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Costco Database Design

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https://github.com/arlingeo99/DATA_SCIENCE_PROJECTS

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Costco Database Design

Abstract

This article depicts a detailed analysis of a database design for Costco Corporation, which supports core business operations such as member management, product inventory, supplier relations, and warehouse operations. The design contains essential tables such as Members, Products, Suppliers, Orders, OrderDetails, Transactions, Inventory, Employees, and Warehouses, with clear relationships and constraints. Proposed optimizations include the addition of another table named Department to better manage employee roles and a ProductSuppliers table to manage the many-to-many relationship between products and suppliers. These enhancements will strengthen Costco's data management, ensuring future scalability and operational efficiency.

Keywords

Costco, Database Design, ER Diagram, Supply Chain, Inventory Management, Employee Roles, Database Optimization, Data Scalability

Introduction

Costco's operational success depends heavily on its ability to manage its members, inventory, and warehouse operations flawlessly. Designing an efficient and scalable database structure is essential to support their business functions, maintain member satisfaction, and streamline supply chain management. The database design proposed here assembles the core elements of Costco's business into interconnected tables, ensuring robust data flow and consistency across operations.

Mission

Costco's mission is to continually provide high-quality goods and services to its members at the lowest possible prices. The company endeavours to maintain customer satisfaction through operational efficiency and a streamlined supply chain. By aiming on a membership-driven model, Costco make sure that it provides exclusive value to its members.

Objectives

This database design of Costco plays a vital role in achieving its objectives through efficient data management, which justifies its importance in the following ways:

Objective 1: Ensure efficient supply chain management and procurement processes

- The **Suppliers Table**, allows Costco to efficiently manage its relationships with vendors, monitor supplier performance, and confirm that products are obtained at competitive prices. The ability to track supplier contracts, pricing agreements, and restocking details makes it easier to well run the supply chain operations and reduce

procurement costs. The **Inventory Table** ensures that Costco can ensure errorless monitoring of stock levels, restock products timely, and avoid overstocking or stockouts, further ensuring efficient supply chain management.

Objective 2: Provide a seamless customer experience through accurate product availability, pricing, and inventory control

- The **Products Table** and **Inventory Table** are crucial for ensuring that Costco always has accurate information on product availability and pricing. This is vital for maintaining Costco's commitment to deliver a seamless shopping experience. By tracking the stock levels in different warehouses through the **Inventory Table**, Costco ensures that members can find the products they want, whether shopping in-store or online, contributing to customer satisfaction and loyalty.

Objective 3: Maintain operational cost-effectiveness to support low-pricing models

- By using the **Orders Table**, **OrderDetails Table**, and **Transactions Table**, Costco can monitor sales trends, evaluate the success of promotions, and adjust pricing strategies in real time. This cost-effective operational management supports Costco's mission of maintaining low prices for customers. The efficient flow of data between these tables enables Costco to reduce operational costs, particularly by optimizing inventory levels and supplier agreements.

Objective 4: Enhance membership satisfaction and retention through personalized services

- The **Members Table** plays a crucial role in tracking member purchases, preferences, and types of memberships (Executive, Gold Star, Business). This data allows Costco to offer personalized promotions, rewards, and tailored marketing efforts, all aimed at improving customer experience and retaining members. The ability to track individual member interactions helps Costco increase membership satisfaction, a key driver in its membership-based business model.

Objective 5: Enable scalable and robust database architecture to support future growth and operational demands

- The proposed design is built to be scalable, allowing for the addition of more members, products, warehouses, and employees as Costco grows. The relationships between the **Orders Table**, **OrderDetails Table**, **Transactions Table**, and **Inventory Table** are designed in a way that allows for smooth scaling of operations. Introducing the **Department Table** adds more flexibility in employee role management. This scalable architecture ensures that Costco can expand its business without being obstructed by database constraints.

DATABASE DESIGN

Core Table Structure and Relationships

■ Justification for Each Table

1. Members Table:

The Members table holds critical information about Costco's customers, their contact details, and membership type (Executive, Gold Star, Business). This is essential for tracking purchases, issuing rewards, and providing personalized services.

2. Products Table:

This table contains product information like name, description, price, and stock quantity. It's linked to suppliers and categories, ensuring that each product has a supplier and fits into a specific category.

3. Suppliers Table:

Holding supplier details, this table ensures Costco can track where products come from, who to contact for procurement, and supplier performance.

4. Orders Table:

Orders capture customer transactions, storing details about the date, member ID, and status (pending, shipped, delivered). This table allows Costco to monitor order trends and fulfillment efficiency.

5. Order Details Table:

This table act as a bridge between Orders and Products, the Order Details table tracks the quantity and price of each product within an order.

6. Inventory Table:

The Inventory keep track of the product availability at different warehouse locations, including when they were last restocked.

7. Employees Table:

This table stores employee details, including their roles and department. It's linked to the Warehouses table through the ManagerID, identifying which employee manages which warehouse.

8. Transactions Table:

Every order generates a financial transaction. The Transactions table captures payment method (cash, card), transaction date, and amount.

9. Warehouses Table:

This table stores each location's capacity, manager, and contact details, ensuring Costco can manage inventory distribution effectively.

10. Categories Table:

Categories organize products into logical groups, making it easier for Costco to manage inventory and provide users with accurate, categorized listings.

■ Key Relationships

1. Members and Orders:

- **Relationship:** One-to-many
- **Explanation:** A member can place multiple orders, but each order is associated with only one member.

2. Orders and Order_Details:

- **Relationship:** One-to-many
- **Explanation:** Each order can contain multiple products (order details), but each order detail belongs to one order.

3. Order_Details and Products:

- **Relationship:** Many-to-one
- **Explanation:** An order detail refers to a single product, but each product can be part of multiple order details.

4. Products and Categories:

- **Relationship:** Many-to-one
- **Explanation:** Each product belongs to one category, but a category can contain multiple products.

5. Products and Suppliers:

- **Relationship:** Many-to-one
- **Explanation:** Each product is supplied by one supplier, but a supplier can supply multiple products.

6. Orders and Transactions:

- **Relationship:** One-to-one
- **Explanation:** Each order is associated with one transaction, and each transaction is linked to one order.

7. Warehouses and Inventory:

- **Relationship:** One-to-many
- **Explanation:** A warehouse can store multiple products (inventory records), but each inventory record refers to only one warehouse.

8. Products and Inventory:

- **Relationship:** One-to-many
- **Explanation:** A product can be stored in multiple warehouses, but each inventory record refers to only one product.

9. **Warehouses and Employees:**

- **Relationship:** One-to-many
- **Explanation:** A warehouse can have multiple employees, but each employee is associated with only one warehouse.

10. **Employees and Warehouses (via ManagerID):**

- **Relationship:** One-to-one (1:1)
- **Explanation:** Each warehouse has one designated manager (employee), and each employee can manage only one warehouse.

Proposed Optimization of the current database design: Department Table

Currently, the relationship between employees and warehouses assigns each employee as a manager. However, not all employees should be managers. To resolve this, I suggest adding a Department Table to define different roles and ensure that only some employees manage warehouses.

Department Table Structure:

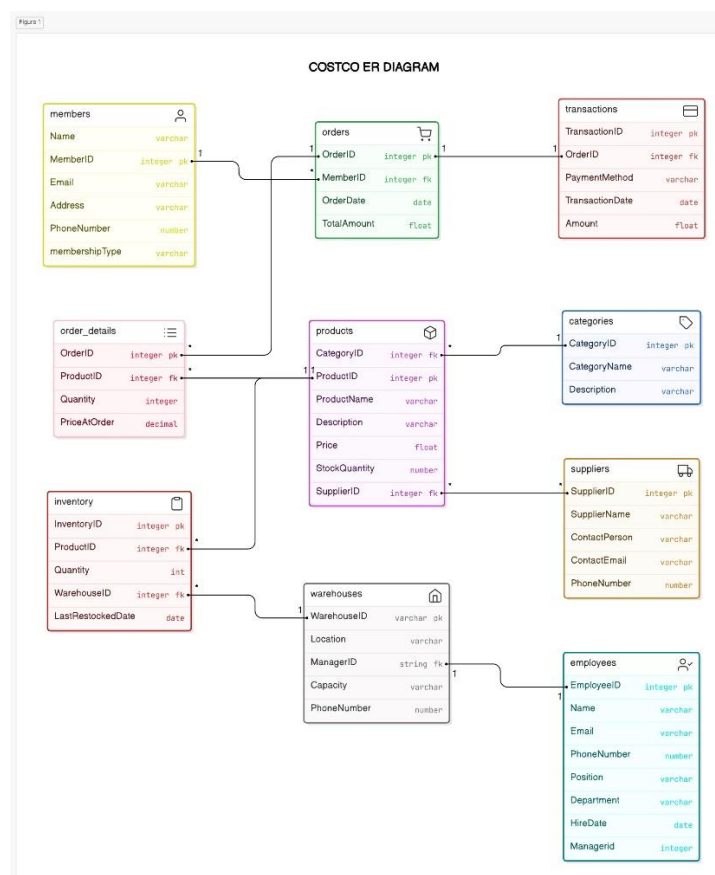
1. DepartmentID (Primary Key)
2. DepartmentName (e.g., Sales, Logistics, Management, etc.)
3. ManagerID (Foreign Key from Employees table)

By linking the Employees table to this Department table, only designated employees (with the ManagerID) would be linked to warehouse management, while others could be associated with various roles and departments. This avoids the assumption that all employees are managers.

ER Diagram

This ER diagram represents the database structure for Costco, showcasing relationships between various entities:

- **Members:** Contains details like name, email, address, phone number, and membership type, linked to the orders table through MemberID.
- **Orders:** Tracks each order's ID, date, member ID, and total amount, connected to order_details, transactions, and members.
- **Order Details:** Holds specific order information, such as the product ID, quantity, and price at the time of order, linked to products.
- **Products:** Stores product details, including price, stock quantity, category, and supplier, connected to both order_details and inventory.
- **Inventory:** Manages product stock levels at various warehouses, linking WarehouseID and ProductID.
- **Warehouses:** Consist of warehouse locations and information about their capacity and management, connected to inventory and employees.
- **Employees:** Lists employee information, including their name, position, and department, linked to warehouses through ManagerID.
- **Transactions:** Tracks payment and transaction details related to each order.
- **Suppliers:** Manages supplier details, linked to products.
- **Categories:** Stores product categories, linked to products.



APPENDIX

A. TABLE DETAILS

1. Members

- **MemberID**: INT, Primary Key
- **FirstName**: VARCHAR(50)
- **LastName**: VARCHAR(50)
- **Email**: VARCHAR(100)
- **City**: VARCHAR(50)
- **PhoneNumber**: NUMBER
- **MembershipType**: VARCHAR(50)

2. Orders

- **OrderID**: INT, Primary Key
- **MemberID**: INT, Foreign Key referencing Members(MemberID)
- **OrderDate**: DATE
- **TotalAmount**: DECIMAL(10, 2)
- **Status**: VARCHAR(50)

3. Suppliers

- **SupplierID**: INT, Primary Key
- **SupplierName**: VARCHAR(100)
- **ContactPerson**: VARCHAR(50)
- **PhoneNumber**: NUMBER
- **Email**: VARCHAR(100)
- **Address**: VARCHAR(255)

4. Categories

- **CategoryID**: INT, Primary Key
- **CategoryName**: VARCHAR(50)
- **Description**: TEXT

5. Products

- **ProductID**: INT, Primary Key
- **ProductName**: VARCHAR(50)
- **Description**: TEXT
- **UnitPrice**: DECIMAL(10, 2)

- **QuantityInStock:** INT
- **SupplierID:** INT, Foreign Key referencing Suppliers(SupplierID)
- **CategoryID:** INT, Foreign Key referencing Categories(CategoryID)

6. Transactions

- **TransactionID:** INT, Primary Key
- **OrderID:** INT, Foreign Key referencing Orders(OrderID)
- **TransactionDate:** DATE
- **PaymentMethod:** VARCHAR(50)
- **Amount:** DECIMAL(10, 2)

7. Inventory

- **InventoryID:** INT, Primary Key
- **ProductID:** INT, Foreign Key referencing Products(ProductID)
- **WarehouseID:** INT, Foreign Key referencing Warehouses(WarehouseID)
- **QuantityAvailable:** INT
- **LastRestockedDate:** DATE

8. Employees

- **EmployeeID:** INT, Primary Key
- **FirstName:** VARCHAR(50)
- **LastName:** VARCHAR(50)
- **Email:** VARCHAR(100)
- **PhoneNumber:** NUMBER
- **Department:** VARCHAR(50)
- **Position:** VARCHAR(50)
- **HireDate:** DATE

9. OrderDetails

- **OrderID:** INT, Foreign Key referencing Orders(OrderID)
- **ProductID:** INT, Foreign Key referencing Products(ProductID)
- **Quantity:** INT
- **PriceAtOrder:** DECIMAL(10, 2)
- **Primary Key:** (OrderID, ProductID)

10. Warehouses

- **WarehouseID:** VARCHAR(20), Primary Key

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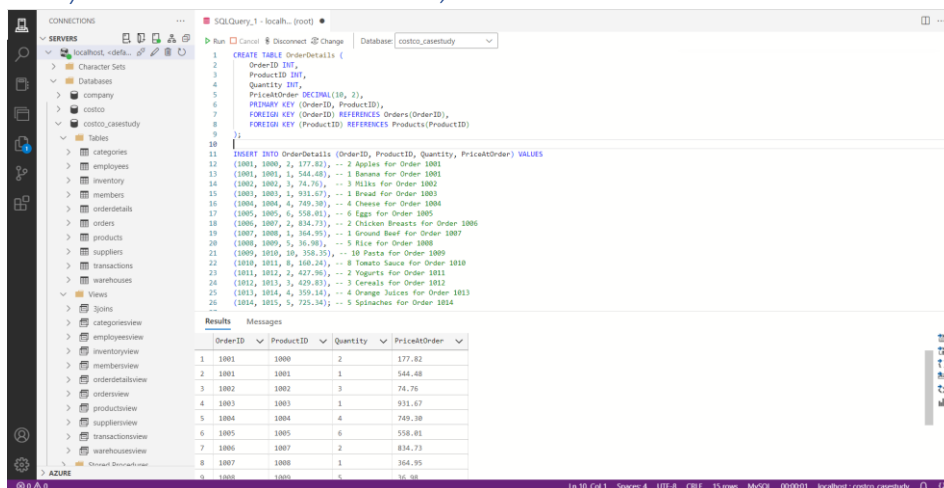
- **Location:** VARCHAR(100)
- **ManagerID:** INT, Foreign Key referencing Employees(EmployeeID)
- **Capacity:** VARCHAR(50)
- **PhoneNumber:** NUMBER

B. CREATING AND TESTING DATABASE WITH QUERIES

A database named Costco_CaseStudy has been created using all the mentioned tables, attributes and constraints, and has been populated with some sample data.

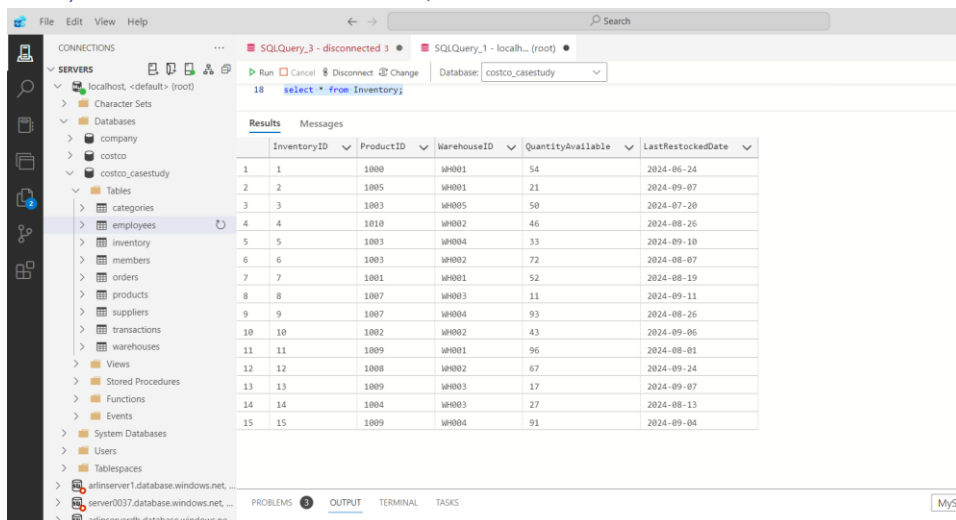
The following snapshot is the result of the SQL query

a) *SELECT * FROM OrderDetails;*



OrderID	ProductID	Quantity	PriceAtOrder
1	1001	2	177.82
2	1001	1	544.48
3	1002	3	74.76
4	1003	1	931.67
5	1004	4	749.39
6	1005	6	558.81
7	1006	2	834.73
8	1007	1	364.95
9	1008	5	16.98
10	1009	10	358.35
11	1010	8	188.24
12	1011	2	427.86
13	1012	3	429.83
14	1013	4	399.34
15	1014	5	725.34

b) *SELECT * FROM INVENTORY;*



InventoryID	ProductID	WarehouseID	QuantityAvailable	LastRestockedDate
1	1	WH001	54	2024-06-24
2	2	WH001	21	2024-09-07
3	3	WH005	50	2024-07-20
4	4	WH002	46	2024-08-26
5	5	WH004	33	2024-09-10
6	6	WH002	72	2024-08-07
7	7	WH001	52	2024-08-19
8	8	WH003	11	2024-09-11
9	9	WH004	93	2024-08-26
10	10	WH002	43	2024-09-06
11	11	WH001	96	2024-08-01
12	12	WH002	67	2024-09-24
13	13	WH003	17	2024-09-07
14	14	WH003	27	2024-08-13
15	15	WH004	91	2024-09-04

c) *JOIN and VIEW QUERY*

The following SQL join query creates a view that combines member, order, transaction, and product details, specifically for completed orders. It accurately links members to their respective orders and products through the order details, providing a comprehensive overview of completed transactions.

CREATE VIEW 4joins AS

SELECT

m.MemberID,
m.FirstName,
m.LastName,
o.OrderID,
o.OrderDate,
od.ProductID,
p.ProductName,
p.UnitPrice,
t.TransactionID,
t.TransactionDate,
t.Amount

FROM

Members m

JOIN

Orders o ON m.MemberID = o.MemberID -- Join Members with Orders

JOIN

Transactions t ON o.OrderID = t.OrderID -- Join Orders with Transactions

JOIN

OrderDetails od ON o.OrderID = od.OrderID -- Join Orders with OrderDetails

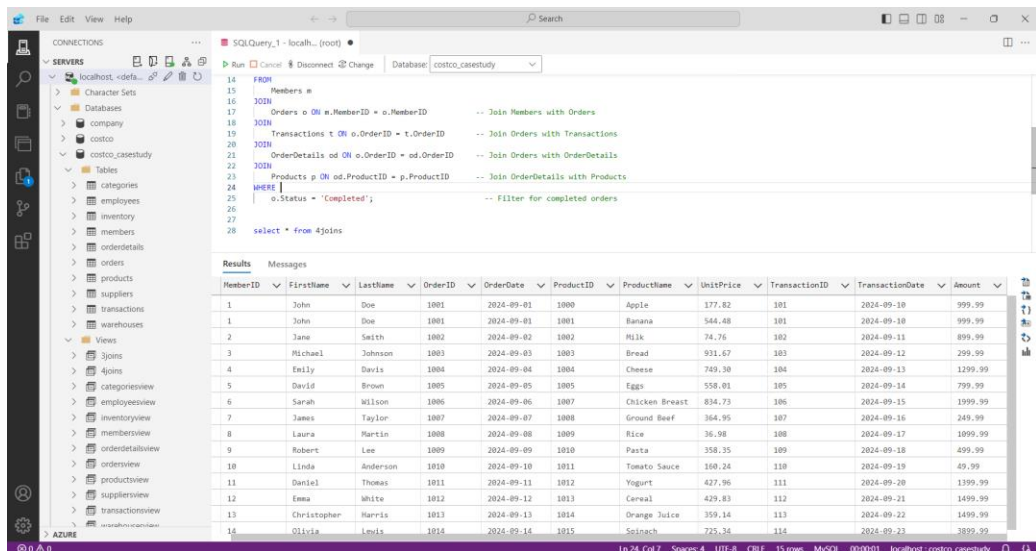
JOIN

Products p ON od.ProductID = p.ProductID -- Join OrderDetails with Products

WHERE

o.Status = 'Completed'; -- Filter for completed orders

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The screenshot shows a SQL query in SQL Server Enterprise Manager. The query is a complex JOIN query that joins the Members, Orders, Transactions, OrderDetails, and Products tables. The query filters for completed orders and returns a list of members and their orders.

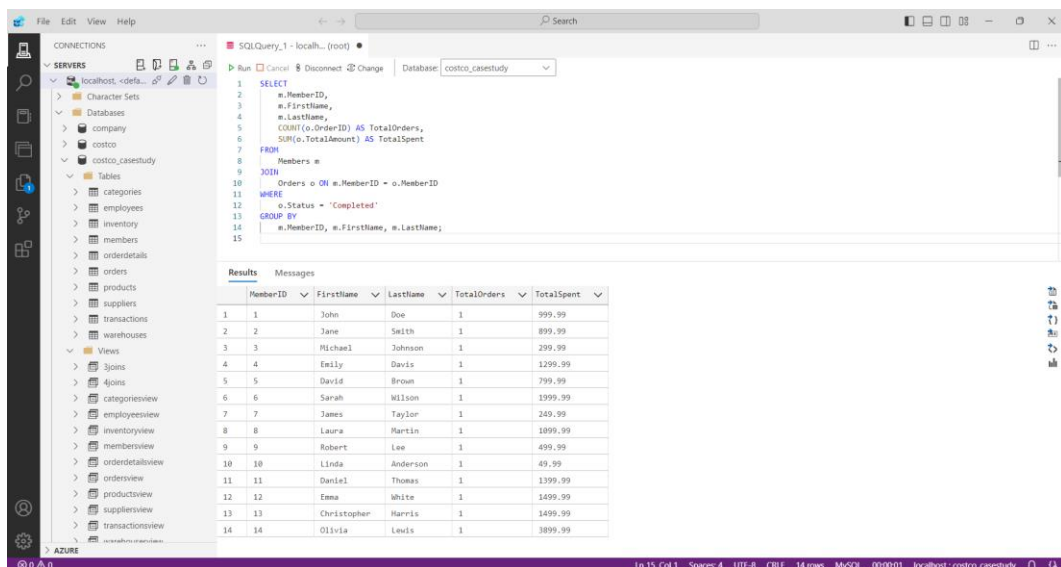
```
14 FROM
15     Members m
16 JOIN
17     Orders o ON m.MemberID = o.MemberID -- Join Members with Orders
18 JOIN
19     Transactions t ON o.OrderID = t.OrderID -- Join Orders with Transactions
20 JOIN
21     OrderDetails od ON o.OrderID = od.OrderID -- Join Orders with OrderDetails
22 JOIN
23     Products p ON od.ProductID = p.ProductID -- Join OrderDetails with Products
24 WHERE
25     o.Status = 'Completed'; -- Filter for completed orders
26
27 select * from #joins
```

The results table shows the following data:

MemberID	Firstname	Lastname	OrderID	OrderDate	ProductID	Productname	UnitPrice	TransactionID	TransactionDate	Amount
1	John	Doe	1001	2024-09-01	1000	Apple	177.82	101	2024-09-10	999.99
1	John	Doe	1001	2024-09-01	1001	Banana	544.48	101	2024-09-10	999.99
2	Jane	Smith	1002	2024-09-02	1002	Milk	74.76	102	2024-09-11	899.99
3	Michael	Johnson	1003	2024-09-03	1003	Bread	931.67	103	2024-09-12	299.99
4	Emily	Davis	1004	2024-09-04	1004	Cheese	749.30	104	2024-09-13	1299.99
5	David	Brown	1005	2024-09-05	1005	Eggs	558.01	105	2024-09-14	799.99
6	Sarah	Wilson	1006	2024-09-06	1007	Chicken Breast	834.73	106	2024-09-15	1999.99
7	James	Taylor	1007	2024-09-07	1008	Ground Beef	364.95	107	2024-09-16	249.99
8	Laura	Martin	1008	2024-09-08	1009	Rice	36.98	108	2024-09-17	1099.99
9	Robert	Lee	1009	2024-09-09	1010	Pasta	358.35	109	2024-09-18	499.99
10	Linda	Anderson	1010	2024-09-10	1011	Tomato Sauce	100.24	110	2024-09-19	49.99
11	Daniel	Thomas	1011	2024-09-11	1012	Yogurt	427.96	111	2024-09-20	1399.99
12	Emma	White	1012	2024-09-12	1013	Cereal	429.83	112	2024-09-21	1499.99
13	Christopher	Harris	1013	2024-09-13	1014	Orange Juice	359.14	113	2024-09-22	1499.99
14	Olivia	Lewis	1014	2024-09-14	1015	Spinach	725.34	114	2024-09-23	3899.99

d) GROUP BY QUERY

This SQL query calculates the total amount spent by each member on their completed orders. This query joins the Members table with Orders table to filter completed orders. This query helps to analyse the member spending behaviour within the Costco database.



The screenshot shows a SQL query in SQL Server Enterprise Manager. The query is a GROUP BY query that calculates the total amount spent by each member on their completed orders. The query joins the Members, Orders, and Transactions tables and filters for completed orders. The results are grouped by MemberID, Firstname, and Lastname.

```
1 SELECT
2     m.MemberID,
3     m.Firstname,
4     m.Lastname,
5     COUNT(o.OrderID) AS TotalOrders,
6     SUM(o.TotalAmount) AS TotalSpent
7 FROM
8     Members m
9 JOIN
10    Orders o ON m.MemberID = o.MemberID
11 WHERE
12     o.Status = 'Completed'
13 GROUP BY
14     m.MemberID, m.Firstname, m.Lastname;
```

The results table shows the following data:

MemberID	Firstname	Lastname	TotalOrders	TotalSpent
1	John	Doe	1	999.99
2	Jane	Smith	1	899.99
3	Michael	Johnson	1	299.99
4	Emily	Davis	1	1299.99
5	David	Brown	1	799.99
6	Sarah	Wilson	1	1999.99
7	James	Taylor	1	249.99
8	Laura	Martin	1	1099.99
9	Robert	Lee	1	499.99
10	Linda	Anderson	1	49.99
11	Daniel	Thomas	1	1399.99
12	Emma	White	1	1499.99
13	Christopher	Harris	1	1499.99
14	Olivia	Lewis	1	3899.99

Conclusion

The database structure designed for Costco captures the core elements of its business, ensuring efficient member management, inventory control, and warehouse operations. Adding the Department table will better represent employee roles, preventing the over-designation of employees as managers. This design not only supports current operations but also lays the foundation for future scalability as Costco continues to grow and evolve its membership-driven model.