



SUPPLY CHAIN AND INVENTORY MANAGEMENT

Data Analysis Project

Track:
Data Analysis Specialist

Group:
GIZ1-DAT1-G4E

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Meet The Team:

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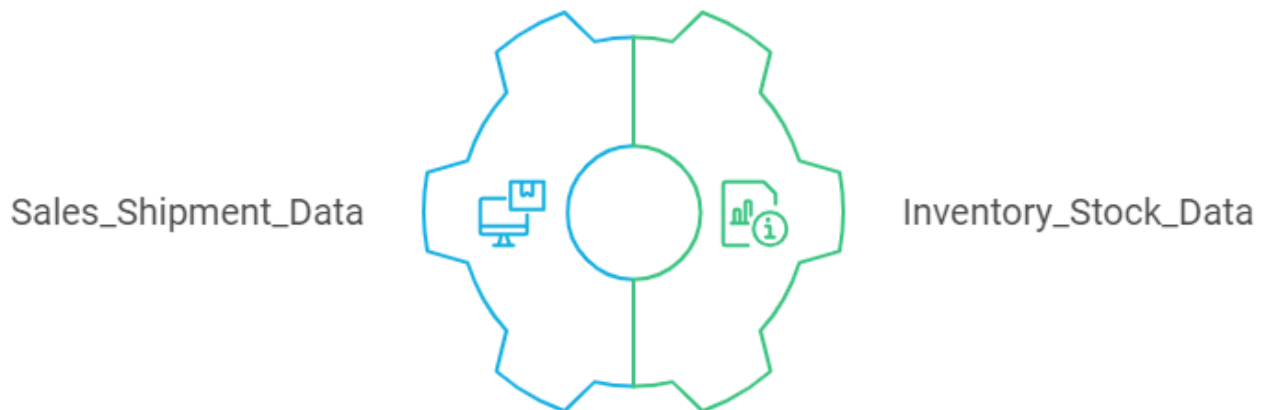
Project Summary and Workflow

1. Introduction

This project focuses on analyzing supply chain and inventory management using data-driven insights. Our main objectives are to track trends, improve processes, and understand how factors like shipping modes, product classes, and customer segments influence inventory performance.

2. Data Sources

We sourced our data from Kaggle under the title "Supply Chain and Inventory Management." The dataset includes essential information on sales, shipping modes, and product classes, all of which are crucial for our analysis.



Up next, is a screenshot from (Sale_Shipment_Data) table, imported as a CSV file on Excel.

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Women's Apparel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	Product	Category	Class	Customer	Customer	Customer	Customer	Customer	Customer	Customer	Customer	Customer	Delivery St	Department	Department	Market	Order City	Order Country	Order date (DateOrders)	Order Id	Order Regi	Order Stat
2	24	Women's / Moderate	Roswell	EE, UU.	Jean	5673	Dunn	Corporate	NM	8837	Blue	88201	Late	5	Golf	LATAM	Talpaon	MÁxico	2/26/2017 17:17	53963	Central Am	Distrito Fe
3	24	Women's / Moderate	Los Angeles	EE, UU.	Rose	9723	White	Corporate	CA	1396	Silver	90024	Late	5	Golf	LATAM	Soyapango	El Salvador	2/27/2015 0:47	3908	Central Am	San Salvad
4	24	Women's / Moderate	Harvey	EE, UU.	Joshua	9511	Brady	Corporate	IL	8414	Wish	60426	Late	5	Golf	LATAM	Managua	Nicaragua	1/29/2017 4:43	52009	Central Am	Managruz
5	24	Women's / Moderate	Elmhurst	EE, UU.	Mary	3326	Smith	Corporate	IL	1269	Tawn	60126	Late	5	Golf	LATAM	Pozarica	MÁxico	1/18/2015 4:42	1179	Central Am	Veracruz
6	24	Women's / Moderate	North Las	EE, UU.	Samantha	907	Kline	Corporate	NV	6396	Blue	89030	Late	5	Golf	LATAM	San Pedro	Honduras	3/28/2017 17:36	56019	Central Am	Cortáde
7	24	Women's / Moderate	Muskogean	EE, UU.	Susan	7647	Shannon	Corporate	MI	8924	Wish	49442	Late	5	Golf	LATAM	SAo Leop	Brasil	06-05-17 15:34	60740	South Ame	Rio Grande
8	24	Women's / Moderate	Chicago	EE, UU.	Mary	7672	Smith	Corporate	IL	5958	Tawn	60632	Late	5	Golf	LATAM	Santo Dom	RepAblica	03-08-17 7:28	54620	Caribbean	Santo Dom
9	24	Women's / Moderate	Muskogean	EE, UU.	Susan	7647	Shannon	Corporate	MI	8924	Wish	49442	Late	5	Golf	LATAM	SAo Leop	Brasil	06-05-17 15:34	60740	South Ame	Rio Grande
10	24	Women's / Moderate	Hanford	EE, UU.	Mary	7733	Torres	Corporate	CA	4741	Red E	93230	Late	5	Golf	LATAM	Cienfuegos	Cuba	1/21/2017 0:52	51450	Caribbean	Cienfuegos
11	24	Women's / Moderate	Aurora	EE, UU.	Christian	6623	Turner	Corporate	CO	9865	Heat	80011	Late	5	Golf	LATAM	Novo Cruz	Brasil	02-11-15 16:35	2857	South Ame	Minas Geri
12	24	Women's / Moderate	New York	EE, UU.	Jacob	5072	Smith	Corporate	NY	5078	Brigh	10009	Late	5	Golf	LATAM	Santo Dom	RepAblica	04-08-15 10:54	6677	Caribbean	Santo Dom
13	24	Women's / Moderate	Tustin	EE, UU.	William	9053	Smith	Corporate	CA	3813	Lost f	92780	Late	5	Golf	LATAM	Consolaci	Cuba	02-07-17 10:50	52643	Caribbean	Pinar del R
14	24	Women's / Moderate	Tallahassee	EE, UU.	Adam	6889	Wright	Corporate	FL	5597	Silen	32303	Late	5	Golf	LATAM	Bayamo	Cuba	2/14/2017 7:29	53113	Caribbean	Gramma
15	24	Women's / Moderate	Las Cruces	EE, UU.	Sandra	8334	Smith	Corporate	NM	1223	Heat	88005	Late	5	Golf	LATAM	Las Tunas	Cuba	4/24/2015 2:28	7749	Caribbean	Las Tunas
16	24	Women's / Moderate	Alpharetta	EE, UU.	Mary	6896	Spencer	Corporate	GA	9726	Gentl	30022	Late	5	Golf	LATAM	San AndrÁ	MÁxico	03-10-17 2:54	54744	Central Am	Veracruz
17	24	Women's / Moderate	Potomac	EE, UU.	Terry	3739	Long	Corporate	MD	1082	Gran	20854	Late	5	Golf	LATAM	Consolaci	Cuba	1/28/2017 5:14	51805	Caribbean	Pinar del R
18	24	Women's / Moderate	Chicago	EE, UU.	Linda	7322	Smith	Corporate	IL	3233	Quak	60638	Late	5	Golf	LATAM	Quetzalten	Guatemala	5/20/2015 9:26	9550	Central Am	Quezalten
19	24	Women's / Moderate	Aurora	EE, UU.	Christian	6623	Turner	Corporate	CO	9865	Heat	80011	Late	5	Golf	LATAM	Novo Cruz	Brasil	02-11-15 16:35	2857	South Ame	Minas Geri
20	24	Women's / Moderate	Cleveland	EE, UU.	Jonathan	9023	Schmidt	Corporate	OH	4571	Rusti	44130	Late	5	Golf	LATAM	Artemisa	Cuba	4/25/2015 0:53	7813	Caribbean	Artemisa
21	24	Women's / Moderate	Los Angeles	EE, UU.	Rose	9723	White	Corporate	CA	1396	Silver	90024	Late	5	Golf	LATAM	Soyapango	El Salvador	2/27/2015 0:47	3908	Central Am	San Salvad
22	24	Women's / Moderate	Salina	EE, UU.	Mary	11546	Schwartz	Corporate	KS	1286	Middl	67401	Late	5	Golf	LATAM	Vacaria	Brasil	02-06-17 15:34	52588	South Ame	Rio Grande
23	24	Women's / Moderate	New Orleans	EE, UU.	Mary	5637	Wong	Corporate	LA	6449	Harvi	70117	Late	5	Golf	LATAM	LeÁn	Nicaragua	4/27/2015 12:48	7984	Central Am	LeÁn
24	24	Women's / Moderate	Endicott	EE, UU.	Mary	7698	Smith	Corporate	NY	1607	Dewy	13760	Late	5	Golf	LATAM	Vilhena	Brasil	2/17/2017 11:10	53329	South Ame	RondÁ nie
25	24	Women's / Moderate	Pittsfield	EE, UU.	Mary	10891	Smith	Corporate	MA	5463	Heat	1201	Late	5	Golf	LATAM	Matagalpa	Nicaragua	03-11-17 5:11	54819	Central Am	Matagalpa
26	24	Women's / Moderate	Hialeah	EE, UU.	Katherine	4226	Smith	Corporate	FL	8988	Shad	33010	Late	5	Golf	LATAM	Vacaria	Brasil	02-06-17 15:55	52589	South Ame	Rio Grande
27	24	Women's / Moderate	Hanover	EE, UU.	Andrea	10693	Sparks	Corporate	PA	3993	Pleas	17331	Late	5	Golf	LATAM	Managua	Nicaragua	04-12-17 8:17	57020	Central Am	Managruz
28	24	Women's / Moderate	Opa Locka	EE, UU.	Richard	11753	Reid	Corporate	FL	9128	Little	33055	Late	5	Golf	LATAM	BrasÁ-lia	Brasil	2/26/2015 4:28	3850	South Ame	Distrito Fei

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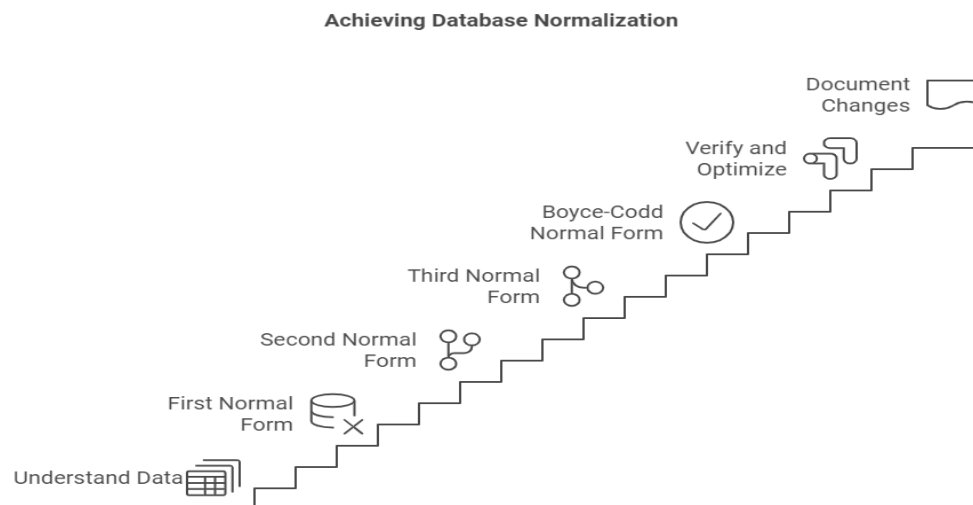
Sales Shipment Data

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****Figure 1 - (Sales_Shipment_Data) Table**

Normalization Process

We began by examining the "Sales and Shipping Data" table, which contained redundant columns. We identified primary and foreign keys and split the data into five distinct tables: Orders, Order Items, Products, Customers, and Shipping.



****As per the diagram shown above, illustrating the normalization process.**

We created the separated tables using SQL, then transferred the data from the unified table to the new columns in the new table.

```
Use [Supply_Chain];

--Creating the customers Table

CREATE TABLE Customers (
    Customer_Id INT PRIMARY KEY,
    Customer_Fname NVARCHAR(50),
    Customer_Lname NVARCHAR(50),
    Customer_Segment NVARCHAR(50),
    Customer_City NVARCHAR(50),
    Customer_State NVARCHAR(50),
    Customer_Country NVARCHAR(50),
    Customer_Zipcode INT,
    Customer_Street NVARCHAR(50)
);

Alter Table Customers Add Sales_per_customer Float;
```

Figure 2 Creating the Customers Table

```
--To only transfer one record for each Customer_Id to Customers Table

WITH UniqueCustomers AS (
    SELECT *,
        ROW_NUMBER() OVER (PARTITION BY Customer_Id ORDER BY (SELECT NULL)) AS rn
    FROM [dbo].[Sales_Shipment_Data]
)
INSERT INTO [dbo].[Customers]
(Customer_Id, Customer_Fname, Customer_Lname, Customer_Segment, Customer_City, Customer_State, Customer_Country, Customer_Zipcode, Customer_Street, Sales_per_customer)
SELECT
Customer_Id, Customer_Fname, Customer_Lname, Customer_Segment, Customer_City, Customer_State, Customer_Country, Customer_Zipcode, Customer_Street, Sales_per_customer, Sales_per_customer
FROM UniqueCustomers
WHERE rn = 1;
```

***Figure 3 Transferring the data from the unified table to the “customers” table*

Applied the previous steps to all the intended new tables.

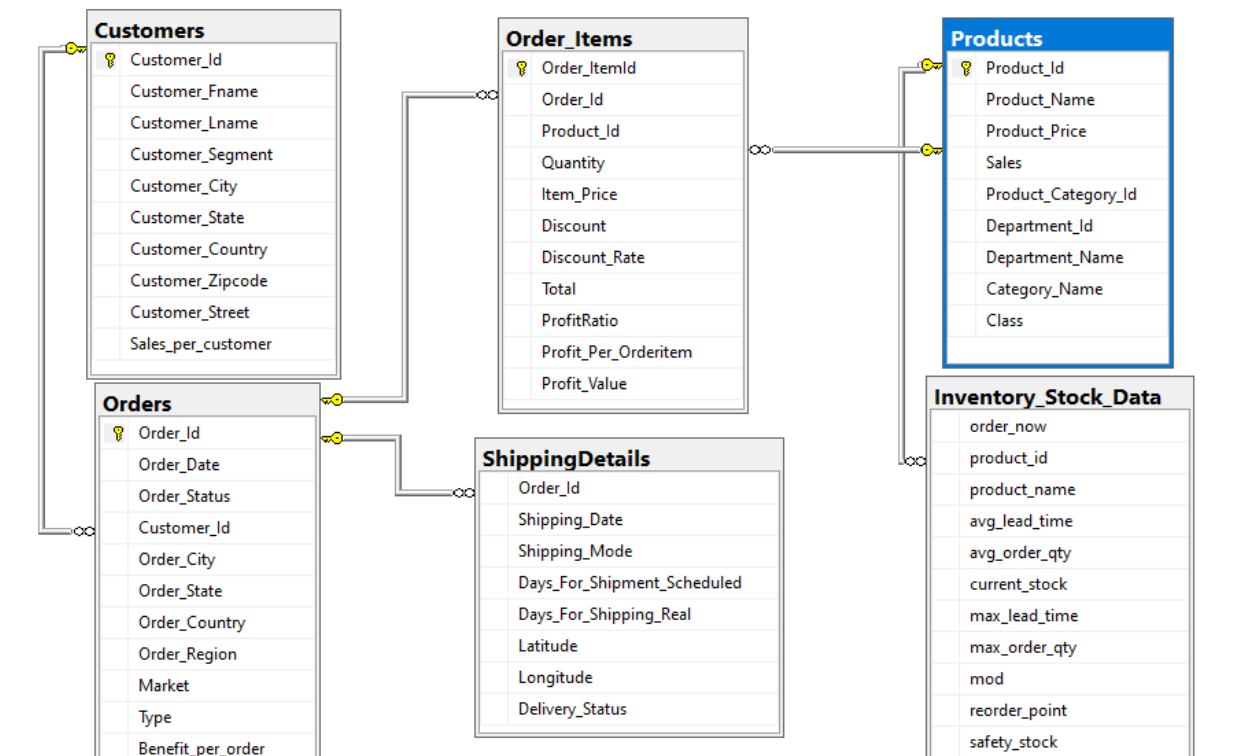
Now, we have 5 new tables and the (Inventory_Stock_Data) table.

Changes to Data Types

As we created the tables, we adjusted data types to handle decimal values and larger data types, ensuring the integrity of our data structure.

Database Diagram

We developed a database diagram by “SQL Server Management Studio” to illustrate the relationships and keys (Primary and Foreign) between the tables, facilitating a clearer understanding of our data structure.



3. Data Exploration

To be able to proceed with the data exploration, analysis and visualization, we created 2 views on SQL: (Customers_Orders_Shippings) & (Inventory_Product).

Then we explored the 2 views one at a time to check for any changes or any calculated columns to be added before proceeding with our analysis.

We connected the views to “Python”

```
import pandas as pd
import pyodbc
connection_string = 'DRIVER={ODBC Driver 17 for SQL Server};SERVER=DESKTOP-JLFVPGL;DATABASE=Supply_Chain;Trusted_Connection=yes'
conn = pyodbc.connect(connection_string)
df_customer_sales = pd.read_sql('SELECT * FROM Vw_Customers_Orders_Shipping', conn)
df_inventory_product_details = pd.read_sql('SELECT * FROM Vw_Product_Inventory', conn)
conn.close()
```

➤ Examples for some transformation applied:

Columns that return the year, month and day from the order date column.

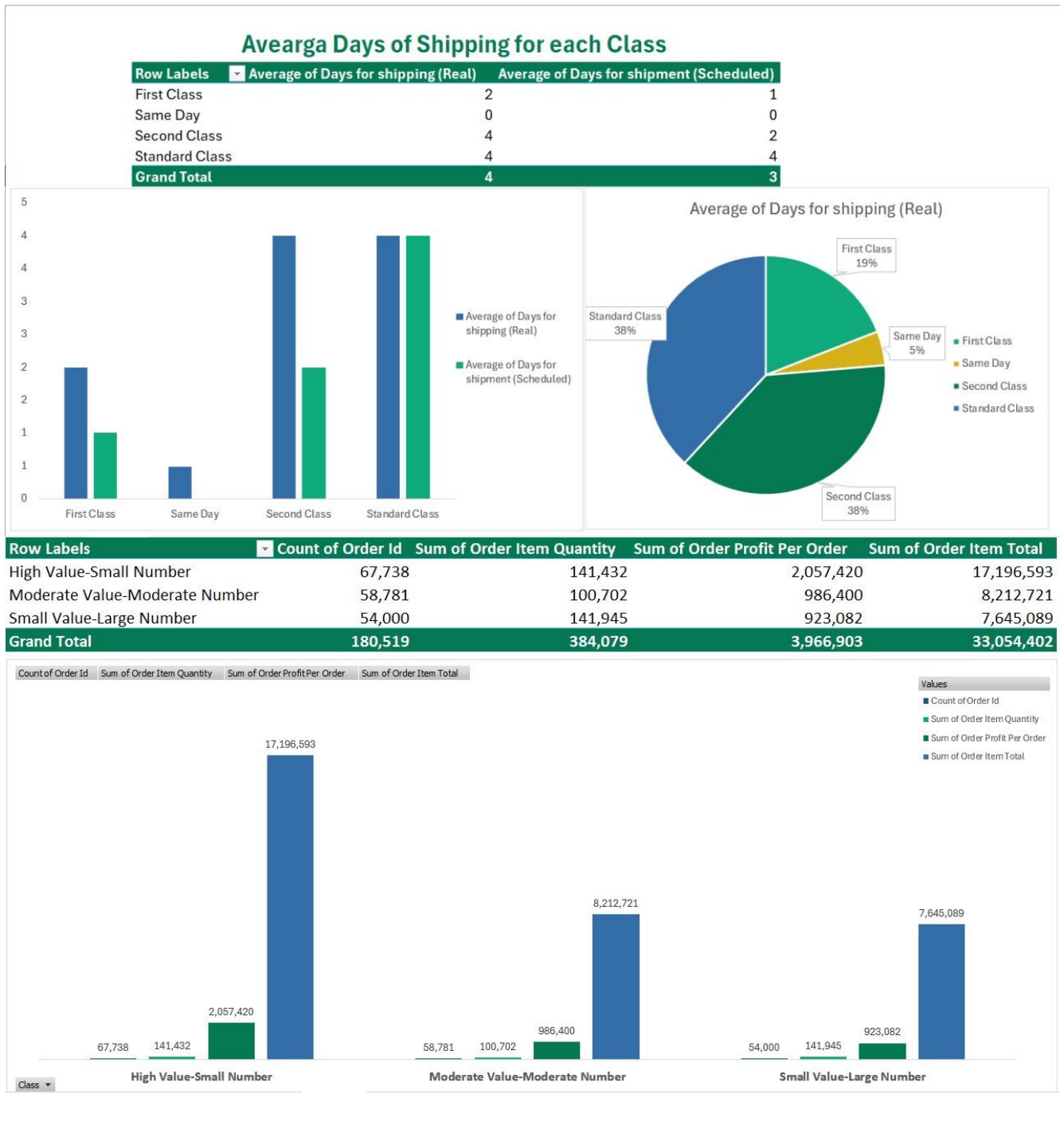
4. Analysis Focus Areas

Our initial exploration revealed critical insights regarding reorder points, lead times, current stock levels, and safety stock. We focused on identifying products that required immediate reordering due to low stock levels. Additionally, we analyzed sales aspects that impact inventory and stock management, including sales volumes and seasonality. Understanding these factors allowed us to better predict demand fluctuations and optimize inventory levels throughout the year.

Key areas of analysis included:

- Calculate high level metrics like, total sale value, total sale units, inventory value, inventory quantity, profit value, number of distinct products, number of distinct categories, number of distinct products
- Top 10 Most ordered products
- Sales units/value by time (by each week, month, year, quarter)
- Product Order quantity trend by time (by each week, month, year, quarter)
- Which shipping mode is more efficient in terms of not delaying?
- Number of orders, sales, quantity by order status.
- Inventory by class.

- As mentioned before, we worked on analyzing and exploring the data, using different tools. Here is some work done on excel.



- Moreover, we made some data analysis queries on “SQL Server Management Studio”

```
---Analysis of Shipping Modes
SELECT
    S.Shipping_Mode,
    COUNT(S.Order_Id) AS TotalShipments,
    AVG(DATEDIFF(day, O.[Order_Date], S.[Shipping_Date])) AS AvgDaysToShip
FROM
    [dbo].[ShippingDetails] S
JOIN
    Orders O ON O.Order_Id = S.Order_Id
GROUP BY
    S.Shipping_Mode
ORDER BY
    AvgDaysToShip;
```

100 %

Results Messages

	Shipping_Mode	TotalShipments	AvgDaysToShip
1	Same Day	3571	0
2	First Class	10079	2
3	Standard Class	39324	3
4	Second Class	12778	4

```
---Total Orders per region
SELECT
    O.Order_Region,
    COUNT(S.Order_Id) AS TotalOrders
FROM
    [dbo].[ShippingDetails] s
JOIN
    Orders O ON S.Order_Id = O.Order_Id
GROUP BY
    O.Order_Region
ORDER BY
    TotalOrders Desc;
```

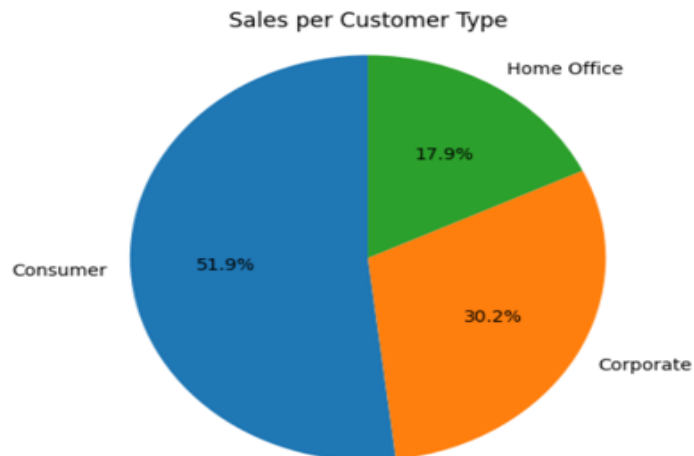
100 %

Results Messages

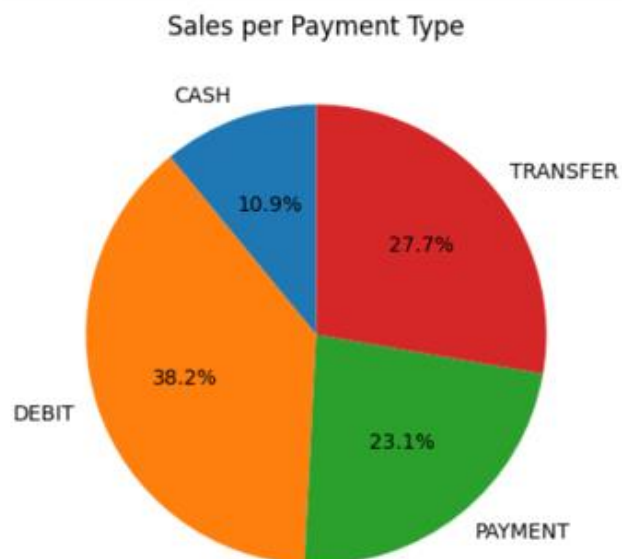
	Order_Region	TotalOrders
1	Western Europe	10010
2	Central America	9396
3	South America	4979
4	Oceania	4362
5	Southeast Asia	4356
6	Northern Europe	3716
7	Southern Europe	3543
8	South Asia	3335
9	Eastern Asia	3318
10	Caribbean	2806

- And using “Python” as well.

```
sales_by_customer_type = df_customer_sales.groupby('Customer_Segment')['Order_ID'].nunique().reset_index(name='Distinct_Order_Count')
plt.figure(figsize=(5, 5))
plt.pie(sales_by_customer_type['Distinct_Order_Count'],
        labels=sales_by_customer_type['Customer_Segment'],
        autopct='%1.1f%%',
        startangle=90)
plt.title('Sales per Customer Type')
plt.axis('equal')
plt.show()
```



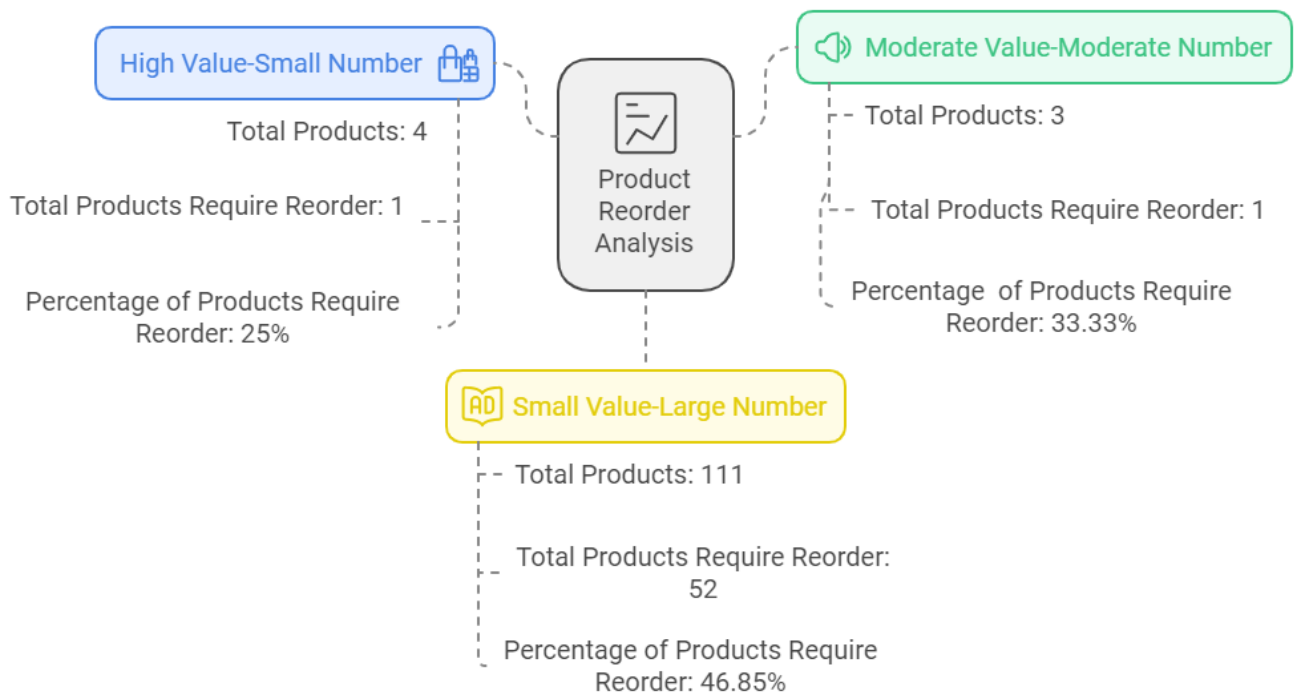
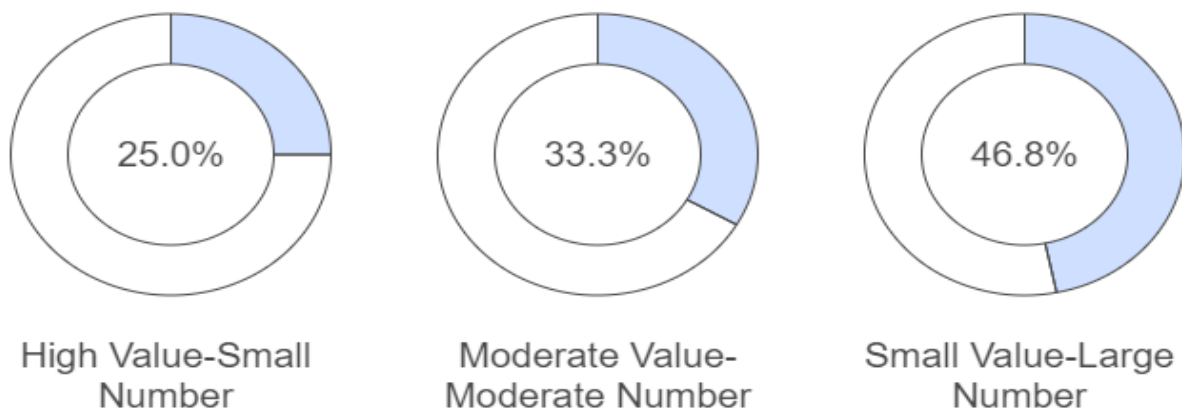
```
sales_by_Payment_type = df_customer_sales.groupby('Type_of_Payment')['Total'].sum()
plt.figure(figsize=(5, 5))
sales_by_Payment_type.plot(kind='pie', autopct='%1.1f%%', startangle=90)
plt.title('Sales per Payment Type')
plt.ylabel('')
plt.show()
```



5. Key Findings

We discovered significant trends related to products class, their sales volumes and their impact on inventory management accordingly. Visuals such as charts and graphs support our findings.

Reorder Requirements by Product Class



For more consolidated visuals we created dashboards on Tableau.

These dashboards included all the insights correlated to the supply chain and inventory management process.

6. Challenges and Limitations

Throughout the analysis, we faced challenges related to data completeness. Additional data on:

- freight costs.
- shipping methods.
- Stockouts history.
- Inventory holding cost.

The presence of such data would have enhanced our evaluation of suppliers and the inventory process.

7. Recommendations and Actionable insights

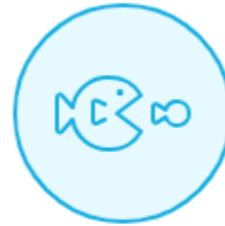
As per the products classification, there are some that return high profit and others of smaller value but get ordered the most.

Which product class to prioritize for reorder?



High Value

Focus on premium products



Small Value

Address high volume needs

- In the dataset, there is a column “Class” and here is a walkthrough what it represents as it is crucial to the supply chain and inventory performance:

1. High Value - Small Number (A-Class Items)

- These are the most expensive or high-value items but are usually few in number (i.e., low volume).
- These items contribute the most to the total inventory value.
- Usually about 10-20% of the items, but they account for about 70-80% of the value.
- Require tight control because of their high cost and criticality to the business.

2. Moderate Value - Moderate Number (B-Class Items)

- These are items with moderate value and quantity. They are of medium importance.
- Usually about 30% of the items, contributing to about 15-25% of the total value.
- Less critical than A-class items but still need efficient inventory control.

3. Small Value - Large Number (C-Class Items)

- These items are low in value but are high in quantity and volume.
 - About 50-60% of the items, but they only account for around 5-10% of the total value.
 - They are often less critical but still necessary for operations.
- One more thing noticed in the data is the sales seasonality that should be considered in the inventory management to avoid stockout during high seasons.

Delayed fulfillment hampers customer satisfaction and sales growth.

