Banking Data Quality & Audit Platform

CASE STUDY/ Data Engineer Intern

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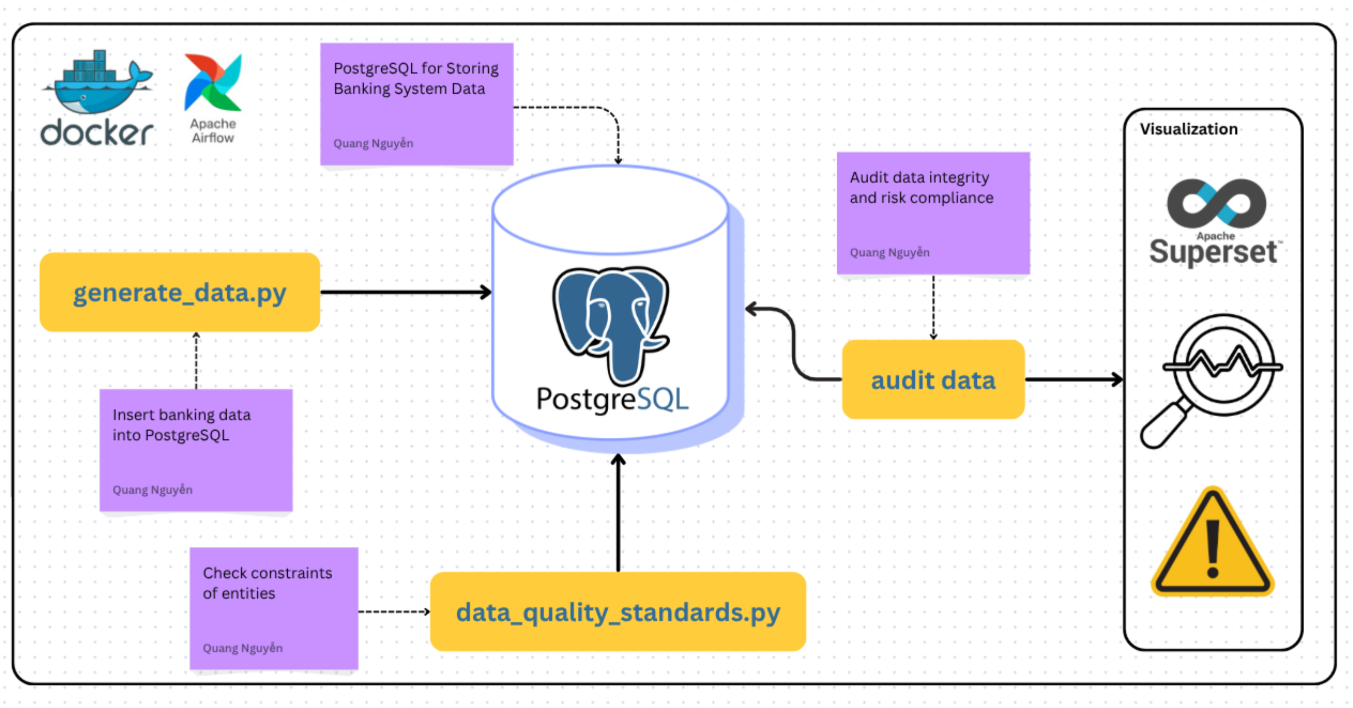
My Story

This is my first time working with a banking system. Initially, I struggled to explore domain knowledge, understand core use cases in banking, and follow the 2345/QĐ-NHNN 2023 regulation. I tried signing up for a TIMO BANK account to learn about the transaction process in the TIMO bank app, but I encountered issues because my information in the TIMO database did not match my CCCD card. So, I used MBBank to learn how a bank app works. Fun fact: I even called a bank support representative to ask more about this domain. Once I understood the domain, I was able to design and implement a simplified banking system more easily. I really hope this project will help me advance to the next round of the internship. I have tried to break down the code into modules for easier understanding. If you need clarification on any part of this project, I am ready to answer any of your questions.

Architecture


docker
Apache Airflow
PostgreSQL for Storing Banking System Data
Quang Nguyễn
generate_data.py
Insert banking data into PostgreSQL
Quang Nguyễn
PostgreSQL
Audit data integrity and risk compliance
Quang Nguyễn
audit data
Check constraints of entities
Quang Nguyễn
data_quality_standards.py
Visualization
Apache Superset

The system is containerized using Docker Compose and consists of several main components:

- **Airflow**: Orchestrates data generation and quality checking workflows.
- **Python Service**: Handles data generation and auditing logic using SQLAlchemy and Faker.
- **PostgreSQL**: Stores all banking data, including customers, accounts, transactions,...
- **Superset**: Provides interactive dashboards for data visualization and monitoring.

Project Directory

```
.
├── airflow                  # Airflow configuration, DAGs, and logs
│   ├── airflow.Dockerfile   # Dockerfile for setting up Airflow
environment
│   ├── config               # Contains airflow.cfg configuration
│   │   └── airflow.cfg
│   ├── dags                 # Data pipelines (DAG definitions)
│   │   └── banking_dq_dag.py
│   └── logs                 # Airflow log files for task/job execution
├── material/                # Project-related images, diagrams
├── source_py                # Core Python source code and data logic
│   ├── python.Dockerfile    # Dockerfile for Python services
│   └── src
│       ├── audit_data/         # SQL scripts for auditing data
│       ├── check_data/         # Python scripts for data validation checks
│       ├── generate_data/      # Python scripts to simulate/mock data
│       ├── model/              # Data models and ORM definitions
│       ├── generate_data.py    # Main script to generate mock data
│       ├── data_quality_standards.py  # Standards for data quality checks
│       └── requirements.txt    # Python dependencies
├── sql
│   └── schema.sql          # Database schema definitions
├── visualization
```

```
│   ├── dashboard_export.zip    # Exported dashboards (e.g., Superset)
│   └── superset.Dockerfile     # Dockerfile for Superset visualization
tool
├── docker-compose.yml      # Compose file to orchestrate services
(Airflow, PostgreSQL, Superset, etc.)
├── Readme.md               # Project overview and documentation
```

Prerequisites

Ensure you have Docker installed on your system before proceeding.

Installation

1. Clone the repository from GitHub and navigate to the project folder:

```
git clone https://github.com/DOCUTEE/TIMO_bank.git
cd TIMO_bank
```

2. Start all services using Docker Compose:

```
docker compose up --build
```

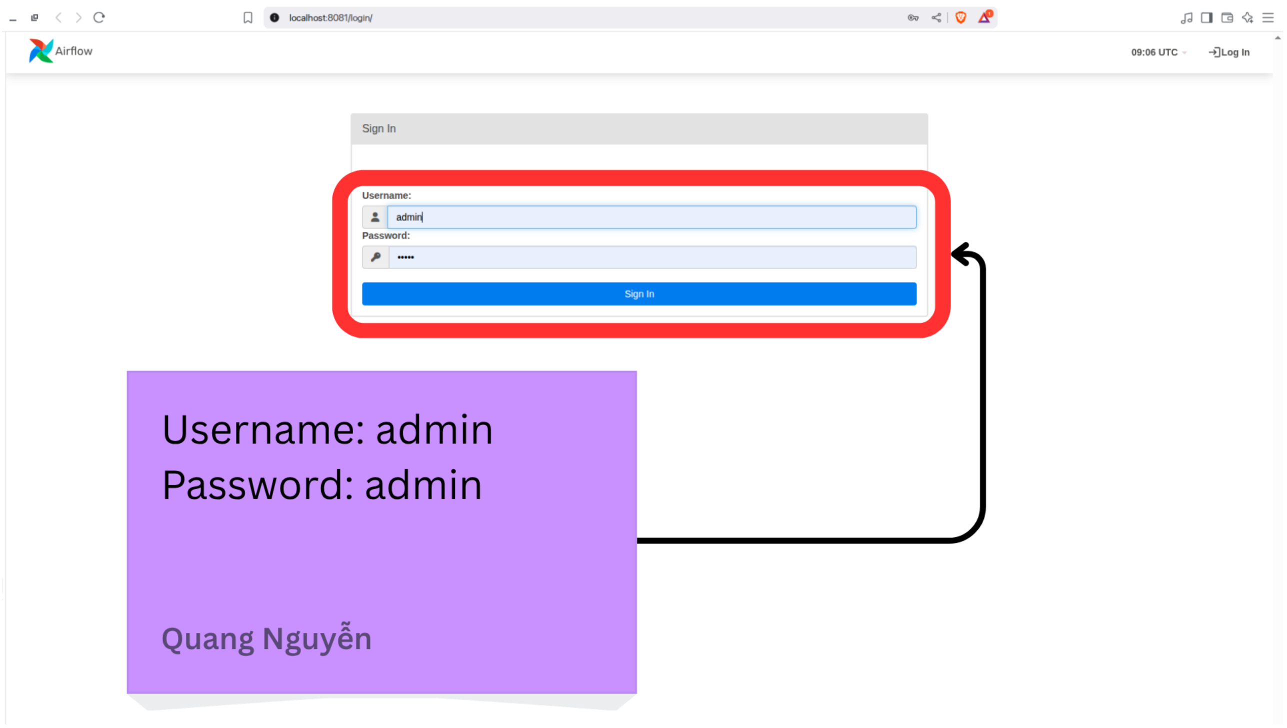
Accessing the Airflow Pipeline

A pre-configured pipeline is available in Airflow to automate data generation and quality checks. Follow these steps:

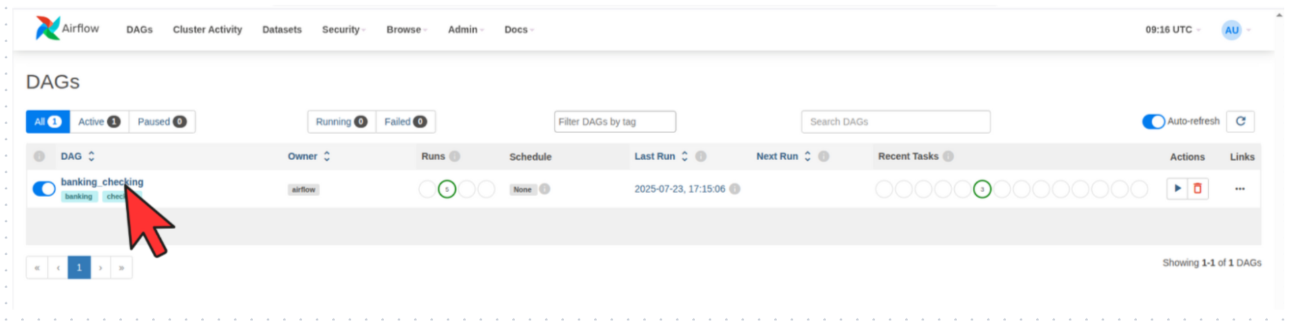
1. Access Airflow at http://localhost:8081/.

2. Log in with the credentials:

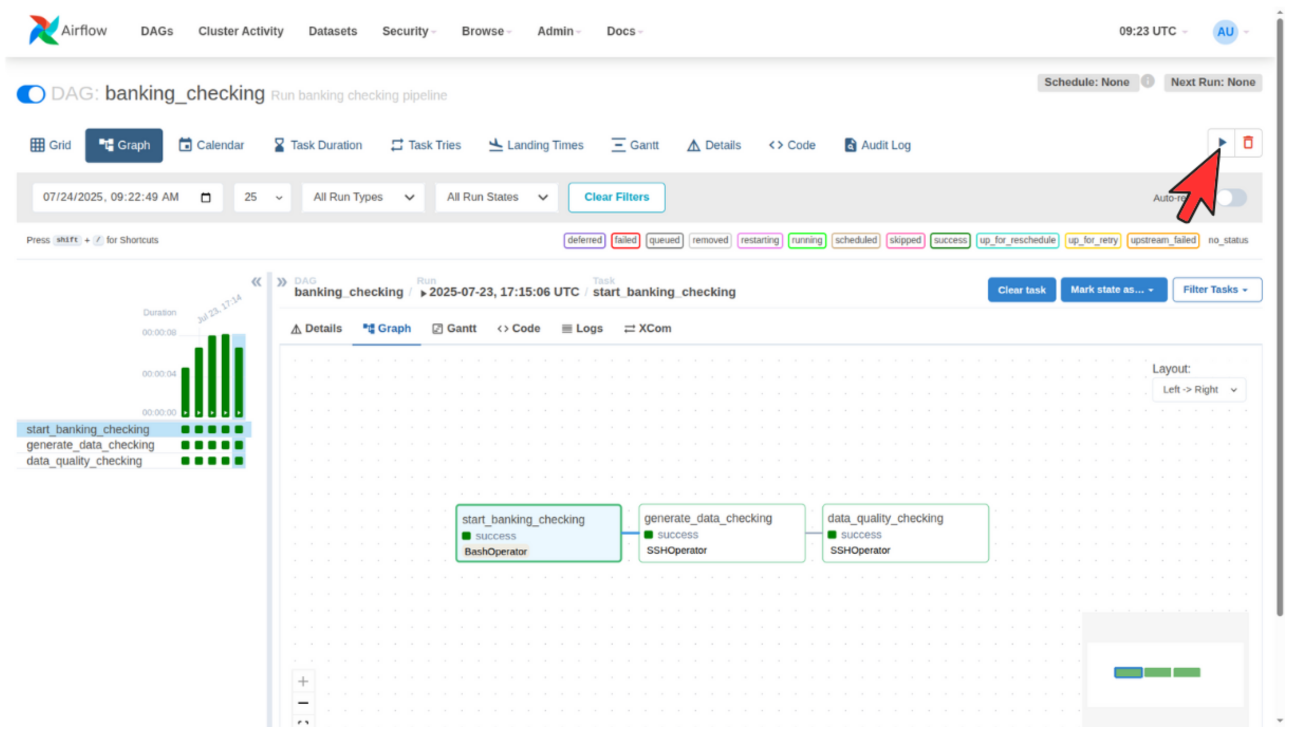
   - **Username**: `admin`
   - **Password**: `admin`



3. Locate the pipeline designed for data generation and quality checks. Click on it to view details.



4. The pipeline is scheduled to run daily. To trigger it manually, click the "Run" button.

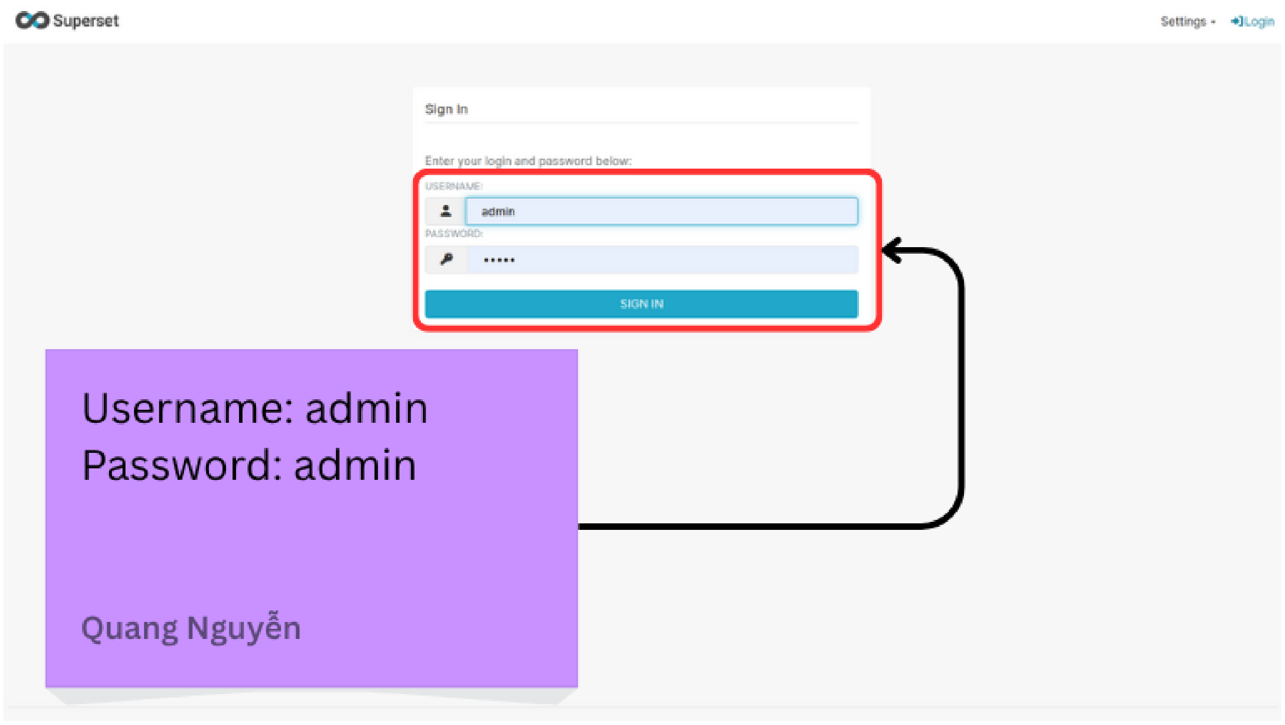


Visualizing Data with Superset

To view risk alerts through a visualization dashboard, use the Superset service:

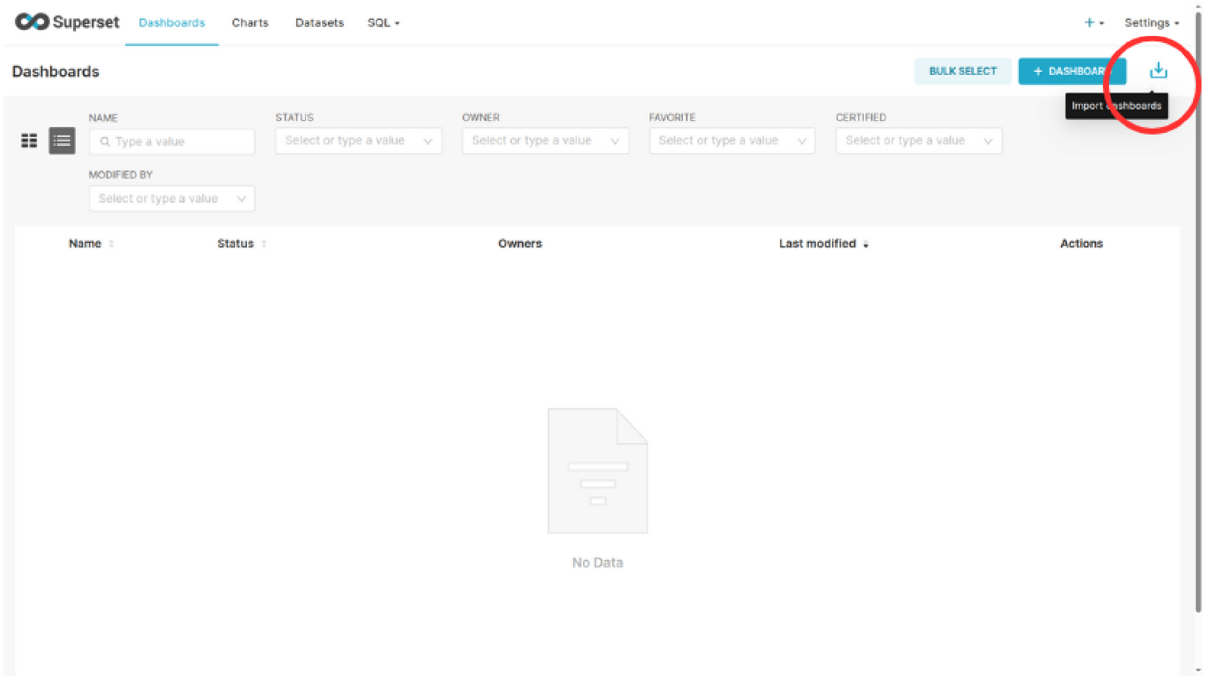
1. Access Superset at http://localhost:8081/ and log in with:

    - **Username**: `admin`
    - **Password**: `admin`

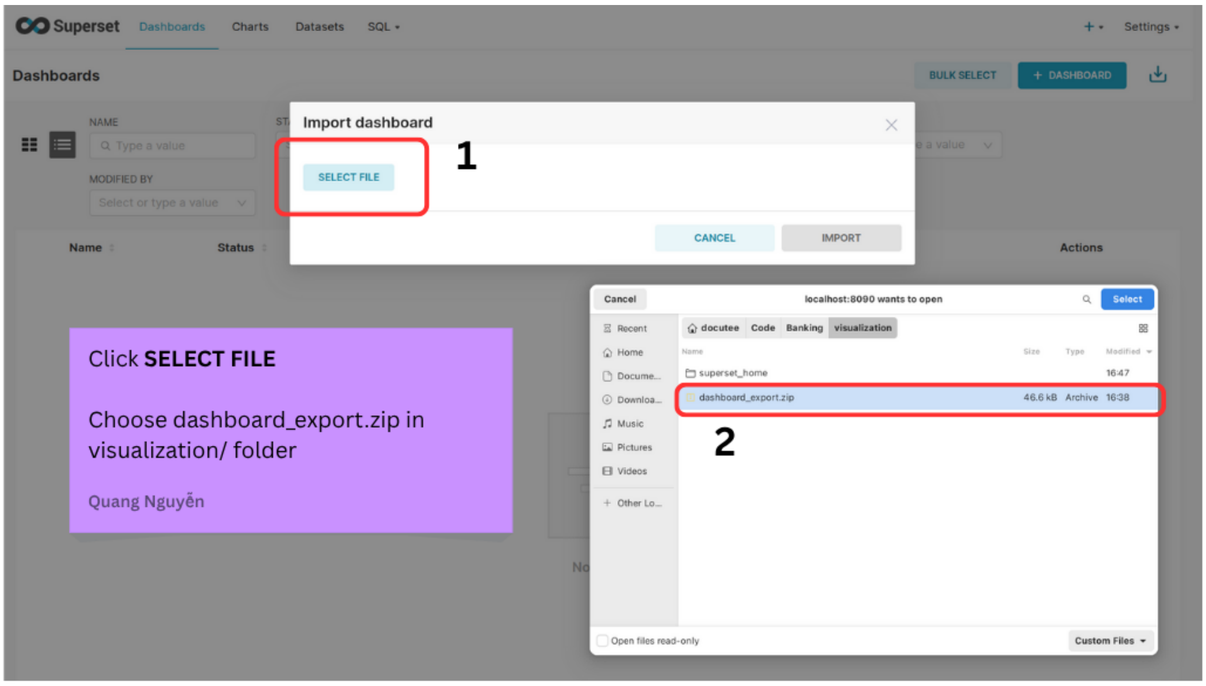


2. If this is your first time accessing Superset, you need to import the dashboard manually:

    - Navigate to the **Dashboards** tab and click the **Import** button.



    - Follow the prompts to import the dashboard using the provided zip file.

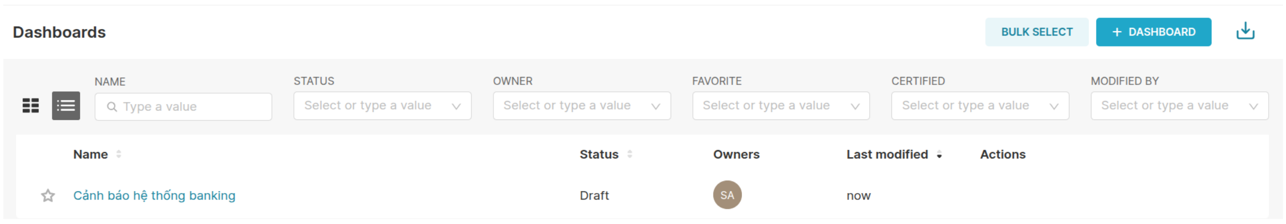


Click **SELECT FILE**

Choose dashboard_export.zip in visualization/ folder

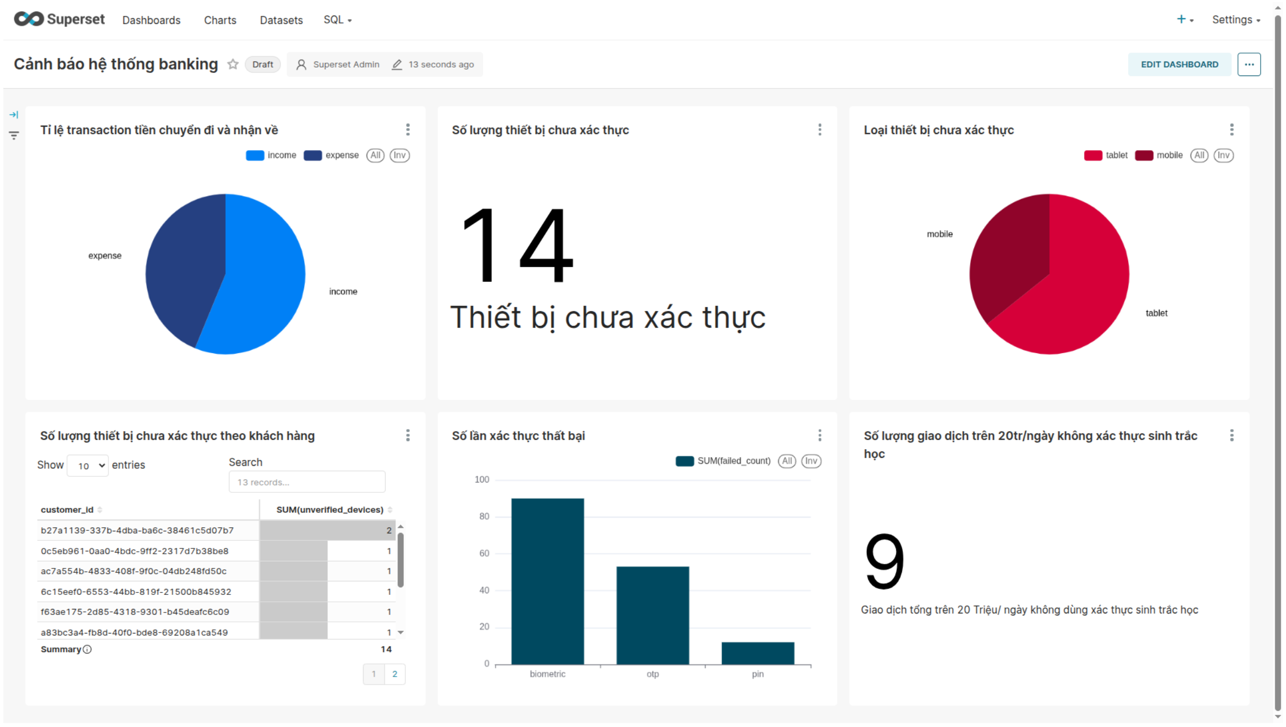
Quang Nguyễn

3. Once imported, you can view the pre-built dashboard.



Name	Status	Owners	Last modified	Actions
Cảnh báo hệ thống banking	Draft	SA	now	

4. Explore the complete dashboard for a comprehensive overview.

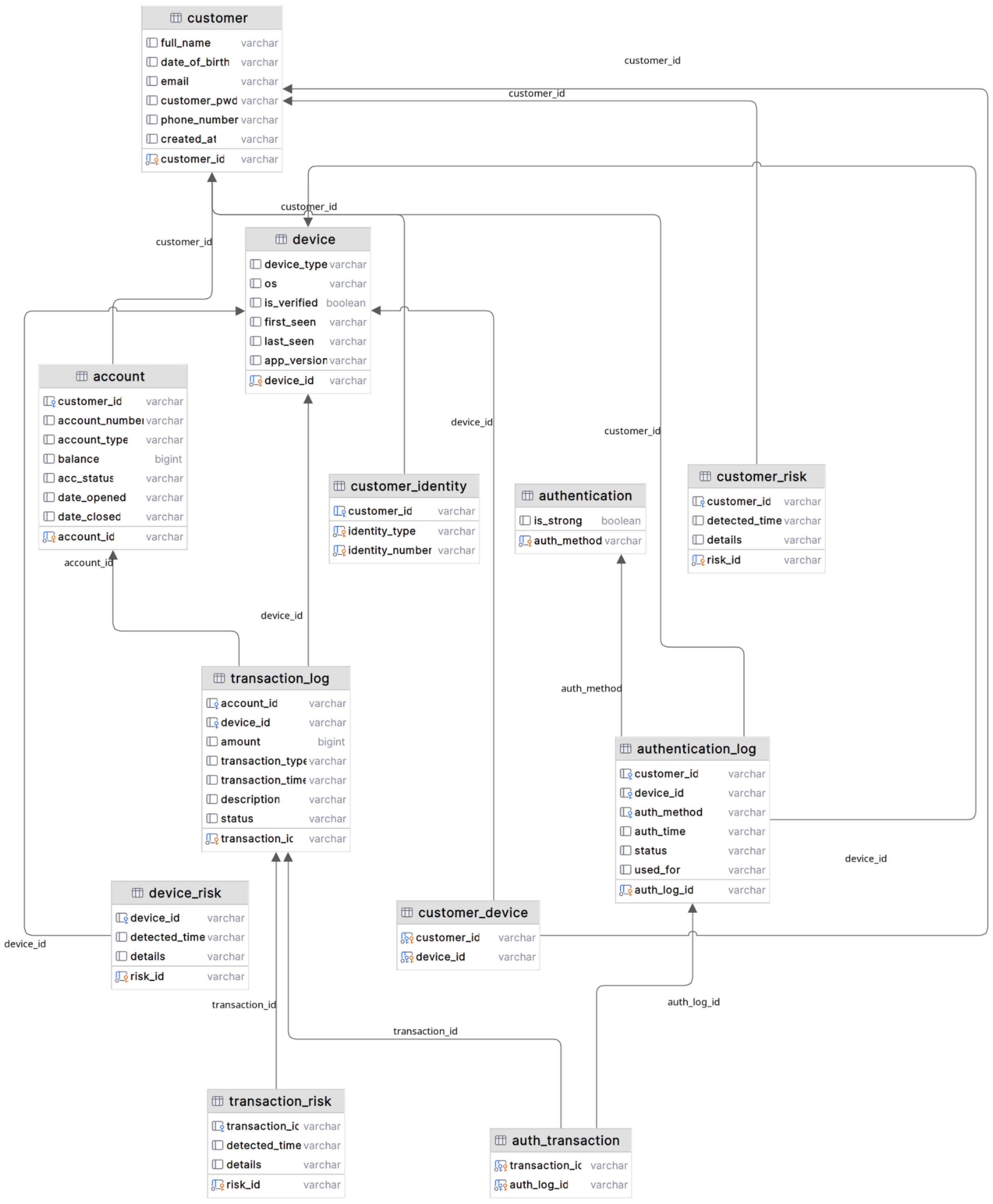

Superset
Dashboards
Charts
Datasets
SQL
Settings
Cảnh báo hệ thống banking
Draft
Superset Admin
13 seconds ago
EDIT DASHBOARD
Tỉ lệ transaction tiền chuyển đi và nhận về
income
expense
expense
income
Số lượng thiết bị chưa xác thực
14
Thiết bị chưa xác thực
Loại thiết bị chưa xác thực
tablet
mobile
mobile
tablet
Số lần xác thực thất bại
SUM(failed_count)
100
80
60
40
20
0
biometric
otp
pin
Số lượng giao dịch trên 20tr/ngày không xác thực sinh trắc học
9
Giao dịch tổng trên 20 Triệu/ ngày không dùng xác thực sinh trắc học

Số lượng thiết bị chưa xác thực theo khách hàng

Show 10 entries — Search: 13 records...

customer_id	SUM(unverified_devices)
b27a1139-337b-4dba-ba6c-38461c5d07b7	2
0c5eb961-0aa0-4bdc-9ff2-2317d7b38be8	1
ac7a554b-4833-408f-9f0c-04db248fd50c	1
6c15eef0-6553-44bb-819f-21500b845932	1
f63ae175-2d85-4318-9301-b45deafc6c09	1
a83bc3a4-fb8d-40f0-bde8-69208a1ca549	1
Summary	14

Schema



Below is a short and simple description of the tables in the provided database schema:

- **customer**: Stores customer information, including `full_name` (full name), `date_of_birth` (date of birth), `email`, `customer_pwd` (password), `phone_number` (phone number), `created_at` (creation time), and `customer_id` (customer ID).
- **device**: Contains device information, with fields like `device_type` (device type), `os` (operating system), `is_verified` (verified status), `first_seen` (first seen), `last_seen` (last seen),

app_version (app version), and device_id (device ID).

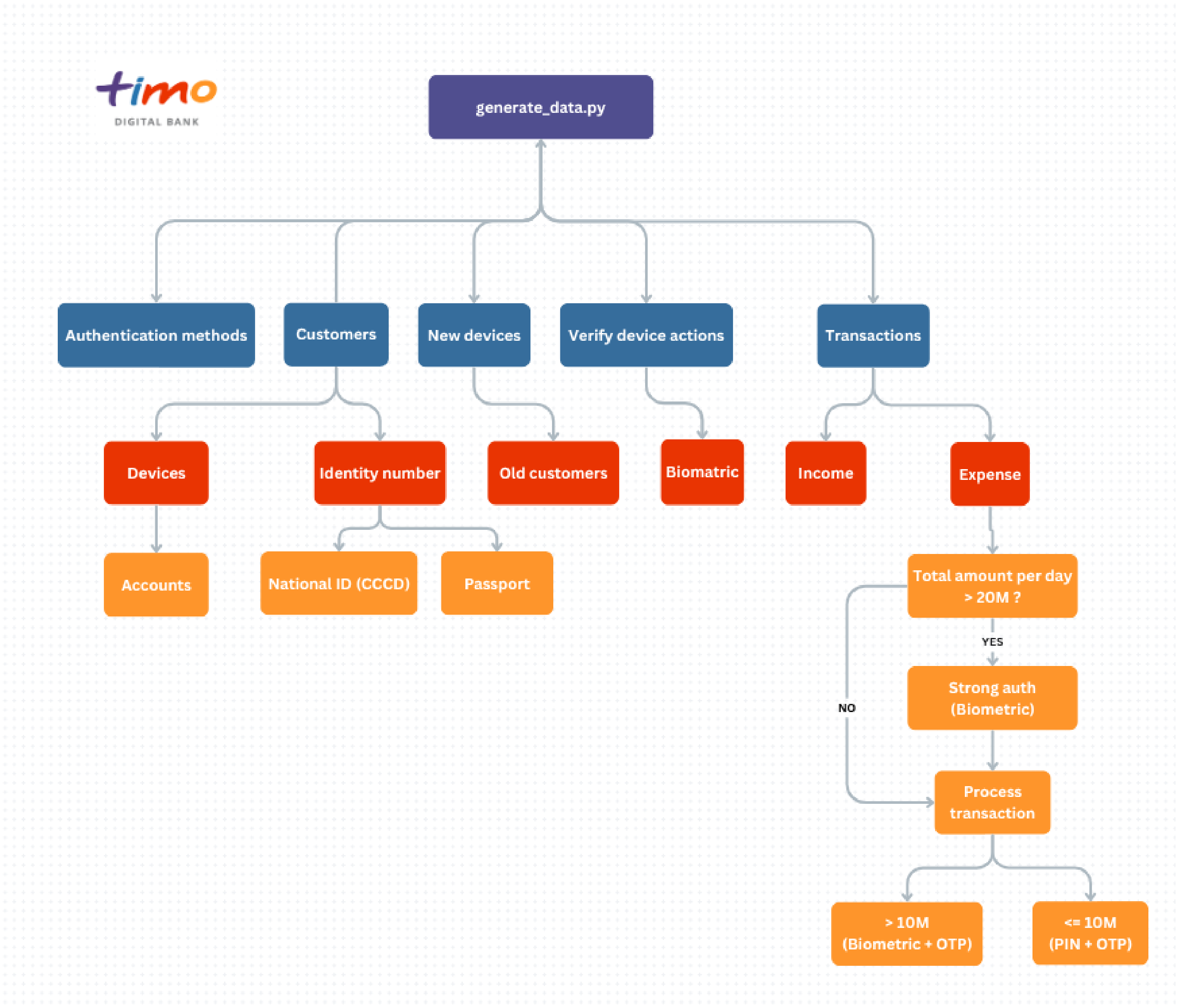
- **account**: Manages bank account details, including customer_id (customer ID), account_number (account number), account_type (account type), balance (balance), acc_status (account status), date_opened (opening date), date_closed (closing date), and account_id (account ID).
- **customer_device**: Links customers to devices, with customer_id and device_id.
- **customer_identity**: Stores customer identification details, including customer_id, identity_type (identity type), and identity_number (identity number).
- **customer_risk**: Tracks risks related to customers, with customer_id, detected_time (detection time), details (details), and risk_id (risk ID).
- **device_risk**: Tracks risks related to devices, with device_id, detected_time, details, and risk_id.
- **transaction_log**: Records transactions, including account_id (account ID), device_id, amount (amount), transaction_type (transaction type), transaction_time (transaction time), description (description), status (status), and transaction_id (transaction ID).
- **authentication**: Stores authentication methods, with auth_method (method) and is_strong (is strong).
- **authentication_log**: Logs authentication events, including customer_id, device_id, auth_method, auth_time (authentication time), status, used_for (purpose), and auth_log_id (log ID).
- **auth_transaction**: Links transactions to authentication, with transaction_id and auth_log_id.
- **transaction_risk**: Tracks risks related to transactions, with transaction_id, detected_time, details, and risk_id.

Relationships

- customer is linked to account, customer_device, customer_identity, customer_risk, and authentication_log.
- device is linked to customer_device, device_risk, transaction_log, and authentication_log.
- account is linked to transaction_log.
- transaction_log is linked to auth_transaction and transaction_risk.
- authentication is linked to authentication_log.
- authentication_log is linked to auth_transaction.

This schema supports the management of customers, devices, accounts, transactions, and related risks.

Data Generation

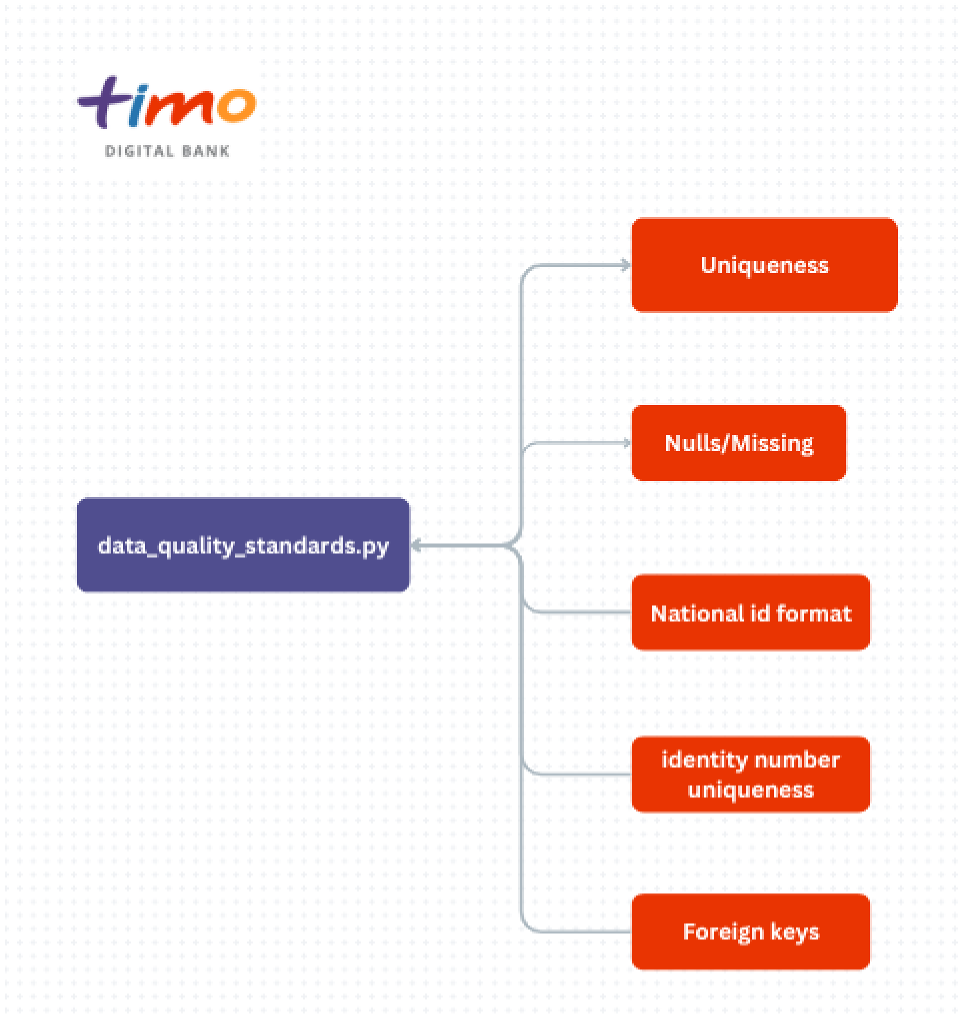


The platform generates synthetic data to simulate key banking scenarios, including:

- **Authentication methods**: Different ways customers can log in, like using passwords or faces.
- **Customers**: Making fake customer profiles with simple details.
- **New devices**: Old customers buying and using new phones for banking.
- **Device verification**: Checking if a device really belongs to the customer.
- **Transactions**: Making fake income and expense transactions.

This data is used to test and validate the platform's data quality and auditing features.

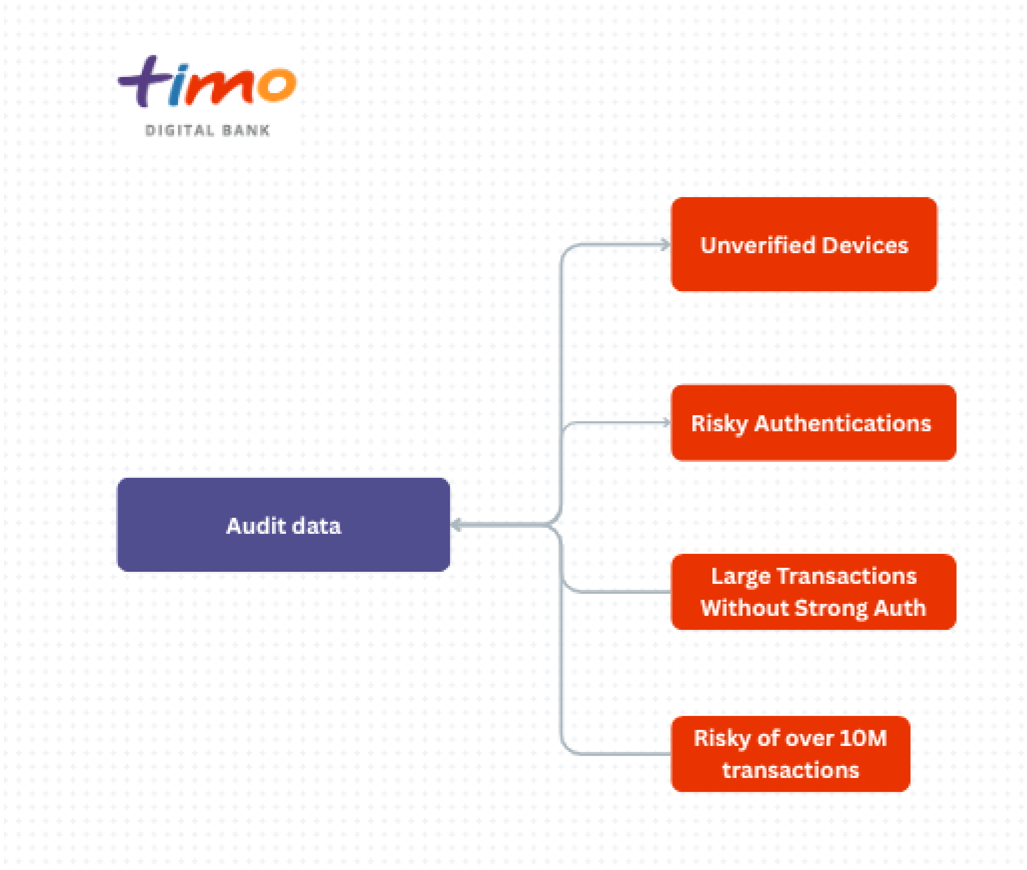
Data Quality Check



Data quality is enforced via scripts in `source_py/src/check_data/`:

- **Null Checks**: Ensures critical columns are not null.
- **Uniqueness**: Verifies primary key and identity uniqueness.
- **Format Checks**: Validates national ID formats.
- **Foreign Key Checks**: Ensures referential integrity across tables.

Audit


timo
DIGITAL BANK
Unverified Devices
Risky Authentications
Audit data
Large Transactions Without Strong Auth
Risky of over 10M transactions

Audit SQL queries in `source_py/src/audit_data/` help monitor security and compliance:

- **Unverified Devices**: Detects devices not yet verified.
- **Risky Authentications**: Finds devices without proper authentication.
- **Transactions Over 10M VND Without Strong Authentication**: Identifies transactions exceeding 10 million VND that were not authenticated using strong methods.
- **Large Transactions Without Strong Auth**: Flags expenses over 20M VND without biometric authentication.

Visualization

Superset is used for interactive dashboards and analytics:

- **Dockerized Superset**: See `visualization/superset.Dockerfile`.
- **Dashboard Exports**: Example dashboards in `visualization/dashboard_export.zip`.

Contact

If you have any questions or need further assistance, feel free to reach out:

- **Email**: quangforwork1203@gmail.com
- **GitHub**: DOCUTEE
- **SMS/ZALO**: 0935601729

I'm happy to help with any inquiries about the project!