Case Study:

E-commerce Order Fulfillment & Delivery Analytics

Background:

An e-commerce company, **"ShopX"**, has implemented **SAP ERP** for managing its business processes, including sales orders, inventory, shipments, and customer data. The company wants to enhance its order fulfillment and delivery processes by integrating the SAP ERP system with a data warehouse for better analytics. This solution would enable the company to monitor order processing times, delivery efficiency, track performance metrics, and ultimately improve customer satisfaction.

Case Study Scope:

The scope of the Case Study includes building a comprehensive **data model** for tracking orders, shipments, deliveries, and performance metrics. The solution will integrate various components such as:

- **Order Management System (OMS)**: Tracks orders from the moment they are placed by the customer until they are delivered.
- **Shipping & Delivery**: Monitors the logistics involved in the delivery process, including carrier selection, tracking, and delivery statuses.
- **Customer Analytics**: Analyzes customer satisfaction metrics based on delivery performance, order fulfillment times, and communication.

The primary objective is to ensure that the business can track and optimize:

- Order processing times
- Delivery durations
- Fulfillment efficiency
- Customer satisfaction scores

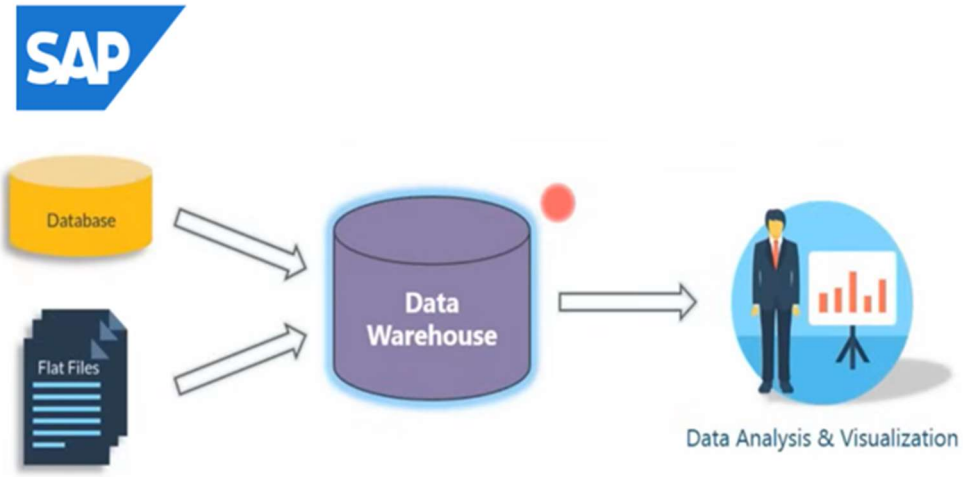
Key Activities:

- **SAP ERP**: Extracting relevant order and shipping data from SAP.
- **Data Model**: Structuring the data to support order fulfillment and delivery analytics.
- **Reporting & Analytics**: Creating custom reports and dashboards to monitor key metrics such as order processing times, delivery performance, and carrier performance.

Key Output Deliverable:

- Mapping sheet for SAP Table to Datawarehouse Tables
- Python + SQL data extraction, validation, and load scripts
- Unit testcase results.
- Power BI dashboard, with all reporting KPI's.

High level flow:



Key Components in the Flow:

1. **SAP ERP**: The source system where all transactional data (orders, shipments, deliveries, etc.) resides.
2. **ETL Process**: Extracts, transforms, and loads data from SAP into a structured SQL database.
3. **Data Warehouse**: A central repository where all cleaned, transformed data is stored and queried for analysis.
4. **Analytics & Reporting Tools**: Business Intelligence tools where insights are visualized, and reports are generated.

SAP ERP Data Integration

SAP ERP provides several modules that are relevant for order fulfillment and delivery tracking, such as Sales and Distribution (SD), Materials Management (MM), and Warehouse Management (WM). The key challenge here is extracting the relevant data from these modules and integrating it into a SQL database for analysis.

Relevant SAP ERP Data:

From SAP, you'll need to pull data from these tables (or views) relevant to the project:

- **Sales Orders**:
    - **VBAK (Sales Document: Header Data)**: Contains order details such as order date, customer, order status.
    - **VBAP (Sales Document: Item Data)**: Contains data related to individual items in the order.
- **Shipping & Delivery**:
    - **LIKP (Delivery: Header Data)**: Contains delivery details such as shipping date, delivery status.
    - **LIPS (Delivery: Item Data)**: Contains details about the delivered items.
    - **VTTK (Shipment: Header Data)**: Shipment details including carrier and shipment status.
    - **VTTP (Shipment: Item Data)**: Details related to the shipping items.
- **Inventory and Stock Management**:
    - **MARA (Material Master)**: Information about products.
    - **MKPF (Document Header)**: Stores transaction-related documents (related to inventory and goods movements).
- **Customer Master Data**:
    - **KNA1 (General Data in Customer Master)**: Basic customer information.

Source Table Definitions

1. Sales Order Data (SAP Tables: VBAK, VBAP)

VBAK (Sales Document: Header Data) - Contains sales order header information.

Column Name	Description
VBELN	Sales document (Order ID)
AUART	Sales document type (e.g., Standard Order)
KUNNR	Customer ID (linked to Customer Master - KNA1)
BSART	Document category (e.g., regular order)
ERDAT	Document creation date
VSBED	Shipping condition (e.g., standard delivery)
LFSTA	Delivery status (indicates if the order is delivered)
NETWR	Total order value (in document currency)
BUDAT	Posting date (used for financial documents)
AEDAT	Last change date

VBAP (Sales Document: Item Data) - Contains item-level data for sales orders.

Column Name	Description
VBELN	Sales document number (links to VBAK)
POSNR	Item number in the sales order
MATNR	Material number (Product ID)
ARKTX	Description of the item/product
KWMENG	Order quantity
NETPR	Net price per unit
KOSTL	Cost center for the item
WERKS	Plant (warehouse or location)
DISPO	Requirement type (production, sales, etc.)

2. Delivery Data (SAP Tables: LIKP, LIPS)

LIKP (Delivery: Header Data) - Contains delivery header data.

Column Name	Description
VBELN	Delivery document number (linked to sales order)
LIFNR	Vendor number (supplier or logistics provider)
WADAT	Goods issue date (shipment date)
BUDAT	Posting date
LFSTA	Delivery status (e.g., completed, in progress)
VSTEL	Shipping point (warehouse or distribution center)
SHIPTO	Ship-to party (customer or location)
ZTERM	Terms of payment
LQDAT	Delivery creation date

LIPS (Delivery: Item Data) - Contains item-level data for deliveries.

Column Name	Description
VBELN	Delivery document number (links to LIKP)
POSNR	Item number in the delivery
MATNR	Material number (Product ID)
LFIMG	Delivery quantity (shipped quantity)
VSTEL	Shipping point (links to LIKP)
WERKS	Plant or warehouse where goods are dispatched
CHARG	Batch number (if applicable)
MEINS	Unit of measure for quantity
LFDAT	Delivery date

3. Shipment Data (SAP Tables: VTTK, VTTP)

VTTK (Shipment: Header Data) - Contains shipment-level details.

Column Name	Description
VSTEL	Shipping point or plant (warehouse)
VBELN	Sales document or delivery document (linked to sales order)
SHIP_ID	Shipment ID
SHIPMENT_DATE	Actual shipment date
ETD	Estimated time of departure
ETA	Estimated time of arrival
LFSTA	Shipment status (e.g., delivered, in transit)

VTTP (Shipment: Item Data) - Contains item-level shipment data.

Column Name	Description
SHIP_ID	Shipment ID (links to VTTK)
VBELN	Sales order or delivery document (links to sales order)
POSNR	Item number (links to delivery)
MATNR	Material number (Product ID)
LFIMG	Quantity shipped
LFDAT	Delivery date

4. Delivery Status (SAP Tables: VTTK, VTTP, LIKP)

You can track the delivery status using SAP's **VTTK**, **VTTP**, and **LIKP** tables, which store information regarding shipment status and updates. For example:

Column Name	Description
SHIP_ID	Shipment ID (linked to VTTK and VTTP)
LFSTA	Delivery status (status of shipment, such as delivered, in-transit, etc.)
LFDAT	Actual delivery date
STATUS_TEXT	Status text description (e.g., "Delivered", "In Progress", "Pending")
STATUS_TIMESTAMP	Timestamp of when the status was updated

5. Carriers (SAP Table: LFA1)

If the carrier information is required (for example, for shipment analysis or performance monitoring), you can pull this data from SAP's **LFA1** table, which contains vendor (carrier) details.

Column Name	Description
LIFNR	Vendor number (Carrier ID)
NAME1	Vendor name (Carrier name)
STRAS	Vendor address
ORT01	City (Vendor location)
TELF1	Telephone number (Carrier contact information)
SMTP_ADDR	Email address (Carrier contact information)

6. Customer Data (SAP Table: KNA1)

To track customer-related details like customer ID, shipping address, etc., you can refer to the **KNA1** table.

Column Name	Description
KUNNR	Customer number (unique ID for each customer)
NAME1	Customer's name
STRAS	Customer's street address
ORT01	Customer's city
LAND1	Country code (Customer's country)
TELF1	Customer's phone number
EMAIL	Customer's email address

7. Delivery Analytics (Custom Table: Delivery_Analytics)

You will need a custom table to store delivery analytics data, such as delivery time, on-time performance, and delay reasons.

Column Name	Description
analytics_id	Unique ID for the record
order_id	Sales order ID (linked to VBAK)
shipment_id	Shipment ID (linked to VTTK and VTTP)
delivery_time	Time taken for the delivery (in minutes)
on_time	Whether the delivery was on time (TRUE/FALSE)
delay_reason	Reason for delay (if applicable)

Data Model Design for SQL

Once the relevant data has been extracted and transformed, the next step is to design the data model for **Order Fulfillment & Delivery Analytics**. The SQL database will serve as the analytical layer that integrates the SAP ERP data.

Table information

Customers Table: This table contains data extracted from SAP's KNA1 table

Orders Table: Pulls order details from the VBAK (Sales Order Header) and VBAP (Sales Order Item) tables in SAP.

Shipments Table: Data comes from the LIKP (Delivery Header) and LIPS (Delivery Item) tables in SAP.

Carriers Table: This table stores carrier information

Delivery_Status Table: This table tracks the status of each delivery and comes from the VTTK and VTTP tables in SAP.

DDLs

DataModel-DDLs.sql

Explanation of Key Fields in Each Table:

- **Customers Table**: Stores customer data such as name, email, phone, address, etc. The customer_id is the primary key.
- **Orders Table**: Stores header-level data of orders like order_id, customer_id, order_date, order_status, etc.
- **Order_Items Table**: Stores item-level details for each order, including order_id, product_id, order_quantity, and unit_price.
- **Shipments Table**: Stores shipment-level data such as shipment_id, order_id, carrier_id, shipment_date, tracking_number, and shipping_status.
- **Shipment_Items Table**: Stores item-level details for shipments, like product_id, shipped_quantity, and delivery_date.
- **Carriers Table**: Contains information about the carriers used for shipping.
- **Delivery_Status Table**: Tracks the status of each delivery and stores timestamps for delivery events.
- **Delivery_Analytics Table**: Stores performance metrics for delivery such as delivery_time, on_time status, and delay_reason.
- **SAP_Customers Table (Optional)**: Stores customer data pulled directly from SAP's **KNA1** table. This is useful if you want to keep customer details from the SAP system integrated into your SQL database.

Additional Considerations:

- **Indexes**: It's essential to create indexes on frequently queried columns, such as order_id, shipment_id, and customer_id to improve query performance.
- **Foreign Key Constraints**: Ensure proper foreign key relationships between the tables, as shown in the DDLs, to maintain referential integrity between entities like orders, shipments, and customers.
- **Data Types**: Adjust data types based on the actual data size. For example, change VARCHAR(100) to a larger size if the data requires more characters or use DECIMAL to represent currency values correctly.

- **Timestamps**: You may need to adjust TIMESTAMP data types based on your business needs for capturing creation, modification, and delivery timestamps.

ETL (Extract, Transform, Load) Process

Data Extraction:

- Data related to Sales Orders, Shipments, Customer Information, Financial Data, etc., is pulled from SAP tables. We can use python scripts to extract and validate the data.

Data Validation

- Data Completeness/Missing values ensure there are no missing or null values in essential fields. Mandatory Fields: Ensure that critical fields are populated.
- Data Consistency/Referential Integrity: Verify that foreign key relationships between tables are consistent. For example: Every Order should have a valid Customer.
- Format Validation: Verify dates formats, no space/special char in string column.
- Data Uniqueness: Check for duplicate recodes

Data Transform:

- Mapping SAP-specific formats to a more user-friendly structure.
- Joining tables like VBAK (Sales Order Header) and VBAP (Sales Order Item) to provide a complete view of the order.
- Aggregating shipment and delivery information by calculating delivery times, shipment statuses, and on-time delivery performance.

Data Load:

- The transformed data is loaded into an **SQL-based Data Warehouse** (e.g. MySQL).
- Tables in the warehouse are created based on the SAP data model (e.g., **Orders**, **Customers**, **Shipments**, **Delivery Analytics**).

Power BI Reporting and Analytics

After integrating SAP ERP data into the SQL system, the following analytical reports need to report on Power BI:

Key Metrics and KPIs:

1. **Order Processing Time: Calculate the time between order creation (VBAK) and shipment (LIKP).**
2. **On-Time Delivery Rate**: Percentage of deliveries that arrived on time.
3. **Average Delivery Time**: Average time taken for deliveries (shipment date to actual delivery date).
4. **Carrier Performance**: Identify the performance of each carrier in terms of delivery time.

Conclusion:

By integrating SAP ERP data with a SQL-based system, the e-commerce company can leverage detailed analytics to optimize its order fulfillment and delivery processes. This integration allows **ShopX** to:

- **Monitor and optimize order processing times**.
- **Analyze delivery performance** and identify any areas of inefficiency.
- **Make data-driven decisions** regarding shipping carriers, customer satisfaction, and inventory management.

SAP ERP provides a reliable source of data, while SQL analytics enables powerful insights into operational performance, helping to improve customer experience and reduce costs.