figure 21: Shortest route between Jadibuti and Kathmandu University

5 CONCLUSION

In this project, the shortest route between Jadibuti, Kathmandu and Kathmandu University was successfully determined using OSM data, PostgreSQL, PostGIS, and pgRouting. The process involved data preparation with osm2po, spatial analysis using pgRouting, and visualization in QGIS. The integration of these tools allowed for accurate calculation of the route and clear visualization on the map. Despite some challenges, such as data quality issues and processing time, the methodology proved effective and demonstrated the robustness of open-source GIS tools.

6 REFERENCES

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Pritee, K., & R.D., G. (2017). Identification of Optimum Shortest Path using Multipath Dijkstra's Algorithm Approach. *International Journal of Advanced Remote Sensing and GIS*, *6*(1), 2442–2448. https://doi.org/10.23953/cloud.ijarsg.321

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