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Enterprise and GIS Application

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Abstract

This paper presents the development of a GIS-based enterprise dashboard tailored for performance analysis of Reliance Jio's offline retail network across India. Moving beyond conventional GIS applications, the study demonstrates how spatial intelligence can be seamlessly integrated with business analytics to enhance operational insights and decision-making. Using open-source tools and synthetic data generation techniques, a comprehensive dashboard was built featuring dynamic maps, interactive visualizations, and key performance indicators. The project utilizes real geospatial data collected through Overpass Turbo from OpenStreetMap, enriched with administrative boundaries and synthetic business metrics like sales, footfall, and customer satisfaction. Through case studies of Jio's retail GIS system and the Kanpur Smart City GIS portal, the report contextualizes the dashboard's relevance in enterprise ecosystems. The resulting dashboard enables granular performance tracking, spatial filtering, and profitability assessment at national, regional, and store levels. It highlights the growing role of GIS in retail analytics, showcases integration with business processes, and offers a framework adaptable for enterprise-scale applications in various sectors.

Keywords: Enterprise GIS, Spatial Dashboard, Business Intelligence, Retail Analytics, Reliance Jio, Synthetic Data, Geospatial Visualization, Gradio, Folium, Plotly, Performance Metrics

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1 Introduction

1.1 Overview of Enterprise Applications

Enterprise applications are large-scale software systems designed to operate in a corporate environment. These applications handle core business functions such as supply chain management, customer relationship management, human resources, and financial operations. Their primary aim is to integrate all key organizational processes into a unified system, ensuring data consistency and streamlined workflows. When embedded with spatial capabilities, these applications become even more powerful, offering a spatial dimension to business analytics and operational intelligence [2][3].

1.2 Role of Spatial Information in Business

Spatial information, or geospatial data, adds location intelligence to enterprise systems. By integrating spatial data with traditional business data, organizations can derive insights that are geographically contextualized. This is particularly useful in sectors such as logistics (route optimization), retail (market analysis), utilities (asset management), and public safety (incident mapping) [1]. The ability to visualize, analyze, and interpret data through maps and spatial models enhances strategic decision-making, improves operational efficiency, and strengthens customer service delivery [4].

1.3 Objectives of the Study

The key objectives of this study are:

- To analyze real-world case studies demonstrating the impact of EGIS.
- To develop a GIS-based interactive dashboard for the offline Jio retail store network that enables store performance tracking, inventory and sales analysis, and spatial comparisons across locations, thereby aiding strategic decision-making for store managers and regional executives.

1.4 Scope and Relevance

This term paper focuses on the practical aspects of Enterprise GIS, particularly its integration with core business systems. It is relevant to organizations seeking to adopt spatial technologies to improve data-driven decision-making and resource optimization. The scope covers technological components (databases, servers, software), industry applications, challenges, and future directions. The relevance is underscored by the growing need for spatial intelligence in managing complex operations and improving public services in rapidly urbanizing environments.

2 Background Work and Literature Review

2.1 Evolution of GIS in Enterprise Context

Geographic Information Systems (GIS) have evolved significantly since their inception in the 1960s. Initially designed for land-use planning and environmental monitoring, GIS was confined to desktop systems used by trained analysts, operating independently from broader business systems [1].

With the advent of the internet and cloud computing, GIS gradually matured into an enterprise technology. Modern enterprise GIS solutions allow organizations to integrate spatial data with other core systems such as Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), and Supply Chain Management (SCM). Esri has highlighted that GIS has transitioned from a "mapping tool" to a "system of record, insight, and engagement" that supports business intelligence and operational workflows [2]. GIS is now employed in sectors such as logistics for real-time fleet tracking, utilities for managing infrastructure, and retail for optimizing store locations based on demographic data. A key milestone in this evolution was the introduction of web GIS, which facilitates organization-wide access to GIS tools and dashboards by enabling the sharing of geospatial data through browsers and mobile devices.

2.2 Key Studies on GIS-Enterprise Integration

The integration of GIS with enterprise systems has provided significant organizational benefits. For instance, a 2021 report by TRC Companies illustrates how integrating Esri's ArcGIS with SAP enables organizations to visualize assets in real-time, linking spatial location with operational data, especially in asset-intensive industries like energy and transportation [3].

GIS can act as a central data repository in distributed environments, facilitating interoperability between different business units. A study by ISPRS outlines how Service-Oriented Architectures (SOA) and Web Feature Services (WFS) can support the integration of GIS with ERP systems, ensuring access to consistent, up-to-date spatial information across departments [4]. Another example of GIS integration is seen in local governments, where GIS platforms are connected with permitting and planning systems to create end-to-end digital workflows, improving transparency and reducing turnaround times.

2.3 Technological Foundations of GIS

Modern enterprise GIS relies on a robust technological stack that includes:

- **Spatial Databases:** PostgreSQL with PostGIS extension and Oracle Spatial are widely used for storing and querying spatial data, supporting spatial indexing and advanced geoprocessing functions.
- **Web Mapping Libraries:** Libraries like Leaflet.js and OpenLayers enable interactive web-based maps, commonly used in custom enterprise dashboards.
- **Cloud-Based GIS Platforms:** Services such as ArcGIS Online, Amazon Location Service, and Google Maps Platform provide scalable infrastructure, supporting real-time location tracking and global basemaps.
- **Interoperability Standards:** The Open Geospatial Consortium (OGC) has developed widely adopted standards such as WMS (Web Map Service), WFS (Web Feature Service), and GeoPackage, which ensure interoperability between GIS and non-GIS systems [5].
- **Mobile GIS and IoT Integration:** Mobile apps and IoT integration allow real-time data collection and visualization, particularly in sectors like utilities, agriculture, and disaster response.

These technologies form the backbone of GIS in enterprise applications.

2.4 Summary of Research Gaps

Despite significant progress, several challenges remain in the adoption of enterprise GIS. Smaller organizations often face skill shortages and resource constraints [6]. Integrating GIS with legacy systems remains complex, particularly without standardized APIs. Data privacy and governance concerns are increasing, especially as GIS handles real-time and personal data. Furthermore, there is limited research on GIS applications in emerging sectors such as education and healthcare, and organizations often struggle to measure the return on investment (ROI) for GIS implementation.

3 Case Studies on Enterprise GIS Applications

3.1 Introduction

Enterprise Geographic Information Systems (GIS) have become a cornerstone in modern organizational decision-making, enabling the seamless integration of spatial data with operational workflows. These systems allow enterprises to move beyond static, tabular data and incorporate geographic context into their strategic and operational decisions.

As industries expand in complexity and scale, the importance of spatial intelligence grows. One of the most impactful advancements in this space has been the development of GIS-based dashboards, which:

- Provide interactive, map-based visualizations.
- Integrate multiple thematic and operational data layers.
- Enable real-time monitoring and spatial pattern analysis.
- Enhance decision-making by revealing location-based insights.

The transition from traditional business intelligence (BI) dashboards to GIS-based alternatives reflects the need for greater contextual awareness in enterprise environments. Unlike conventional BI tools that offer static charts and

KPIs, GIS dashboards dynamically connect data to geography, enabling organizations to visualize and respond to trends more effectively.

To understand the practical value of Enterprise GIS and its dashboard capabilities, this section presents real-world case studies across diverse sectors. Each case illustrates:

- The organizational context and challenges.
- The GIS implementation strategy.
- Specific applications of GIS dashboards.
- Key outcomes, benefits, and lessons learned.

These case studies serve as foundational examples supporting the development of the GIS-based dashboard in the current study for the Jio offline retail network. They help demonstrate how spatial data integration can lead to more efficient operations, improved resource allocation, and smarter decision-making.

3.2 Case Studies by Sector

3.2.1 Retail: Reliance Jio's GIS Application for Store Mapping

a) **Background**

Reliance Jio Infocomm Limited (RJIL), one of India's largest telecom service providers, faced challenges in monitoring its expanding network of modern trade retail outlets. Manual data collection methods were time-consuming, error-prone, and lacked spatial context, leading to inefficiencies in store performance analysis and decision-making. To address this, RJIL developed a customized GIS-based web application named **StÓchos** (Greek for "target") to enable dynamic mapping and performance visualization of its retail footprint across India.

b) **GIS Implementation**

The application was developed using:

- ESRI's ArcGIS Platform for geospatial services and map rendering.
- Oracle 11g integrated with ArcSDE for spatial data storage and querying.
- ArcGIS Web API for JavaScript for building an interactive web interface.
- ASP.NET, C#, JQuery for backend functionality and interactivity.
- Highcharts and Bootstrap DataTables API for dashboard graphs and tabular analytics.

The application supports multiple roles with varying access levels. Only registered users can perform edit operations such as adding, deleting, or modifying stores on the map.

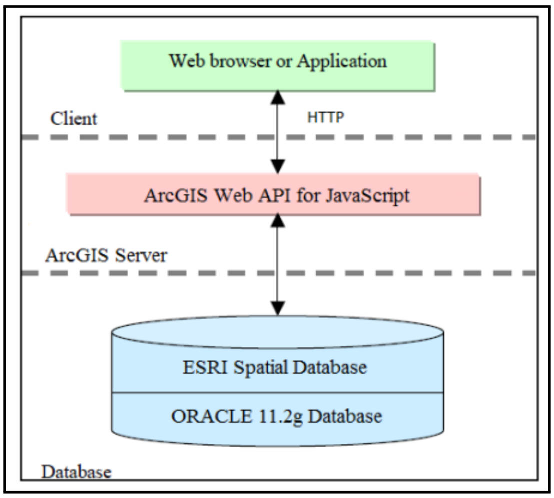

Figure 1: *Application Architecture*[13]

c) **Objectives**

- To centralize and digitize retail outlet mapping across India.

- To integrate store-wise performance and sales data into a geospatial dashboard.
- To provide real-time visualization and filtering of retail chains by zone, state, Jio Center (JC), and store category.
- To eliminate manual errors and optimize sales territory management.

d) **Outcomes and Benefits**

The deployment of this application led to:

- Pan-India store visualization, supporting multiple levels of aggregation such as zone-wise, state-wise, and JC-wise.

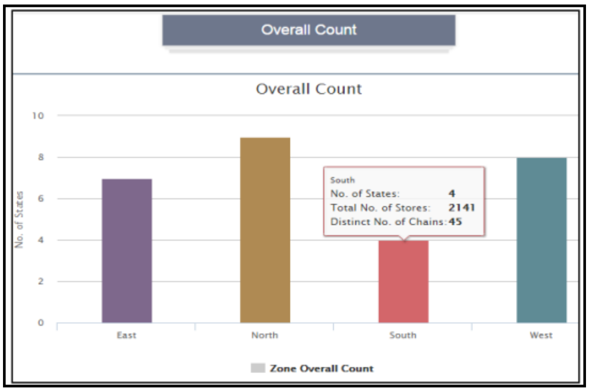

Figure 2: *Overall Count - Statewise*[13]

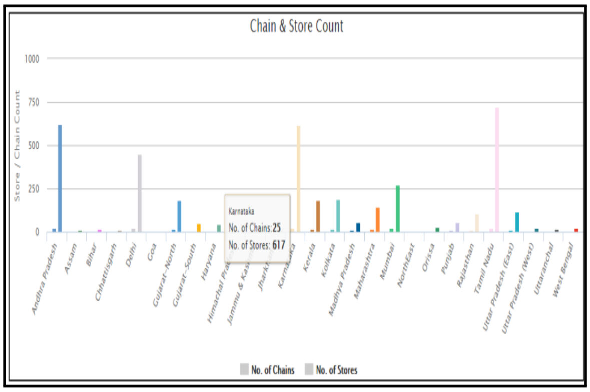

Figure 3: *Overall Count - Zonewise*[13]

- Interactive filtering by category, chain, or geography, with store-level pop-ups displaying detailed information like location, store attributes, and performance data.

Figure 4: *Store Identification*[13]

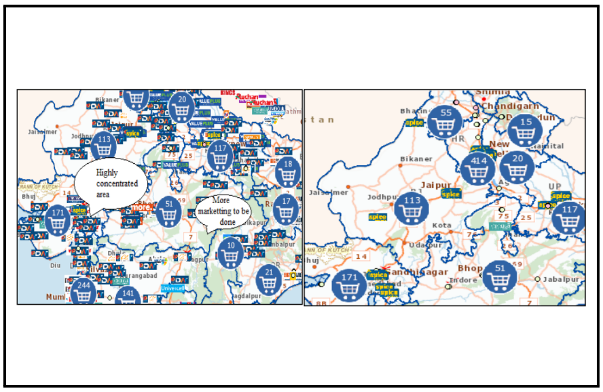

Figure 5: *Store Performance Detection*[13]

- Advanced dashboard analytics, with visual tools such as bar and column charts, donut and pie charts, and dynamic tables for state-, JC-, and category-level breakdowns.
- Real-time update and versioning, allowing any additions or edits by authorized users to be instantly reflected in the spatial database and visible on the dashboard.
- Operational improvements, including reduced time and cost associated with manual data entry, elimination of redundancy, and enhanced accuracy of spatial and business information.
- Strategic decision support, enabling retail managers to identify high-potential areas and underperforming territories for targeted interventions.

e) **Challenges Faced**

- Integrating multiple spatial and tabular datasets.
- Implementing count overlays dynamically on the map (resolved using Oracle aggregate views).
- Customizing dashboard components beyond native Highcharts functionality.

f) **Lessons Learned**
- A centralized GIS dashboard for retail monitoring significantly improves operational agility.
- Spatial intelligence facilitates a proactive approach to market development, territory realignment, and resource allocation.
- Combining BI and location analytics yields a holistic view of store performance and retail density.

3.2.2 Enterprise GIS Portal for Spatial Data Mapping for Kanpur Smart City

a) **Background**

Kanpur, the largest city in Uttar Pradesh, spans approximately 260 sq km and serves as a major commercial, industrial, and educational hub. Under the Smart Cities Mission, the Kanpur Municipal Corporation (KMC) established Kanpur City Limited (KSCL) as a Special Purpose Vehicle (SPV) to oversee and implement smart city initiatives. A significant component of this initiative involves retrofitting 1,475 acres adjacent to the south bank of the Ganga River into a vibrant, mixed-use area aimed at promoting economic growth, environmental sustainability, and citizen-centric governance.

b) **GIS Implementation**

To address challenges related to data collection and accessibility across various departments, KSCL developed an Enterprise GIS portal. This portal integrates a new geodatabase to map essential city components, including administrative boundaries, water supply infrastructure, emergency services, educational facilities, transportation networks, and building footprints. The system also played a crucial role during the COVID-19 pandemic by mapping affected areas and residents, enabling timely interventions .

Figure 6: *Visualization of Interface*[12]

c) **Objectives**
- Data Integration: Consolidate spatial data from multiple city departments into a unified platform.
- Enhanced Decision-Making: Provide tools for visualization and analysis to support informed urban planning and management.
- Scalability: Ensure the system can accommodate additional data layers and functionalities as the city evolves.
- Citizen Engagement: Facilitate transparent governance and improve service delivery to residents.

d) **Outcomes and Benefits**
- **Rapid Data Collection:** Accelerated the gathering of data on various smart city assets.
- **Scalability:** Allowed for the addition of more data layers to the geodatabase, supporting future growth.
- **Enhanced Security:** Provided secure and easy web access to spatial and non-spatial data and services.
- **Improved Visualization:** Simplified understanding across various city management verticals, including signage, traffic monitoring, and transportation facilities.
- **Optimized Routing:** Enabled the use of routing services for efficient location identification and multimodal transport planning.

e) **Challenges Faced**
- **Data Availability:** Initial difficulties in obtaining authenticated data from KMC concerning various civic amenities.
- **Stakeholder Coordination:** Challenges in making data and solutions accessible to various hierarchical roles amidst rapid urban growth.
- **System Integration:** Integrating diverse data sources and ensuring compatibility across different city

departments.

f) **Lessons Learned**

- **Importance of Data Standardization:** Standardizing data formats and protocols is crucial for seamless integration across departments.
- **Stakeholder Engagement:** Continuous involvement of all stakeholders ensures the system meets the diverse needs of the city.
- **Scalable Architecture:** Designing systems with scalability in mind allows for future enhancements without significant overhauls.
- **Training and Capacity Building:** Investing in training for city officials and staff ensures effective utilization of GIS tools and data.

3.3 Link to Current Study

Insights from both case studies highlight the power of spatial dashboards in enhancing decision-making. While the former focused on mapping Jio's retail outlets with real-time performance metrics, the latter demonstrated centralized spatial data use for urban governance.

Building on these, the current study applies GIS dashboard principles to the offline Jio retail network. It aims to deliver an interactive, map-based interface for store performance tracking and spatial analysis, extending GIS utility from governance and infrastructure to commercial retail operations.

4 About the Dataset

As established in the literature, Geographic Information System (GIS)-based dashboards are increasingly being adopted in place of traditional business intelligence dashboards due to their ability to seamlessly integrate spatial data with multiple thematic layers. This spatial integration provides enhanced situational awareness and supports more data-driven and location-aware decision-making processes. Unlike conventional dashboards that primarily rely on static charts or tabular summaries, GIS dashboards offer dynamic, map-based visualizations that enable users to interactively explore spatial patterns, analyze relationships, and monitor trends in real time.

In this study, a GIS-based dashboard is developed specifically for the offline Jio retail store network. The objective is to design a comprehensive and interactive interface that incorporates relevant features tailored to the operational and strategic needs of key stakeholders, such as store managers and regional executives. The dashboard aims to facilitate efficient store performance tracking, inventory and sales analysis, and spatial comparison across locations, thereby supporting more informed managerial decisions.

4.1 Data Collection

To obtain the spatial location data for Jio retail stores across India, OpenStreetMap (OSM) was utilized via the Overpass Turbo API interface (https://overpass-turbo.eu/). Overpass Turbo provides a powerful query language that allows users to extract specific geospatial data based on custom filters.

The following Overpass QL (Query Language) script was used to retrieve all nodes, ways, and relations associated with the name "Jio" within the geographical boundary of India:

Overpass QL Script

```
[out:json][timeout:30];
area["name"="India"]->.searchArea;
(
  node["name"~"Jio"](area.searchArea);
  way["name"~"Jio"](area.searchArea);
  relation["name"~"Jio"](area.searchArea);
);
out center;
```

Figure 7: *Overpass QL script to extract Jio retail store data in India*

This script filters the data by name using a regular expression that matches the term "Jio" and limits the search within the administrative boundaries of India. The output format is JSON, and the use of out center ensures that each feature (including complex geometries like ways and relations) is represented by a central coordinate, which facilitates integration with GIS platforms.

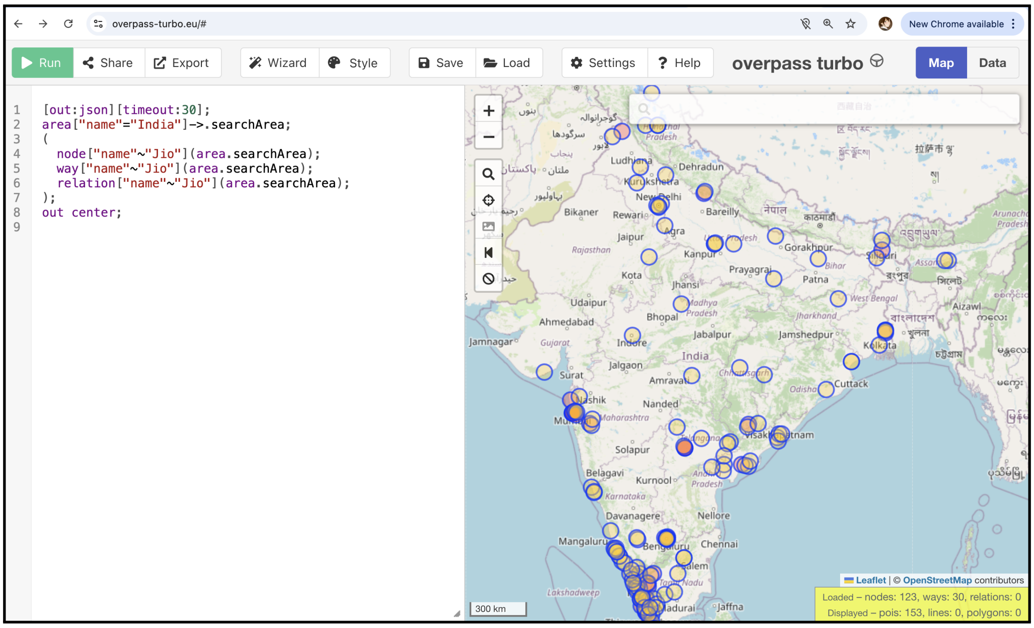

Figure 8: *Screenshot: Extracted Jio retail store locations from Overpass Turbo*[14]

The resulting data was exported and further processed for use in the development of the GIS-based dashboard.

4.2 Synthetic Data Generation and Enrichment

4.2.1 Geographic Data Enrichment

To enhance the spatial dimension of the dataset, geographic information such as state and district names was appended to each retail store location. This enrichment process was carried out by mapping the geographic coordinates (latitude and longitude) of each store to administrative boundaries.

Coordinate-Based Mapping: Latitude and longitude of each store were used to map its state and district through spatial joins with Indian administrative shapefiles.

Use of Shapefiles: Shapefiles for Indian states and districts were sourced from open GitHub repositories, providing polygon data for each administrative unit.

Python-Based Geospatial Processing: Geographic enrichment was automated using Python and GeoPandas, applying a point-in-polygon method to assign stores to their corresponding administrative regions.

Python Script for State and District Mapping

```python
import geopandas as gpd
import pandas as pd
import numpy as np
# Load and Preprocess Data
gdf = gpd.read_file("jiostores432.geojson")
gdf = gdf[gdf.geometry.notnull()]
states_gdf = gpd.read_file("India_State_Boundary.shp")
districts_gdf = gpd.read_file("India_Districts_2011Census.shp")
gdf = gdf.to_crs(epsg=4326)
states_gdf = states_gdf.to_crs(epsg=4326)
districts_gdf = districts_gdf.to_crs(epsg=4326)
# Assigning State Information
state_col = "State_Name"
gdf_with_state = gpd.sjoin(
    gdf,
    states_gdf[["geometry", state_col]],
    how="left",
    predicate="within"
)
gdf_with_state.rename(columns={state_col: "state"}, inplace=True)
gdf_with_state.drop(columns=["index_right"], errors="ignore", inplace=True)
gdf = gdf_with_state.copy()
# Assigning District Information
district_col = "DISTRICT"
gdf_with_district = gpd.sjoin(
    gdf,
    districts_gdf[["geometry", district_col]],
    how="left",
    predicate="within"
)
gdf_with_district.rename(columns={district_col: "district"}, inplace=True)
gdf_with_district.drop(columns=["index_right"], errors="ignore", inplace=True)
gdf = gdf_with_district.copy()
```

Figure 9: *Python code for mapping Jio store coordinates to administrative units using shapefiles.*

By enriching the dataset with state and district information, the spatial analysis capabilities of the dashboard were significantly improved. This allowed for more granular visualizations and region-specific decision-making insights, such as identifying underperforming districts or comparing sales trends across states.

4.2.2 Augmentation of Retail Attributes

In the absence of access to authentic operational data, synthetic attributes were generated to simulate key metrics commonly associated with retail chains. These attributes were designed to reflect plausible business conditions and support meaningful analysis within the GIS-based dashboard.

1. **Initialization**
   We specify the number of stores to be created as $m = 500$, and define four store types with weighted probabilities reflecting their real-world prevalence. For instance, `Express` stores are the most common, while `Super` stores are rare.

Python Script for State and District Mapping

```python
m = 500  # number of new rows to generate
new_data = []
store_types = ["Mini", "Express", "Standard", "Super"]
type_weights = {"Mini": 0.2, "Express": 0.4, "Standard": 0.3, "Super": 0.1}
```

Figure 10: *Python code for initializing store types and weights*

2. **Generating Store Entries**
   Each store is assigned a type with the corresponding sales range. Monthly sales (in lakhs) are randomly chosen from realistic ranges depending on the type.

Python Script for State and District Mapping

```
for i in tqdm(range(m), desc="Generating synthetic stores"):
    store_type = np.random.choice(store_types, p=[type_weights[t] for t in store_types])

    base_sales = {
        "Mini": np.random.randint(5, 15),
        "Express": np.random.randint(10, 30),
        "Standard": np.random.randint(30, 70),
        "Super": np.random.randint(60, 100),
    }
    sales = base_sales[store_type]
```

Figure 11: *Randomly assigning store types and monthly sales ranges*

3. **Derived Metrics: Footfall, Ratings, Staff, and Area**
   Footfall is proportional to sales, and customer rating is derived from a normal distribution centered around: The value is clipped to the range $[2.5, 5.0]$.

Python Script for State and District Mapping

```
footfall = int(sales * np.random.uniform(5, 8))
rating = round(np.clip(np.random.normal(2.5 + (sales / 100) * 2.5, 0.5), 2.5, 5.0), 1)

staff = int(np.random.normal(loc=footfall / 20 + 3, scale=2))
staff = max(3, min(staff, 25))

area = int(np.random.normal(loc=store_types.index(store_type) * 300 + 300, scale=100))
area = max(100, min(area, 3000))
```

Figure 12: *Estimating footfall, rating, staff, and store area based on store type and sales*

4. **Sales, Dates, and Location Assignment**
   Staff count depends on footfall and is constrained between 3 and 25. Store area grows with store type index, with randomness added using a normal distribution and limited to [100, 3000] sq. ft.
   SKU count is randomized within a wide range, and total monthly revenue is calculated in INR.
   - `open_since`: A random opening date from the past 1 to 5 years.
   - `point`: Random geographic coordinate within approximate Indian bounds (longitude: 68–97°, latitude: 7–37°).

Python Script for State and District Mapping

```
sku_count = np.random.randint(100, 3000)
sale_value = sales * 100000
open_since = datetime.now() - timedelta(days=random.randint(365, 2000))

region = np.random.choice(["North", "South", "East", "West", "Central"])
district = "Synthetic District"
state = "Synthetic State"
point = gpd.points_from_xy([np.random.uniform(68, 97)], [np.random.uniform(7, 37)])[0]
```

Figure 13: *Generating revenue, open date, and spatial data*

5. **Final Store Attributes and Export**
   These attributes add behavioral and operational complexity, capturing promotions, network type, store audits, and customer satisfaction.
   All records are combined into a new GeoDataFrame using WGS84 CRS. The final dataset is saved in GeoJSON format for use in spatial dashboards and map-based interfaces.

Python Script for State and District Mapping

```python
new_data.append({
    "store_id": f"JIO-{1000 + len(gdf) + i}",
    "monthly_sales": sales,
    "num_skus": np.random.randint(50, 500),
    "store_type": store_type,
    "footfall": footfall,
    "staff_count": staff,
    "sale_value": sale_value,
    "sku_count": sku_count,
    "rating": rating,
    "is_profitable": sale_value > 150000,
    "open_since": open_since,
    "store_name": f"Synthetic Store {i}",
    "category": np.random.choice(["Digital", "Express", "Mini", "Warehouse"]),
    "area_sqft": area,
    "inventory_turnover": round(np.random.uniform(1.5, 12.0), 2),
    "revenue_per_sqm": round(sale_value / area, 2),
    "last_audit_date": datetime.now() - timedelta(days=random.randint(1, 365)),
    "customer_satisfaction_score": round(np.clip(rating + np.random.normal(0, 0.5), 1.0, 5.0), 1),
    "operational_status": np.random.choice(["Open", "Temporarily Closed", "Under Renovation"], p=[0.85,
    ↪  0.1, 0.05]),
    "connectivity": np.random.choice(["4G", "5G", "Fiber", "None"], p=[0.4, 0.3, 0.2, 0.1]),
    "promotion_active": np.random.choice([True, False], p=[0.3, 0.7]),
    "store_rating": rating,
    "region": region,
    "state": state,
    "district": district,
    "geometry": point
})

new_gdf = gpd.GeoDataFrame(new_data, crs="EPSG:4326")
gdf = pd.concat([gdf, new_gdf], ignore_index=True)
gdf.to_file("final_jio_stores_with_more_data.geojson", driver="GeoJSON")
```

Figure 14: *Combining all features, saving to GeoJSON format*

This synthetic data generation process is designed to:

- Simulate realistic store distribution based on type and performance.
- Create regionally diverse and spatially enabled records.
- Provide meaningful attributes for downstream analytics such as dashboards, clustering, or sales predictions.

The synthetic dataset complements the original data and is crucial for testing visualizations, models, and exploratory tools in the absence of complete ground-truth information.

5 Methodology

The **Jio Retail Store Dashboard** is a comprehensive, interactive tool for analyzing the performance of Jio Retail stores. Built using **Gradio**, **GeoPandas**, **Folium**, and **Plotly**, the dashboard allows users to upload a GeoJSON file containing store data, filter by region and category, and gain insights into key performance metrics. Below is a step-by-step breakdown of the methodology used to construct and implement the dashboard.

5.1 Data Ingestion and Preprocessing

The first step in the dashboard is data ingestion and preprocessing:

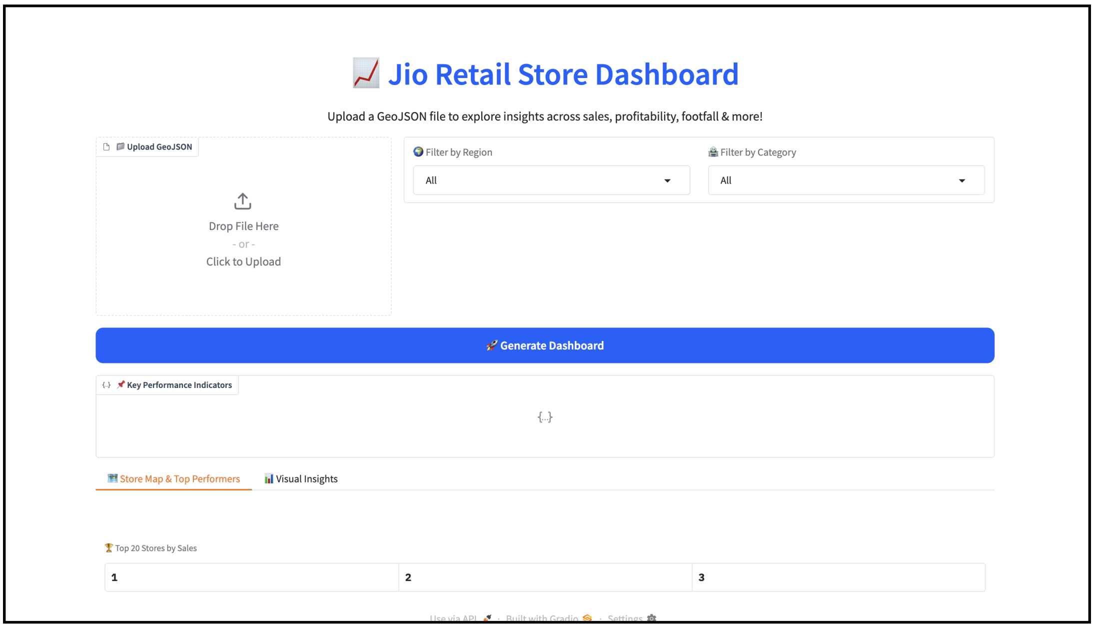

Figure 15: *Screenshot: User interface showing feature of Upload file*

- **File Upload:** Users upload a **GeoJSON** file, which is read using `GeoPandas`' `read_file()` method. The **GeoJSON** format is a common format for geospatial data that stores both location (latitude and longitude) and associated attributes (e.g., sales, ratings, footfall) of each store.
- **Data Cleaning and Conversion:**
  - The `open_since` column (representing store opening dates) is converted to a **datetime** object to enable time-based analysis.
  - Columns such as `sale_value`, `footfall`, and `sku_count` are converted to numeric types using `pd.to_numeric()`. This step ensures that these values can be used in mathematical computations.
  - **Missing Data Handling:** The code contains logic to drop rows with missing values in critical columns like `sale_value`, `footfall`, and `sku_count`. Alternatively, these missing values could be replaced with a default value (e.g., zero), depending on the desired behavior.

5.2 Interactive Map Rendering

The **Folium** library is used to generate an interactive map showing the location of all stores:

- **Map Creation:**
  - A **Folium Map** is created using the geographical center of all store locations. The center is calculated by averaging the latitudes and longitudes of the store coordinates, and the map is initialized with a **zoom level of 5** for broader coverage.
  - The `MarkerCluster` feature in **Folium** is used to group nearby store locations into a single cluster on the map. This improves performance by reducing clutter and allowing the user to zoom in to see individual markers.
- **Store Markers:** Each store's marker is created with detailed information in a **popup**. The popup contains various metrics about each store, including:
  - Store name, location (district and state)
  - Sales value, footfall, SKU count, and area
  - Rating and customer satisfaction score
  - Profitability status (whether the store is profitable or not)
  - Operational status (e.g., open, closed)
- **Color Coding:** Markers are color-coded based on profitability (green for profitable, red for non-profitable), providing a quick visual cue for store performance.
- **Popup Formatting:** The popup text is dynamically generated for each store with HTML formatting to display the relevant data.

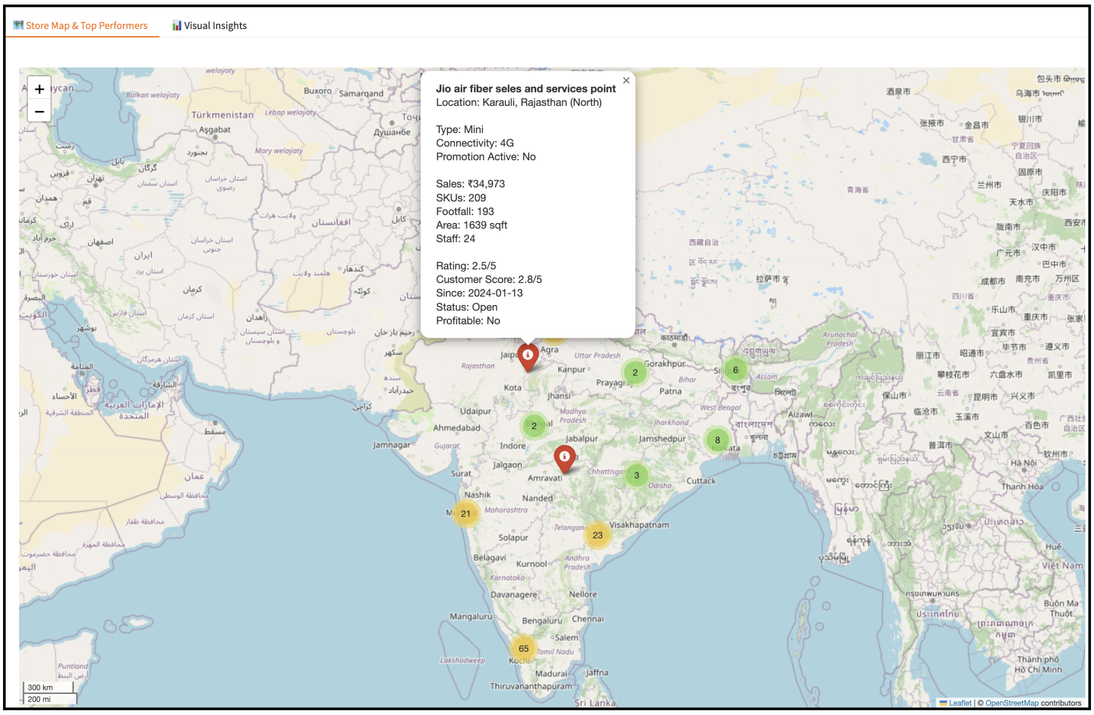

Figure 16: *Screenshot: Showing Folium Map, Color coding, Popup on the store icon*

5.3 Key Performance Indicator (KPI) Metrics

The dashboard calculates and displays key performance indicators (KPIs) at the top:

- **Total Number of Stores:** The count of stores in the dataset is calculated by checking the length of the GeoDataFrame (`len(gdf)`).
- **Total Sales (INR):** The total sales value across all stores is calculated by summing the `sale_value` column.
- **Profitable Stores:** A count of profitable stores is derived by summing the `is_profitable` column, which is a boolean indicating whether the store is profitable.

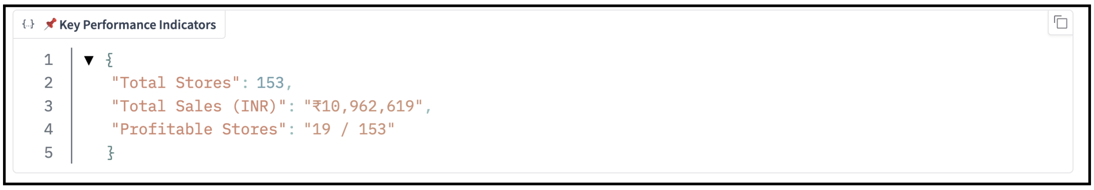

Figure 17: *Screenshot: Interface showing KPI's*

These KPIs provide an at-a-glance summary of the overall store network's performance.

5.4 Dynamic Visualizations

The core analysis of the dashboard is driven by **Plotly** visualizations. These dynamic charts allow users to explore different aspects of store performance in-depth. The visualizations include:

- **Sales by Category:** A bar chart showing total sales by store category, helping identify top-performing categories.
- **Profitability by State:** A bar chart displaying average profitability by state, highlighting regional performance.
- **Footfall vs Sales:** A scatter plot correlating footfall with sales, with bubble size indicating SKU count.
- **Rating Distribution:** A histogram of store ratings, showing customer satisfaction spread.
- **Monthly Store Openings:** A line chart showing store openings over time.
- **Revenue per Square Meter:** A bar chart showing average revenue per square meter by category, assessing

space efficiency.

- **Customer Satisfaction vs Profitability:** A box plot comparing satisfaction scores between profitable and non-profitable stores.
- **Operational Status:** A pie chart showing store operational status (open, closed, etc.).
- **Staff vs Rating:** A scatter plot showing the relationship between staff count and store ratings.

Figure 18: *Screenshot: Analysis Graphs in the Gradio Interface*

5.5 Top 20 Stores Table

In addition to the visualizations, the dashboard presents a table with the top 20 stores by sales, providing a detailed breakdown of their performance metrics. This table includes:

- Store name, state, and district
- Sales, SKU count, footfall, rating, and profitability status
- Customers' satisfaction score
- The date when the store was opened

🏆 Top 20 Stores by Sales

store_name	state	district	sale_value	sku_count	footfall	rating	is_profitable	category	open_since
Jio	Goa	North Goa	201924	229	741	4.6	false	Warehouse	2022-09-27 14:15:44.346000
Jio World Convention Centre	Maharashtra	Mumbai Suburban	182375	264	629	4.4	true	Mini	2022-12-29 14:15:44.346000
Jio BP	Uttar Pradesh	Unnao	175006	445	666	4.4	false	Mini	2020-10-11 14:15:44.346000
Jio-bp	Karnataka	Bangalore	174021	100	723	4.5	false	Express	2024-02-24 14:15:44.346000
Jio Digital Life	Kerala	Ernakulam	173124	107	703	4.4	true	Express	2023-11-28 14:15:44.346000
Jio BP	Andhra Pradesh	West Godavari	170156	443	627	4.3	true	Digital	2021-04-11 14:15:44.346000
Reliance Jio Infocomm	Kerala	Ernakulam	162607	107	639	4.2	true	Express	2021-10-03 14:15:44.346000
Jio BP petrol bunk	Gujarat	Amreli	161460	307	723	4.5	false	Mini	2023-10-15 14:15:44.346000

Use via API · Built with Gradio · Settings

Figure 19: *Screenshot: Interface showing the top 20 locations*

This table allows users to quickly identify the highest-performing stores in the network and analyze key metrics at a granular level.

6 Results

The Jio Retail Dashboard successfully integrates geospatial and business performance data into an interactive web interface. Users can upload a GeoJSON file to explore key metrics such as sales, profitability, footfall, store categories, staff allocation, and customer satisfaction. Visualizations include:

- **Bar plots** for sales by category and profitability by region.

- **Scatter plots** for footfall vs. sales to analyze conversion efficiency.
- **Box plots** showing the relationship between customer satisfaction and profitability.
- **Dynamic store map** with markers displaying real-time attributes like sales, staff count, and ratings.

The dashboard also presents KPI summaries and ranks top-performing stores, enabling quick performance evaluation and comparative analysis across locations.

7 Discussion

The dashboard offers a holistic view of store operations across India by combining spatial analysis with business intelligence. It facilitates:

- Regional analysis of store performance based on profitability and footfall.
- Identification of trends and outliers using interactive charts.
- Insight into the correlation between customer satisfaction and store profitability.
- Exploration of store distribution and performance through a spatial map layer.

The results suggest that certain store categories consistently outperform others in sales, and some regions exhibit higher profitability, possibly due to local demographic or economic advantages. While a positive trend exists between footfall and sales, outliers indicate potential inefficiencies in converting visits into purchases.

8 Limitations and Future Work

While the dashboard is functional and insightful, several limitations were identified, along with opportunities for future enhancement:

8.1 Current Limitations

- **Data Quality**: Missing or inconsistent values in key fields like `footfall`, `sale_value`, and `rating` were handled through coercion or exclusion, potentially affecting analysis accuracy.
- **Temporal Scope**: The dashboard includes basic temporal analysis (e.g., store openings over time) but lacks real-time updates or fine-grained time-series insights (e.g., daily/weekly sales).
- **Categorical Imbalance**: Uneven data distribution across categories or regions may skew visualizations or reduce representativeness.
- **Static Input**: Only static GeoJSON input is currently supported, limiting data dynamism.

8.2 Suggested Enhancements

- **Live Data Integration**: Support for real-time data updates and database connectivity for dynamic insights.
- **Feature Management**: Functionality to add, update, or delete store records directly within the dashboard.
- **Advanced Visualizations**: Inclusion of time-series graphs, hierarchical plots (e.g., sunburst charts), and heatmaps for deeper exploration.
- **Predictive Analytics**: Integration of forecasting models to predict sales trends or footfall.
- **User Customization**: Role-based access, filter persistence, and customizable dashboards tailored to different user types (e.g., regional manager vs. head office).

9 Conclusion

The Jio Retail Dashboard demonstrates the power of integrating geospatial data with business intelligence for retail performance analysis. It enables stakeholders to interactively explore and interpret complex operational data, supporting informed decision-making at both strategic and tactical levels.

Despite current limitations, the dashboard establishes a strong foundation for enterprise GIS applications in retail. With enhancements such as live data support, dynamic feature management, and predictive analytics, the platform could evolve into a comprehensive decision-support system for large-scale retail networks.

10 Contribution of Each Team Member

- **Shreya Gupta (221027)**:
  Background Analysis, **Data Acquisition**, **Interface Development (Coding)** for demonstration, Handled **Dataset**, **Methodology**, **Results**, Discussion & **Limitations** sections for the Term Paper & Presentation
- **Saloni Mittal (220942)**:
  Conducted an **in-depth literature review** and **extracted relevant information** from research papers. Contributed to the **term paper and presentation** by extracting **data and corresponding images** from the case study *"Reliance Jio's GIS Application for Store Mapping."*
- **Varun Gupta (221172)**:
  Contributed to the term paper and presentation by extracting **data and corresponding images** from the case study *"Enterprise GIS Portal for Spatial Data Mapping for Kanpur Smart City."* and contributed to the **introduction** and **references** sections and selected **key visuals** for the presentation.

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