E-commerce Database System - ERD Analysis

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1. Introduction

The Entity-Relationship Diagram (ERD) for an e-commerce system defines the database structure, outlining entities, attributes, and relationships. This analysis provides an overview of:

- **Entities and their attributes**
- **Relationships and their types (One-to-Many, Many-to-Many)**
- **Mandatory vs. Optional Relationships**

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2. Entities, Attributes, and Data Types

1. Customer

- **Primary Key**: CustomerID (string)
- **Attributes**:
    - FirstName (string)
    - LastName (string)
    - Email (string)
    - Phone (string)

2. Address

- **Primary Key**: AddressID (string)
- **Attributes**:
    - Street (string)
    - City (string)
    - State (string)
    - ZipCode (string)
    - Country (string)
    - CustomerID (Foreign Key)

3. Product

- **Primary Key**: ProductID (string)
- **Attributes**:

    - Name (string)
    - Description (string)
    - Price (float)
    - Stock (int)
    - CategoryID (Foreign Key)

4. Category

- **Primary Key**: CategoryID (string)
- **Attributes**:
    - Name (string)

5. Review

- **Primary Key**: ReviewID (string)
- **Attributes**:
    - CustomerID (Foreign Key)
    - ProductID (Foreign Key)
    - Rating (int)
    - Comment (string)

6. Order

- **Primary Key**: OrderID (string)
- **Attributes**:
    - OrderDate (date)
    - Status (string)
    - CustomerID (Foreign Key)
    - CouponID (Foreign Key, Optional)
    - DiscountID (Foreign Key, Optional)

7. OrderItem

- **Primary Key**: OrderItemID (string)
- **Attributes**:
    - OrderID (Foreign Key)
    - ProductID (Foreign Key)
    - Quantity (int)

8. Shipping

- **Primary Key**: ShippingID (string)
- **Attributes**:
    - OrderID (Foreign Key, Mandatory)
    - ShipDate (date)
    - Carrier (string)
    - TrackingNumber (string)

9. Payment

- **Primary Key**: PaymentID (string)
- **Attributes**:
    - OrderID (Foreign Key, Mandatory)
    - PaymentDate (date)
    - PaymentMethod (string)
    - Amount (float)

10. Coupon

- **Primary Key**: CouponID (string)
- **Attributes**:
    - Code (string)
    - DiscountValue (float)
    - ExpiryDate (date)

11. Discount

- **Primary Key**: DiscountID (string)
- **Attributes**:
    - Name (string)
    - DiscountPercentage (float)
    - ExpiryDate (date)

12. Warehouse

- **Primary Key**: WarehouseID (string)
- **Attributes**:
    - Location (string)

13. Inventory

- **Primary Key**: InventoryID (string)

- **Attributes**:
    - ProductID (Foreign Key)
    - WarehouseID (Foreign Key)
    - Quantity (int)

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3. Relationships and Their Types

I. Product - Inventory (1:M) [Optional-Mandatory]

- **Type:** One-to-Many (1:M)
- **Cardinality:** One Product can have multiple Inventory records (stored in different warehouses), but an Inventory record must belong to one Product.
- **Logic:**
    - Each product can be stored in multiple warehouses, but each inventory entry belongs to a single product.
    - **Mandatory (Inventory)** - An inventory entry must be associated with a product.
    - **Optional (Product)** - A product might not be in any warehouse.

II. Warehouse - Inventory (1:M) [Mandatory-Mandatory]

- **Type:** One-to-Many (1:M)
- **Cardinality:** One Warehouse can store multiple Inventory items, but each Inventory record belongs to one Warehouse.
- **Logic:**
    - A warehouse can store multiple products, but each inventory record is assigned to one warehouse.
    - **Mandatory (Inventory)** - An inventory record must belong to a warehouse.
    - **Mandatory (Warehouse)** - A warehouse must be associated with Inventory.

III. Category - Product (1:M) [Mandatory-Mandatory]

- **Type:** One-to-Many (1:M)
- **Cardinality:** One Category can have multiple Products, but each Product belongs to one Category.
- **Logic:**

- A product must be assigned to a category, but a category can exist even if it has no products.
- **Mandatory (Product)** - A product must have a category.
- **Mandatory (Category)** - A category must have products.

IV. Customer - Address (1:M) [Mandatory-Mandatory]

- **Type:** One-to-Many (1:M)
- **Cardinality:** One Customer can have multiple Addresses, but an Address belongs to one Customer.
- **Logic:**
  - A customer can have multiple addresses (e.g., home, office), but each address is linked to one customer.
  - **Mandatory (Address)** - An address must be associated with a customer.
  - **Mandatory (Customer)** - A customer must register at least one address.

V. Customer - Review (1:M) [Mandatory-Optional]

- **Type:** One-to-Many (1:M)
- **Cardinality:** One Customer can write multiple Reviews, but each Review is written by one Customer.
- **Logic:**
  - A customer may write multiple reviews for different products.
  - **Mandatory (Review)** - A review must belong to a customer.
  - **Optional (Customer)** - A customer can exist without any reviews.

VI. Product - Review (1:M) [Mandatory-Optional]

- **Type:** One-to-Many (1:M)
- **Cardinality:** One Product can have multiple Reviews, but each Review is for one Product.
- **Logic:**
  - A product may have multiple reviews from different customers.
  - **Mandatory (Review)** - A review must be linked to a product.
  - **Optional (Product)** - A product can exist without any reviews.

VII. Customer - Order (1:M) [Mandatory-Optional]

- **Type:** One-to-Many (1:M)
- **Cardinality:** One Customer can place multiple Orders, but each Order is placed by one Customer.
- **Logic:**
    - A customer can place many orders over time.
    - **Mandatory (Order)** - An order must be linked to a customer.
    - **Optional (Customer)** - A customer can exist without placing any orders.

VIII. Order - OrderItem (1:M) [Mandatory- Mandatory]

- **Type:** One-to-Many (1:M)
- **Cardinality:** One Order can contain multiple Order Items, but each Order Item belongs to one Order.
- **Logic:**
    - An order may consist of multiple items from the product catalog.
    - **Mandatory (OrderItem)** - An order item must belong to an order.
    - **Mandatory (Order)** - An order must have items.

IX. Product - OrderItem (1:M) [Mandatory-Optional]

- **Type:** One-to-Many (1:M)
- **Cardinality:** One Product can be part of multiple Order Items, but each Order Item represents one Product.
- **Logic:**
    - A product can be part of multiple orders from different customers.
    - **Mandatory (OrderItem)** - An order item must reference a product.
    - **Optional (Product)** - A product can exist without being ordered.

X. Order - Shipping (1:1) [Mandatory-Mandatory]

- **Type:** One-to-One (1:1)
- **Cardinality:** One Order can have one Shipment, and each Shipping record belongs to one Order.
- **Logic:**

- An order will have one shipping entry.
- **Mandatory (Shipping)** - A shipping entry must correspond to an order.
- **Mandatory (Order)** - An order needs a shipment records.

XI. Order - Payment (1:1) [Mandatory- Mandatory]

- **Type:** One-to-One (1:1)
- **Cardinality:** One Order will have one Payment, and each Payment belongs to one Order.
- **Logic:**
  - An order will be paid in full in one transaction.
  - **Mandatory (Payment)** - A payment must be linked to an order.
  - **Mandatory (Order)** - An order must have a payment record.

XII. Order - Coupon (M:1) [Optional-Optional]

- **Type:** Many-to-One (M:1)
- **Cardinality:** Multiple Orders can use the same Coupon, but a Coupon is not mandatory for an Order.
- **Logic:**
  - An order may or may not have a discount through a coupon.
  - **Optional (Order)** - An order might not use a coupon.
  - **Optional (Coupon)** - A coupon can exist without being used in any order.

XIII. Order - Discount (M:1) [Optional-Optional]

- **Type:** Many-to-One (M:1)
- **Cardinality:** Multiple Orders can use the same Discount type, but a Discount is not mandatory for an Order.
- **Logic:**
  - Discounts may be applied to orders as part of a promotion.
  - **Optional (Order)** - An order might not have a discount.
  - **Optional (Discount)** - A discount type can exist without being applied.

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4. ERD Diagram