Pharmaceutical Distribution Logistics

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Introduction

Our objective is to streamline and optimize the logistics operations for a pharmaceutical company by orchestrating a comprehensive simulation that encompasses supply chain and operational spectrum. This initiative is designed to address a multitude of critical requirements to ensure the efficient and compliant functioning of the pharmaceutical enterprise.

- To streamline and optimize the logistics operations for a pharmaceutical company through a comprehensive simulation.
- It covers the procurement of raw materials from vendors, the selling of drugs to distributors, and the entire supply chain and operational spectrum.
- It focuses on optimizing the procurement of raw materials and distribution operations while respecting inventory capacities.
- It can reduce operational costs, improve assets, and enhance overall shareholder value .
- It not only ensures compliance but also positions the company for long-term profitability by optimizing procurement strategies based on real-time insights and demand forecasting

Database Design

Our first step in designing a database that could facilitate and achieve the desired objectives was to decide how many entities would be involved in the system. The main component in a logistics pipeline is the product and the ‘Drug’ entity serves that purpose for a pharmaceutical organization. The manufacturing of the drug requires raw materials, chemicals being the frontrunners of those, hence another main entity is ‘Chemical’. Each drug must also have the approval to be sold and distributed in the market without legal or safety concerns, hence giving the entity ‘Approvals’ linked to each drug. To simulate the sales and purchases, we required entities who would facilitate the same, resulting in two more entities - ‘Distributors’ that purchase drugs, and ‘Vendors’ that sell chemicals and a corresponding ‘Inventory’ for each vendor. A ‘Shipper’ entity is required for the transportation of products, be it drugs or chemicals. One of the main components of maintaining a logistics chain is a record or log to track the details, which we can do with the ‘Order’ entity. This entity keeps track of the items in the orders, the total pricing and the distributor/vendor involved. These sum up the key entities of the database.

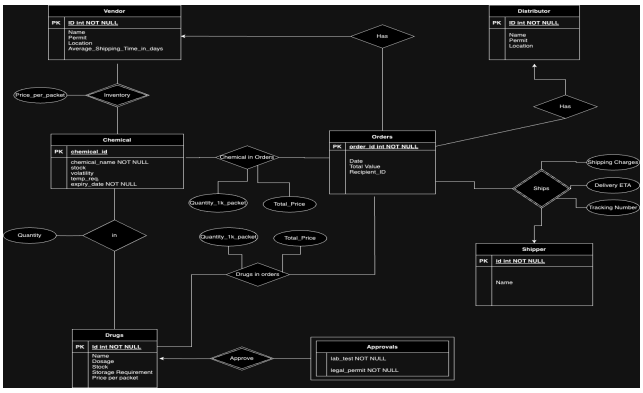
To accurately simulate the working, we require relevant fields to mimic the processes and data. However, having more of these fields can cause redundancy and can introduce a lot of non-essential data into the system. Hence, we conducted a comprehensive online research into the fields required by each entity to function correctly, simulate the system accurately and provide us with an opportunity to gain analytical insights into the system.

We have also introduced a Not Null constraint on entity attributes. The Not Null constraint is essential for maintaining data consistency by ensuring that a specific column in a database table cannot have Null values. This constraint guarantees the presence of meaningful data in the designated column, preventing unexpected behaviors in queries that might arise from attempting to manipulate or retrieve data that is missing or undefined. By enforcing the presence of valid information, the Not Null constraint enhances the reliability and integrity of the database, supporting accurate analysis and reporting.
Data integrity is enforced through these constraints - primary keys, foreign keys, unique constraints, and check constraints.

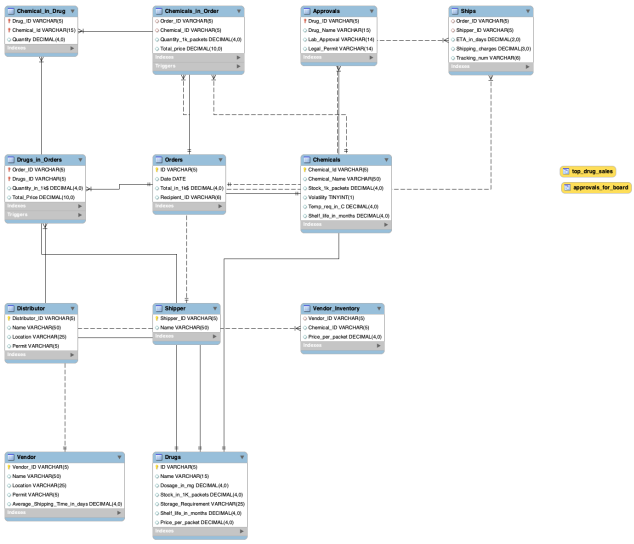
Whenever entities with similar attributes are present in a system, it is essential to ensure they don't have redundant attributes which can violate normalcies. An example of this in the system is the record of the chemicals involved in manufacturing a drug. Simply writing them down as a multivalued attribute with a drug violates the normalcy. Hence, a separate table must be created to ensure normalcy. Another example is the various items involved in an order. It is also essential to differentiate between a sales order and a purchase order. Creating more tables helps to accurately represent the relationship between two entities while also preserving normalcy. Expanding on this idea gives us more tables in the system namely - ‘Chemicals in Drug’, ‘Drugs in Order’, ‘Chemicals in Order’, ‘Ships’.

Designing the database with future changes in mind is also essential. It helps ensure the maintainability of the system and proper functioning when more entities or data need to be introduced into the system. Another way of ensuring

good maintainability is to use standard and easy to understand naming conventions and documentation.



Final ERD



Final Database Schema extracted from mySQL

Data Collection

We conducted a comprehensive study of existing distribution pipelines and dissected the components involved. The data required by each component to function optimally was observed and studied. We simulated our own data to closely resemble that of each component for accurate analytical performance and resemblance to the real-world industry. The data of drugs and chemicals was replicated, as closely as possible, to that of the drugs and chemicals used in the real world to accurately represent and analyze the workings of a pharmaceutical organization. The distributors, vendors and shippers data mimics those of their real-world counterparts. The data in orders closely resembles how a distributor would actually map their orders and includes the necessary parts of total price and the items in the order as well. Each drug is also linked to the chemicals used to manufacture the same. Although the simulated entries are meant to represent real-world data, any resemblance to actual distributors, vendors, shippers, drugs and chemicals is purely coincidental and has been used for educational purposes.

Application Description

To facilitate seamless communication between a MySQL database and Python, the MySQL Connector Python driver was employed. This driver enables the retrieval and storage of data between the MySQL tables and Python scripts. Data stored in MySQL tables can be retrieved using SQL queries executed through the MySQL Connector Python driver. This retrieved data is crucial for feeding information to applications, ensuring that the latest and relevant data is utilized.

In addition to interacting with MySQL, the Python script employs Pandas DataFrames providing a convenient structure for storing, manipulating, and analyzing tabular data.

Some of the features of the application include:

Order Placement
An admin-driven order placement system plays a pivotal role in pharmaceutical inventory management. It empowers administrators to initiate orders for drugs from distributors or procure raw chemicals from vendors. This process triggers internal procedures, orchestrating the update of stock levels in the inventory system. By seamlessly integrating order placement with inventory management, pharmaceutical companies ensure efficient control over their supply chain, enabling timely replenishment of essential pharmaceutical components. This streamlined approach enhances operational resilience and supports the continuous availability of critical materials for drug manufacturing.

Get Best Vendor
This feature is a critical component of the procurement process, aiding in the strategic selection of vendors based on a company's specific needs. It considers the urgency of raw material requirements. In situations where immediate supply is crucial, the system identifies vendors capable of prompt delivery. Simultaneously, for scenarios where cost reduction is a priority, it evaluates vendors offering the best pricing structures and favorable terms.

Low Stock Alert
This feature plays a crucial role in pharmaceutical and chemical inventory management by promptly notifying administrators when specific drugs and chemicals fall below a predefined threshold. This proactive alert mechanism ensures that the administrative team remains vigilant about the inventory levels. By preventing stocks from reaching critically low levels, the system facilitates seamless inventory management and safeguards against potential disruptions in the manufacturing or distribution processes. Ultimately this enables timely actions to replenish essential pharmaceutical components and maintain the continuity of production and distribution.

Lab Approvals
Lab approvals in the pharmaceutical industry are a critical step in ensuring the compliance of drugs with stringent quality standards. After undergoing rigorous lab tests, this process verifies the validity, reliability, and high quality of pharmaceutical products. By preventing the release of inaccurate or substandard drugs into the market, lab approvals play a pivotal role in safeguarding public health. Moreover, the documentation and evidence generated through this approval process are invaluable in making legal decisions for the company, providing a robust foundation for regulatory adherence and fostering trust with regulatory bodies.

Shipper Tracking
Shipper tracking provides customers with essential details such as the shipper's information, estimated time of arrival (ETA), and the tracking number for their shipments. This transparency in logistics empowers customers with real-time insights into the status and location of their packages, contributing to a positive customer experience. By ensuring customers are well-informed and confident about their deliveries, shipper tracking plays a pivotal role in enhancing overall customer satisfaction.

Analytical Decisions
Using analytics to derive insights from data to optimize operations and maximize profit. By analyzing total sales and purchases, businesses can make informed decisions for resource allocation and process improvement. Additionally, identifying top-selling drugs provides pharmaceutical companies with crucial market insights, aiding strategic planning. Vendor optimization, considering factors like minimum delivery periods, ensures efficient supply chain management, minimizing delays and enhancing overall productivity. Detailed sales analysis by drugs allows businesses to tailor marketing strategies and product offerings, aligning with customer preferences and market trends.

Conclusion

The proposed system is built to closely resemble how operations work in an actual distribution pipeline for a pharmaceutical organization. This includes stock-keeping, refilling raw materials, placing new orders, etc. The system also provides analytical insights into different aspects and outlooks such as the total monthly profits over a year, the top selling products, and the vendor delivery performances. There are also functionalities to optimize the procurement costs such as finding a product and the corresponding cheapest vendor or the vendor who provides the fastest delivery.

Although the system performs all the necessary basic functionalities, certain features can be added to boost its utility and performance. A capability of decision-forecasting can be added that can study the data available so far and use it to make predictions about the demand. Further functions can include improving the tracking functions for each order to show more accurate and important details. The functionality to cancel an order should also be added.