International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 13 Issue: 03 | Mar 2026 www.irjet.net p-ISSN: 2395-0072

Etlytix BI: Self-Service Data Analytics and Visualization Tool

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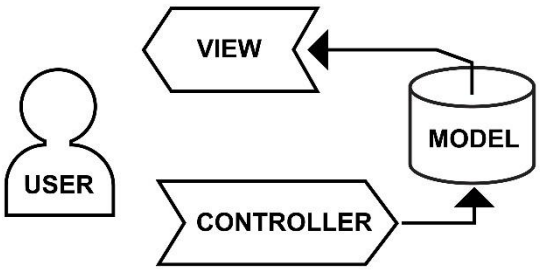
ABSTRACT: *In the era of Industry 4.0, data-driven decision- making is critical for business sustainability. However, Small and Medium Enterprises (SMEs) often face significant bar- riers to entry regarding Business Intelligence (BI) adoption due to the high costs and steep learning curves associated with proprietary tools like Tableau or Power BI. This paper presents Etlytix BI, a comprehensive, lightweight, and open- source BI framework. Built using Python, Flask, and the Pandas library, the system provides an end-to-end solution for Extract, Transform, and Load (ETL) processes and dynamic data visualization. The proposed architecture supports hybrid deployment as both a web application and a standalone desktop application using Pywebview. Key features include multi- source data connectivity (CSV, Excel, MySQL, PostgreSQL), an interactive drag-and-drop chart builder, and automated data cleaning pipelines. This study demonstrates that high- performance analytics can be democratized through efficient open-source architecture without compromising on essential features like security or interactivity.*

Key Words: Business Intelligence (BI), ETL Pipeline, Data Visualization, Flask, Pandas, SME Analytics, Hybrid Application, Data Cleaning.

1. INTRODUCTION

The Etlytix BI project is designed for Small and Medium Enterprises (SMEs) and data analytics beginners, providing a cost-effective and simplified method to transform raw data into actionable insights. Traditional Business Intelligence (BI) adoption is often hindered by high licensing costs, steep learning curves, and the complex resource requirements of proprietary tools like Power BI or Tableau. Etlytix BI overcomes these barriers by offering an open-source, lightweight framework that abstracts the complexities of SQL queries and manual spreadsheet manipulation behind an intuitive visual interface.

Moreover, the system supports a versatile range of data inputs, including flat files such as CSV and Excel, as well as direct connectivity to external databases like MySQL and PostgreSQL. It features a robust Extract, Transform, and Load (ETL) engine powered by the Python Pandas library, enabling automated data cleaning and preparation. With an integrated drag-and-drop chart builder, the platform emerges as a powerful tool for dynamic data visualization and democratized analytics.



MODEL - VIEW - CONTROLLER PATTERN

1.1 Project Plan

The Etlytix BI project is intended to be an intelligent and accessible environment that encourages data-driven decision-making and self-service analytics. The project leverages contemporary technologies, specifically the Flask web framework and Plotly visualization library, to provide a structured and efficient workspace for users to manage their data lifecycles.

This platform includes a variety of specialized modules, including secure user authentication, multi-source data connectors, a data preparation area for handling missing values, and a primary chart builder canvas. By utilizing a hybrid architecture, the project offers a seamless experience as both a web-based application and a standalone desktop executable using the Pywebview library. Utilizing a Model-View-Controller (MVC) pattern for effective communication between the frontend UI and the Python backend, the project places a strong emphasis on modular processing and performance optimization. The portal also seeks to offer a user-friendly experience where non-technical users can quickly move between data ingestion, cleaning, and dashboard generation. Through this initiative, Etlytix BI envisions a more efficient and affordable ecosystem for SMEs, enabling them to visualize their data effectively and close the gap between complex data warehouses and simple spreadsheets.

2. Review of Literature

The Etlytix BI project is founded on insights from extensive research in Business Intelligence (BI), open-source data processing, and self-service analytics. Studies highlight the critical nature of data-driven decision-making for business sustainability in the Industry 4.0 era. Research emphasizes that while large enterprises

successfully integrate sophisticated BI ecosystems, Small and Medium Enterprises (SMEs) often face significant barriers due to high licensing costs and steep learning curves. By integrating best practices from the Python ecosystem—specifically Pandas for data manipulation and Plotly for visualization—Etlytix BI provides a modular and user-friendly environment that bridges the gap between complex enterprise data warehouses and simple spreadsheets.

2.1 Existing Systems

Numerous Business Intelligence applications currently dominate the market, primarily focusing on robust, enterprise-grade features for large-scale data analysis. Some of the most prominent systems include:

Microsoft Power BI & Tableau: These industry leaders offer comprehensive features but come with significant licensing costs and high hardware resource requirements that are often prohibitive for smaller organizations.

Traditional Spreadsheets (Excel/Google Sheets): While accessible, these often lead to manual data manipulation, "data silos," increased human error, and delayed insights when used for complex analysis.

Standard Python Libraries (Pandas/Matplotlib/Seaborn): These tools provide powerful data processing and visualization capabilities but require substantial programming knowledge and specialized training, creating a "skills gap" for non-technical users.

Cloud-Based BI Solutions (Google Cloud Looker/AWS QuickSight): These provide high scalability but often rely on expensive cloud subscriptions and complex setup procedures that can be difficult for beginners or SMEs to navigate.

Most current BI tools are either too expensive for small-scale use or too technically demanding for non-specialists to operate without extensive training. There is a lack of lightweight, "plug-and-play" options that offer both web-based and standalone desktop functionality without requiring a browser installation.

2.2 Literature Survey of Similar Ideas

The evolution of data analytics has shifted from mere storage to real-time processing and visualization. Various methodologies have been explored to democratize data access:

Self-Service BI Architectures: Research argues that enabling non-technical users to generate their own reports is the future of BI. Tools like Etlytix BI build upon this by abstracting the complexities of SQL queries and coding behind a visual drag-and-drop interface.

Multi-Source Connectivity: Recent advancements emphasize the need for systems that can handle a variety of data sources, from flat files (CSV, Excel) to relational databases like MySQL and PostgreSQL.

ETL (Extract, Transform, Load) Pipelines: Effective BI adoption relies on the foundational layer of clean, transformed data. Modern frameworks utilize automated data cleaning pipelines to handle missing values and perform type conversion, ensuring accuracy in final visualizations.

Hybrid Deployment Models: Integrating web-based flexibility with native desktop performance allows for versatile deployment environments. Utilizing wrappers like Pywebview facilitates the conversion of web apps into standalone executables, increasing accessibility for users with limited server infrastructure.

Traditional BI is often concerned with large-scale data warehouses, but recent trends focus on "SME Analytics," where cost-effectiveness and ease of use are prioritized over high-velocity big data processing. Etlytix BI addresses these trends by providing a high-performance analytics solution through efficient open-source architecture without compromising on essential features like security or interactivity.

3. Proposed System

The proposed system, Etlytix BI, offers an integrated, structured, and cost-effective approach to data analytics, specifically addressing the accessibility gaps for Small and Medium Enterprises (SMEs). By combining real-time data processing, hybrid deployment capabilities, and an intuitive drag-and-drop interface, the project ensures that non-technical users have the professional tools needed to derive actionable insights from their data without prohibitive licensing costs.

3.1 Analysis/Framework/Algorithm

Etlytix BI is suitable for business owners and data analytics beginners, providing an easy-to-use framework to analyze information from CSV files, Excel spreadsheets, and SQL databases. The system is designed to be lightweight and accurate, employing Pandas for data manipulation, Flask for backend control, and Plotly for interactive visualization.

The core logic for transforming flat data into visual insights follows this algorithmic path:

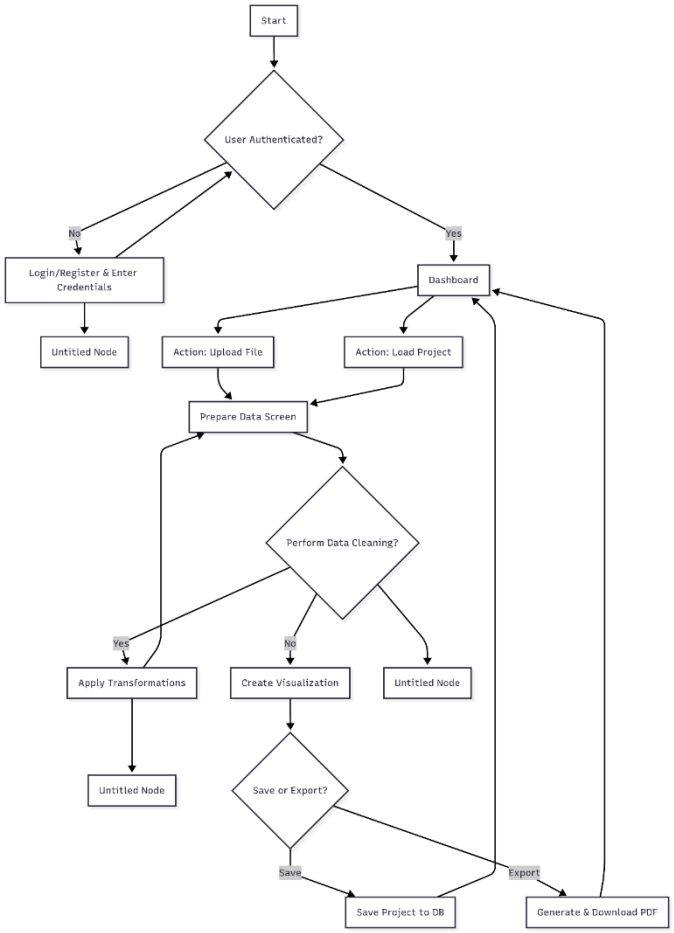


Fig. 3.1 flowchart

3.2 System Architecture (Challenges of BI Tools)

Existing Business Intelligence tools face several challenges in catering to smaller organizations. The following issues highlight the architectural limitations of traditional systems and our proposed solutions:

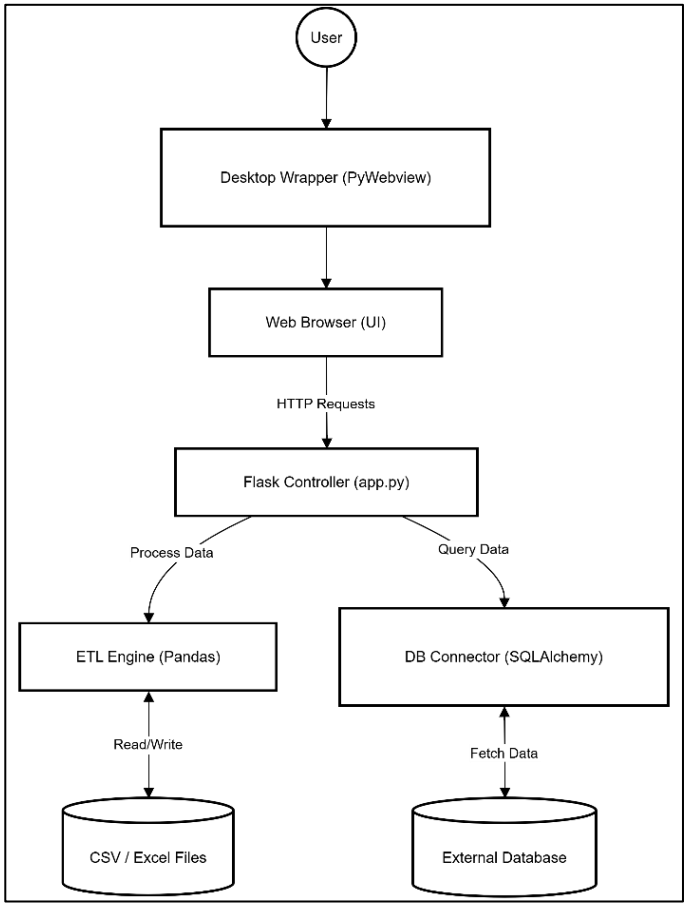


Fig 3.2 System Architecture

Deployment Complexity:

- Challenge: Most BI tools require complex server setups or high-end hardware.
- Solution: A lightweight MVC (Model-View-Controller) architecture that can run in a virtual environment (venv) on standard consumer hardware.

User Accessibility:

- Challenge: The "skills gap" created by tools requiring specialized training or SQL knowledge.
- Solution: Abstracting the backend logic into a visual "Dimension and Measure" sidebar, allowing users to build dashboards without writing code.

Data Scalability vs. Memory:

- Challenge: Loading massive datasets can crash standard browser-based applications.
- Solution: Implementing in-memory processing via Pandas DataFrames and optimizing loading times through bytecode compilation (__pycache__).

3.3 Data Model

The data model for Etlytix BI follows a structured approach to ensure efficient management of user and business data:

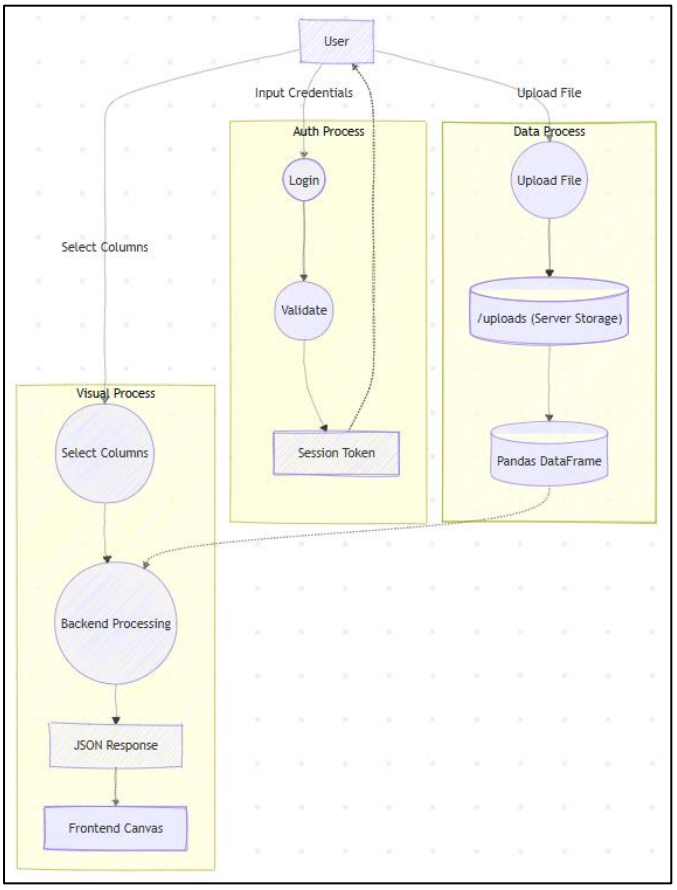


Fig 3.3 Data Flow Diagram (DFD)

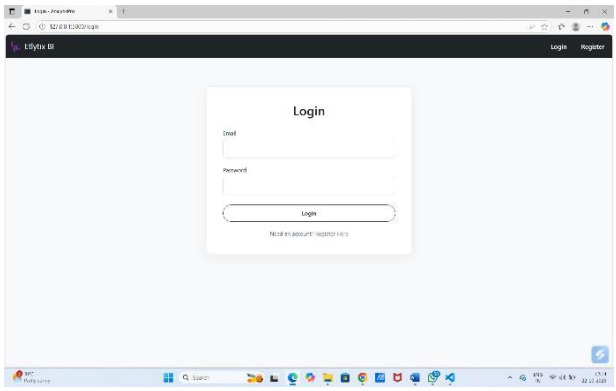
4. Methodology

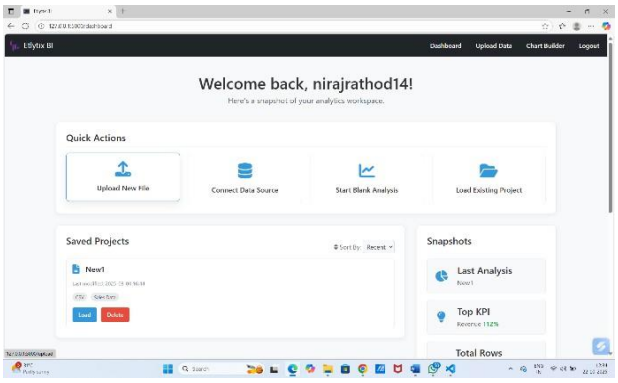
The implementation of Etlytix BI is structured into a modular pipeline that handles high-velocity data ingestion, rule-based cleaning, and client-side rendering.

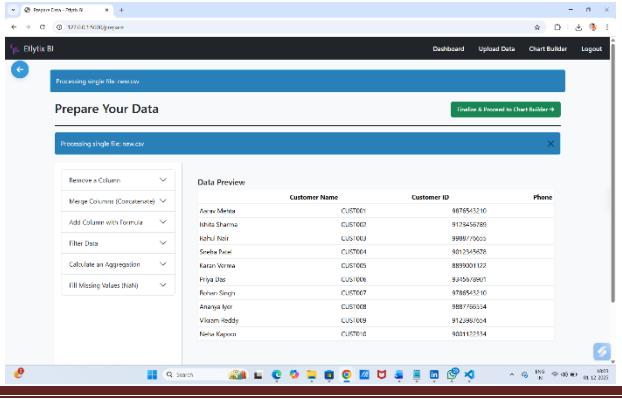
- Data Ingestion Phase: Utilizing multipart/form-data for secure file uploads and SQLAlchemy engines for database handshaking.
- Data Preparation Phase: Generating summary statistics (min, max, mean) and a "head" preview (first 5 rows) for initial data assessment.
- Visualization Engine Phase: Leveraging a POST request system where the backend processes DataFrames and returns JSON representations of graphs to the frontend.
- Optimization & Hybridization: Converting the web-based Flask routes into a native window container using run_desktop.py for versatile deployment.

4.1 Proposed System Result:

The implemented **Etlytix BI** project provides a streamlined and efficient approach to data analytics, specifically designed to empower users with self-service visualization capabilities. By successfully integrating the **Pandas** ETL engine and **Plotly** visualization library, the system allows for the rapid transformation of raw CSV, Excel, and SQL data into interactive dashboards. The architecture ensures high performance through in-memory processing and optimizes user accessibility by replacing complex coding requirements with an intuitive drag-and-drop interface.







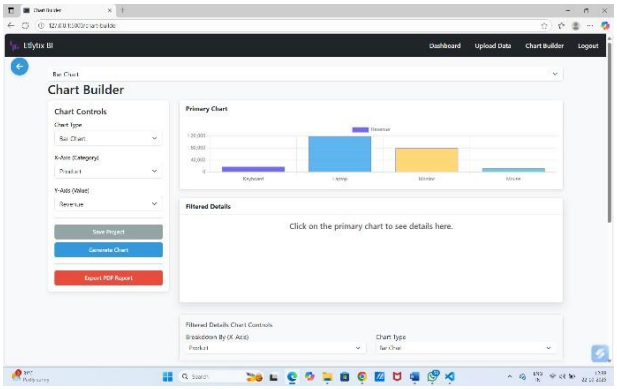


Fig. 3. Data Preparation and Visualization Figure

6. Conclusion

Etlytix BI successfully demonstrates that a robust Business Intelligence tool can be both high-performing and cost-effective. By utilizing open-source technologies like **Flask** and **Pandas**, the project provides a comprehensive solution for data ingestion, cleaning, and dynamic visualization tailored for SMEs. The inclusion of **hybrid desktop capabilities** via Pywebview ensures the tool is versatile enough for various deployment environments, from web servers to standalone local machines. This system serves as a foundational step toward democratizing data analytics, enabling non-technical users to derive meaningful insights without the barriers of high licensing fees or specialized technical expertise. Future enhancements will focus on **cloud scalability** through Docker, **AI-powered forecasting** via Scikit-learn, and the integration of **NoSQL database connectors** to further expand the tool's analytical reach.

ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to **Asst. Prof. Ashwini Thakare** for his invaluable guidance, continuous encouragement, and technical support throughout the development of *Etlytix BI*. We also extend our thanks to **Asst. Prof. Ashwini Thakare** (Project Coordinator) and **Prof. Radhika Nanda** (Head of Department, Computer Engineering) for providing the necessary academic resources and laboratory facilities at **Bharat College of Engineering, Badlapur**.

Finally, we thank the University of Mumbai for providing the curriculum platform that motivated this research work.

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