SQL & ERL Design for Coffee Roaster Inc.

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Introduction

In the coffee supply chain, the coffee roasting industry is essential, turning green coffee beans into the roasted beans that serve as the basis for the fragrant drinks that 73% of Americans drink every day (National Coffee Association, 2023). A series of procedures are used at this point in the supply chain to guarantee the coffee's flavor, quality, and client delivery. These procedures include obtaining raw beans from growers or exporters, roasting, processing defects, chilling, packing, and distributing them to both B2B and B2C sectors (CareerExplorer, 2024).

Image Credits: Intercontinental Coffee Trading

Business Case Overview

Coffee Roaster Inc. is a growing American coffee roasting company that has been in the market for more than five years. While operating in Massachusetts, the company has established a strong regional presence. Now, it’s planning to expand into New York and Washington and to position itself as a premium coffee brand. This expansion involves strengthening quality control, supply chain processes, and operational efficiency.

Currently the company sources beans from exporters in Colombia, but it plans to work directly with coffee growers to achieve cost savings, traceability, and robust supplier relationships. However, problemas such as delayed payments to suppliers and equipment maintenance, have led to supply chain disruptions and delayed deliveries.

Maintaining equipment reliability, tracking batch payments, fostering strong supplier relationships, and monitoring the journeys of different batches and orders are crucial to their operational success and successful growth. Thus, the development of a new and enhanced relational database system, instead of relying on spreadsheets for each team and only trusting informal communication between teams is significant for supporting their expansion.

Entities & Attributes Identification

Suppliers

Description: Exporters and coffee growers who provide green coffee beans. The new system will help the company track and strengthen supplier relationships, leading to better supply chain efficiency, improved bean quality insights, and more favorable pricing and delivery terms.

Attributes:

- SupplierID
- SupplierName
- ContactInfo (Email & Phone)
- Country
- PaymentsDue (If there Is any payment to be made to the supplier)
- DeliveryTime (Delivery Terms)
- Rating
- SupplierCategory (Exporter or Grower)

Bean Batches

Description: Batches of green coffee beans sourced from suppliers.

Attributes:

- BeanBatchID
- OriginCountry
- BeanType
- DateOrdered
- DeliveryDate
- IsPaid (If the specific batch was already paid to the supplier)
- QualityRating
- PurchasePrice
- Quantity
- RoastStatus (Stage of the roasting journey that the specific batch Is in)

Equipment

Description: Roasting machines and packaging tools.

Attributes:

- EquipmentID
- Type (Roaster/Packaging)
- PurchaseDate
- MaintenanceSchedule
- Status (Operating/Under Maintenance)
- LastMaintenanceDate

Customers

Description: Includes both B2B clients and a small segment of B2C customers. For B2C, tracking preferences helps personalize services and analyze buying behavior.

Attributes:

- CustomerID
- CustomerName
- ContactInfo (Email & Phone)
- CustomerType (B2C/B2B)
- Address
- State
- Preferences
- OrderFrequency

Orders

Description: Ccustomer purchases and delivery statuses.

Attributes:

- OrderID
- CustomerID
- OrderDate
- OrderAmount
- DeliveryStatus (Pending/Delivered)
- PaymentStatus (Paid/Unpaid)

Roasting Batches

Description: Tracks batches of beans that were already roasted and their metrics to track batch histories and quality trends without losing credibility.

Attributes:

- BatchID
- RoastDate
- BatchSize
- Temperature (Temperature at which coffee beans are roasted)
- RoR (Rate of Rise, monitors the rate at which temperature increases in the coffee beans (User, 2024))
- Airflow (Amount of air moving through the roasting chamber during the roasting process (Yoong, 2021))
- FirstCrackTime (Signals that the beans are transitioning from raw to roasted and affect flavor development)
- SecondCrackTime (Further caramelization (*First Crack and Second Crack | Knowledge Base | Giesen Coffee Roasters*, 2021))
- EndingTemperature (Final temperature of the beans at the end of the roasting cycle)
- RoastType (RoastProfile)

Delivery Trucks

Description: Delivery vehicles that bring green coffee beans from the suppliers and deliver roasted coffee to the customers..

Attributes:

- TruckID (Primary Key)
- TruckType (String, e.g., Van/Truck)
- DeliveryRegion (String)

- MaintenanceStatus (String, e.g., Operational/Under Maintenance)
- Capacity (Integer)
- LastServiceDate (Date)

Relationships Identification

Suppliers & Bean Batches

Each supplier can provide zero or multiple batches of green coffee beans. Each batch of green beans delivered must be associated with only one supplier.

Roasting Batches & Orders

Each order from customers can include multiple roasting batches. A specific roasting batch can fulfill zero or multiple customer orders.

Roasting Batches & Bean Batches

Every roasting batch uses a specific batch of green beans as its input source and every batch of green beans output a specific roasting batch.

Customers & Orders

Each customer has the ability to place multiple orders over time, but each order is tied to only one specific customer.

Orders & Delivery Trucks

Delivery trucks have to carry at least one or multiple customer orders. Each order will leave the roasting facility and reach its destination using only one delivery truck.

Equipment & Roasting Batches

Every batch of roasted coffee will pass through multiple pieces of equipment during the production process. Each piece of machinery will participate in the roasting process for zero or multiple batches over time.

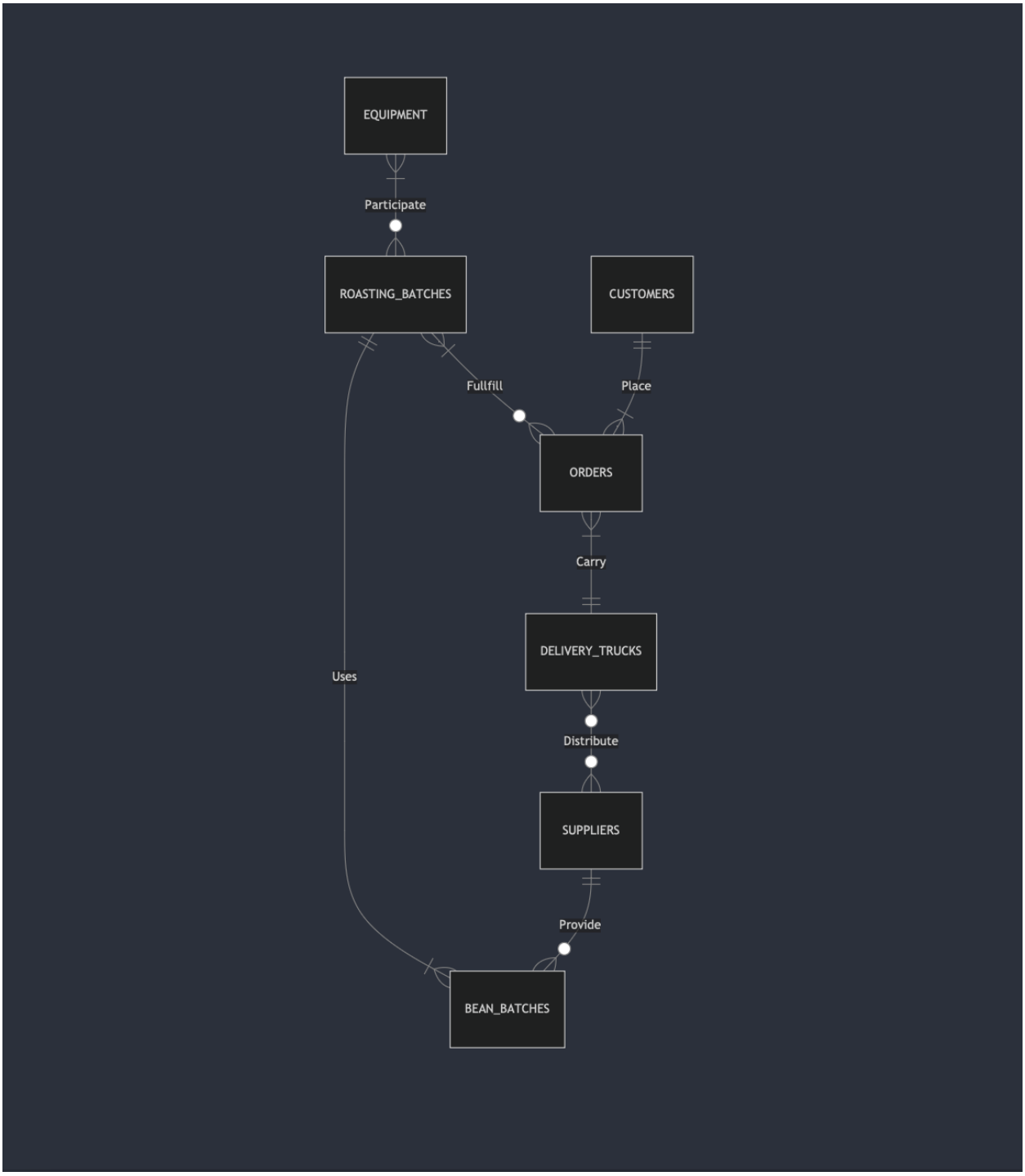
Delivery Trucks & Suppliers

Delivery trucks can pick up orders from zero or multiple suppliers. Suppliers can distribute green beans to zero multiple delivery trucks as part of their distribution process.

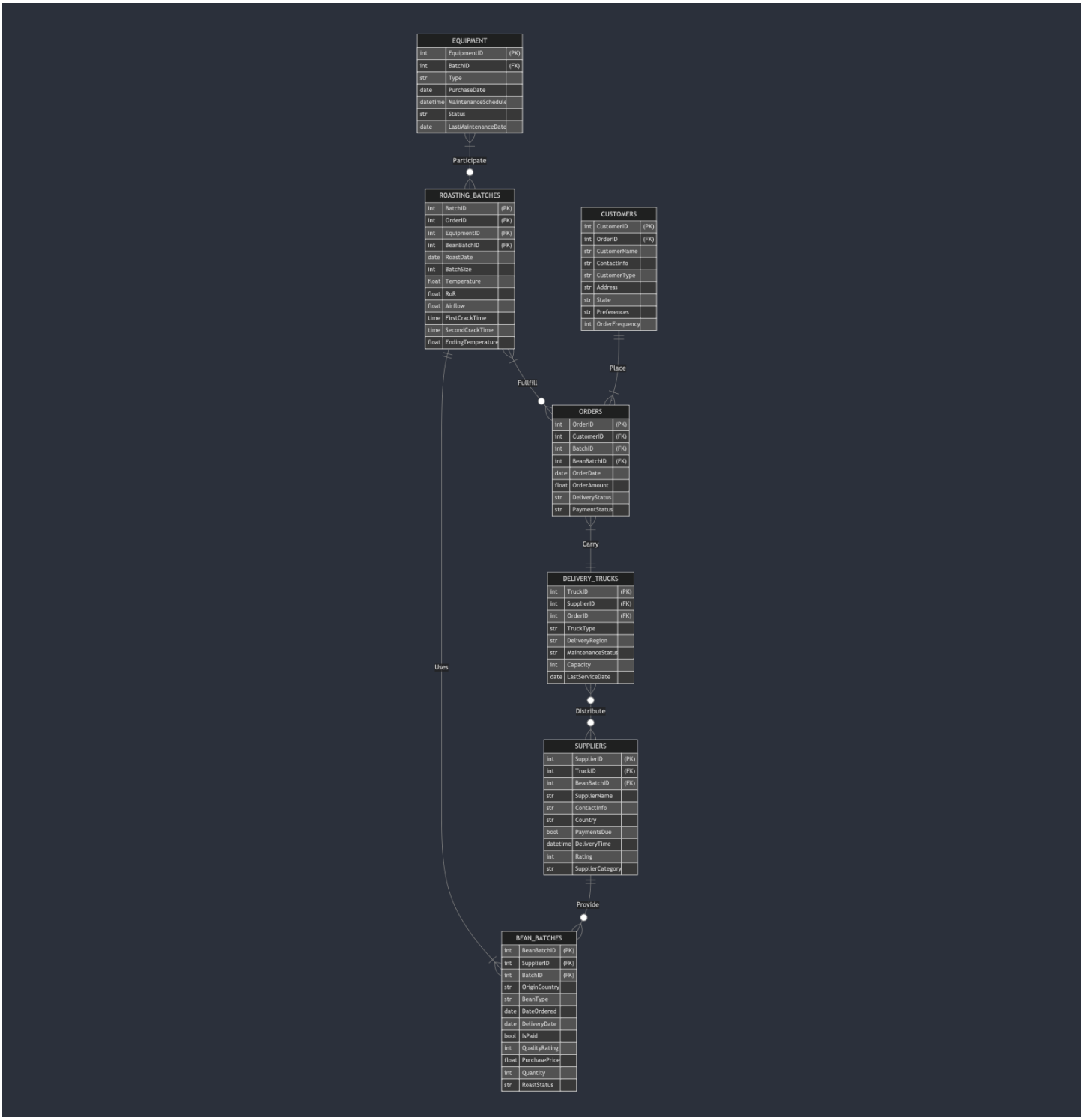
Associative Entity

The relationship between the entities Equipment and Roasting Batches is a many-to-many relationship. To ensure accurate tracking of the production stages of coffee beans and the machinery involved, the associative entity “Equipment-Roasting_Batches” will be introduced. Similarly, the relationship between Roasting Batches and Orders will be resolved through the associative entity “Roasting_Batch-Order”. Additionally, the relationship between Delivery Trucks and Suppliers will be resolved through the associative entity “Truck-Supplier”.

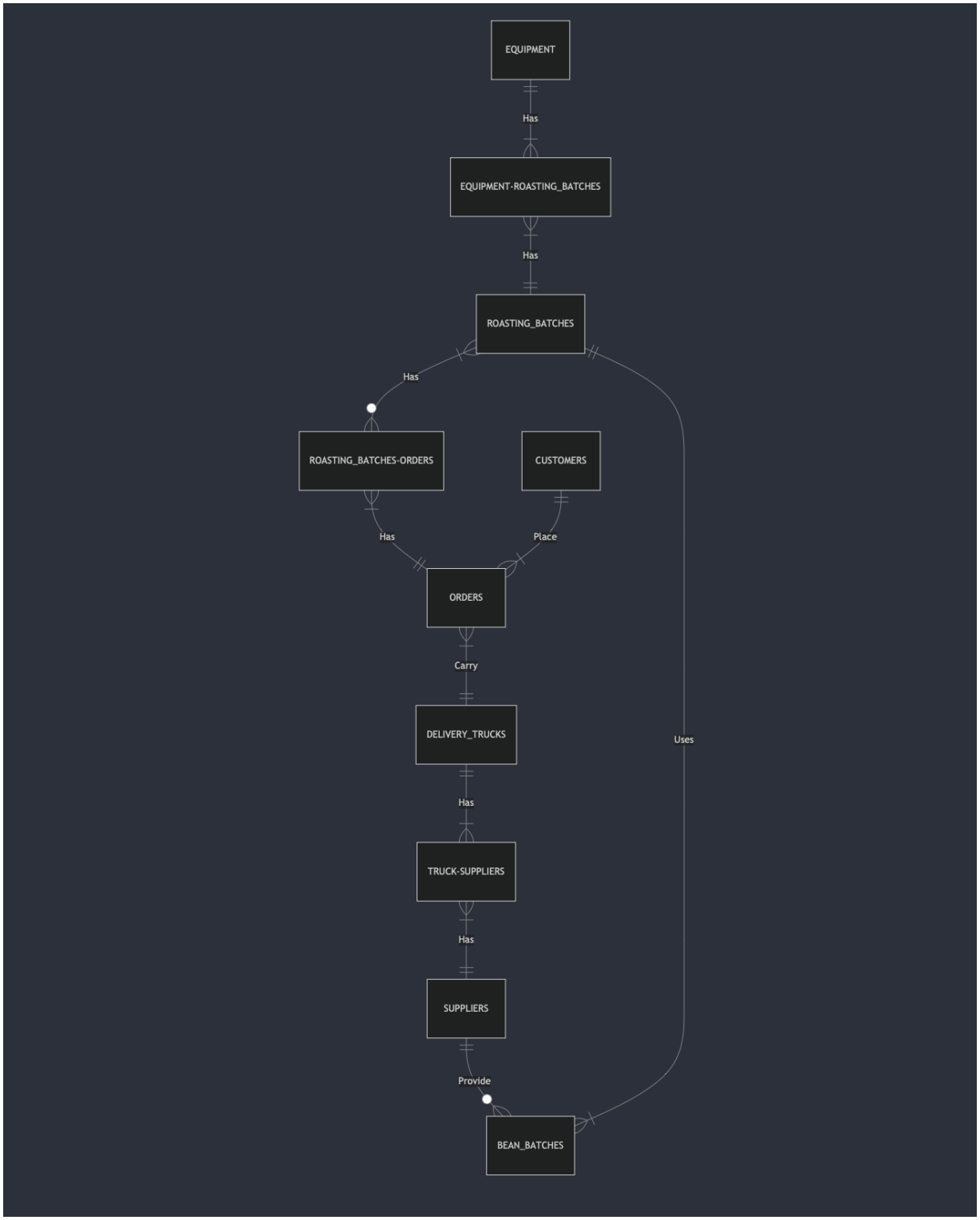
ERD Without Associative Entities:



Logical Without Associative Entities:



ERD With Associative Entities:



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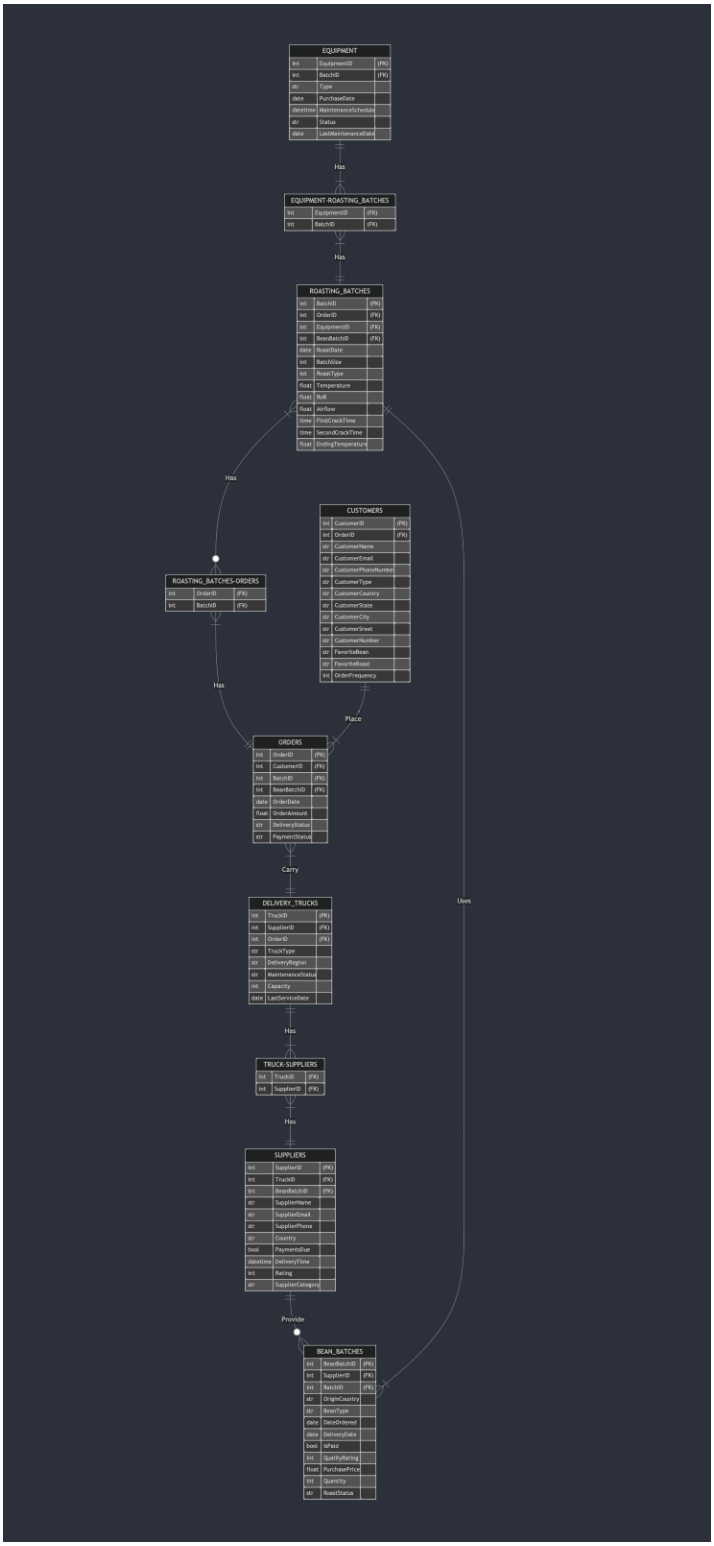

Normalization

1NF

Each record is already unique due to the presence of primary keys in all tables. To ensure compliance with 1NF by making all fields atomic and eliminating repeating groups, the "Customer Info" field was split into CustomerEmail and CustomerPhone, while the "Customer Address" was broken into separate fields: CustomerCountry, CustomerState, CustomerCity, CustomerStreet, and CustomerNumber. The Preferences column was divided into FavoriteBean and FavoriteRoast to capture distinct customer preferences. Additionally, the "ContactInfo" in the Suppliers table was split into SupplierEmail and SupplierPhone.

2NF

In the join table, only foreign keys are present; there are no additional non-key attributes. Furthermore, all non-key attributes are fully dependent on the entire composite primary key in the database.

3NF

Roasting Batches Table:

Attributes such as temperature, Rate of Rise (RoR), airflow, and ending temperature are functionally dependent on roast type. To eliminate transitive dependencies these fields will be moved into their own new table, Roast Type.

Customers Table:

In the Customers table, fields like state, street, city, and number are functionally dependent on

customer country. To resolve this, these fields will be moved into a new table called Customer Address.

Delivery Trucks Table:

The attribute delivery region is functionally dependent on truck type in the Delivery Trucks table. Delivery region will be moved to a new table named Truck Types.

Bean Batches Table:

In the Bean Batches table, the attributes quality rating and purchase price are functionally dependent on bean type. These fields will be moved to a new table called Bean Quality & Pricing.

References

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