

OPTIMIZATION OF MALWA CONFECTIONARY WORKS' DATABASE

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Client: Malwa Confectionary Works (MCW) Pvt. Ltd., Indore, India

Author Note

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BACKGROUND

Client Overview:

Malwa Confectionary Works (MCW), established in 1974 is a key market player in the manufacturing of a broad assortment of best quality toffee jars, toffee boxes, flavored candies and other packaged confectionary items. These products are highly acclaimed for their high quality, nontoxic nature, long shelf life, accurate composition and rich taste and are available at several confectionary outlets in Central and Western part of India.

Dataset Description:

We have a Vendor Management system to track vendor, raw materials that are supplied by various vendor, raw materials used for a product, raw material inventory, orders placed for raw materials in the past few months and shipping company information.

Requirement analysis-business scenario

To enhance MCW's current vendor management system by improving the existing database infrastructure, thereby boosting operational efficiency, facilitating strategic growth and driving potential business decisions.

INTRODUCTION

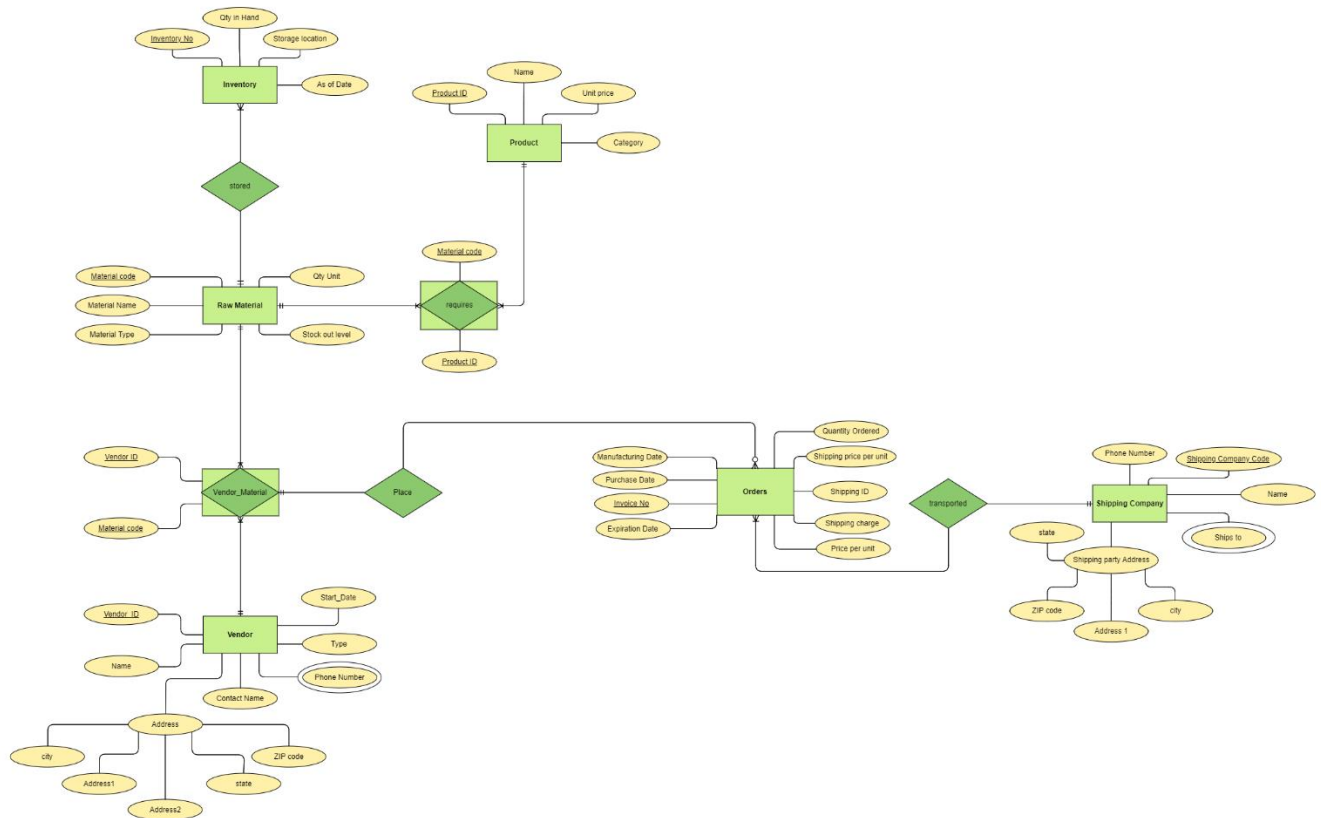
Objectives:

- ✓ Analyzing the existing vendor, raw material and product entities,
- ✓ Identifying data wrangling business rules to establish structured database that caters easy data manipulation and retrieval in terms of cost and efficiency mapping
- ✓ Modelling the realistic spreadsheet system into optimized schema and normalizing to have a secured dynamic query-based relational database system in place
- ✓ Ensuring data integrity and scalability with relationships between entities to setup the foundation for strategic optimization
- ✓ Implementing the augmented database system to diagnose reliability of vendors, reduce raw material to product price gaps and prospect new vendors that decrease overall manufacturing cost of the products

CONCEPTUAL DATA MODELLING

Entity Relationship Diagram (ERD):

We used this graphical representation to illustrate the logical structure of a database, helping to visualize the entities, the relationships between these entities, attributes associated with each entity and the cardinality of the entities.



RELATIONAL DATA MODEL

Relational Schema

We performed relational modelling representing relations and their relationships in the database along with preserving the integrity constraints.

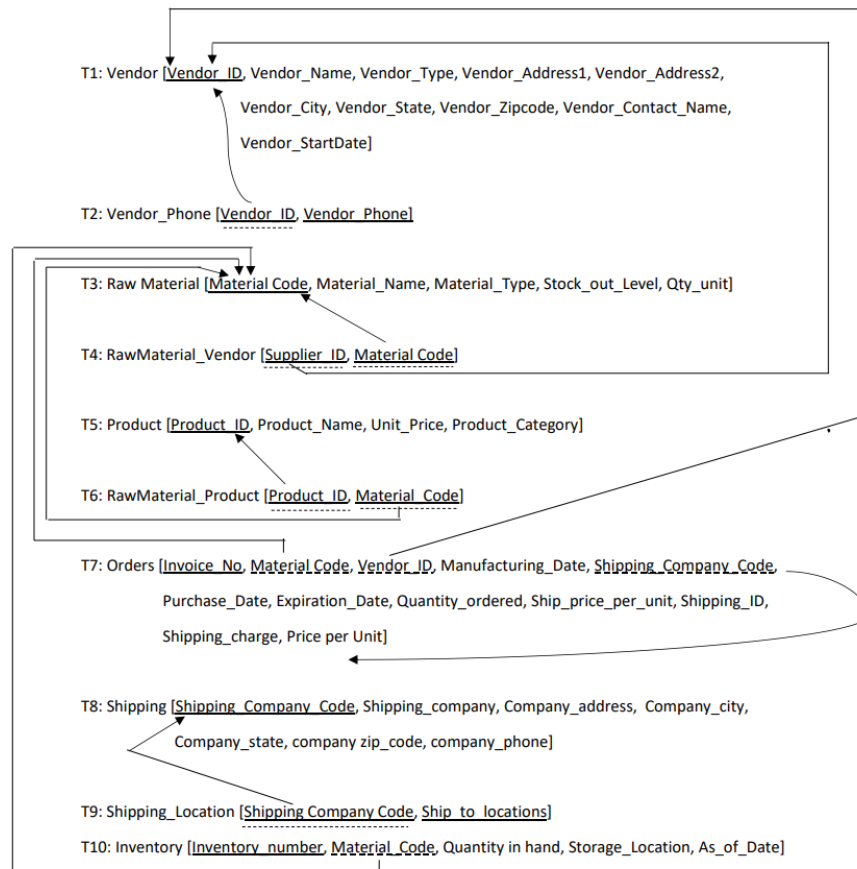


TABLE SCHEMA

Vendor	Product	Raw_Materials	Inventory	Shipping	Orders
Vendor_ID	Product_ID	Material_Code	Inventory_number	Shipping_Company_code	Invoice_No
Vendor_Name	Product_Name	Material_Name	Material_Code	Shipping_company	Purchase_Date
Vendor_Type	Product_Category	Material_type	Storage_Location	Company_address	Material_Code
Vendor_Address1	Unit_Price	Stock_out_level	Quantity in Hand	Company_city	Vendor_ID
Vendor_Address2		Qty_unit	As_of_Date	Company_state	Quantity_ordered
Vendor_City				company zip_code	Price per Unit
Vendor_State				company_phone	Shipping_Company_Code
Vendor_Zipcode					Ship_price_per_unit
Vendor_Contact_Name					Shipping_charge
Vendor_StartDate					Shipping_ID
					Manufacturing_Date
					Expiration_Date

Vendor_Phone	RawMaterial_Product	RawMaterial_Vendor	Shipping_Location
Vendor_ID	Product_ID	Material_Code	Shipping_Company_code
Vendor_Phone	Material_Code	Supplier_ID	Ship_to_locations

- **Inventory** (Inventory_number is the primary key)

1	Inventory_number	Material_Code	Storage_Location	Quantity_in_Hand	As_of_Date
2	IN263	ITM00550	Malwa Manufacturing Unit	16510.46	8/26/23
3	IN252	ITM00550	Malwa Warehouse	12348.58	8/31/23
4	IN898	ITM00974	Malwa Manufacturing Unit	24203.56	8/31/23

- **Shipping** (Shipping_Company_Code is the primary key)

1	Shipping_Company_code	Shipping_company	Company_address	Company_city	Company_state	company_zip_code	company_phone
2	SP00327	Fast Move Cargo	Lane 7, Koregaon Park	Pune	Maharashtra	411014	9437081215
3	SP00830	Delhivery	Lane 12, GT Road	Indore	Madhya Pradesh	468520	7659771101
4	SP00222	Wefast	75, Shivaji Complex, Mitra Nagar	Bhopal	Madhya Pradesh	487909	7978665511

- **Orders** (Invoice_No. is the primary key)

1	Invoice_No	Purchase_Date	Material_Code	Vendor_ID	Quantity_ordered	Price_per_Unit	Shipping_Company_Code	Ship_price_per_unit	Shipping_charge	Shipping_ID	Manufacturing_Date	Expiration_Date
2	IMW-3781	8/28/23	ITM00550	MWV00192	3400	23.12	SP00327	22	74800	H-2549	1/6/23	12/4/24
3	IMW-3760	6/5/23	ITM00550	MWV00192	8000	23.12	SP00327	22	176000	N-8710	1/2/23	12/27/24

ASSOCIATIVE TABLES

(composite primary keys)

- RawMaterial_Product

1	Product_ID	Material_Code
2	CA101	ITM00550
3	CA101	ITM00974

- RawMaterial_Vendor

1	Material_Code	Supplier_ID
2	ITM00550	MWV00192
3	ITM00974	MWV00192
4	ITM00197	MWV00649

DERIVED TABLES

- Shipping_Location (Shipping_Company_Code is the primary key)

1	Shipping_Company_code	Ship_to_locations
2	SP00327	Rajasthan
3	SP00327	Maharashtra
4	SP00830	Pan India

- Vendor_Phone (Vendor_ID is the primary key)

1	Vendor_ID	Vendor_Phone
2	MWV00298	9812345678
3	MWV00298	9856324712

NORMALIZATION

The team performed Normalization to structure a relational database in a way that reduces redundancy and minimizes issues related to data anomalies, such as update anomalies, insertion anomalies, and deletion anomalies.

The team had two tables with 0NF having multivalued attributes, which was decomposed into two separate tables in 1NF, there was no partial and transitive functional dependency and tables are in 3NF without any data anomalies:

1. Vendor to Vendor and Vendor_Phone
2. Shipping to Shipping and Shipping_Location

The team had Raw-Material to Product and Vendor mapping , which was decomposed to two associative entities to handle M:M cardinality. There was no multivalued attributes, partial and transitive functional dependency. The tables are in 3NF without any data anomalies:

1. RawMaterial_Vendor
2. RawMaterial_Product

FUNCTIONAL DEPENDENCY

Vendor_ID ---> Vendor_Name, Vendor_Type, Vendor_Address1, Vendor_Address2,
Vendor_City, Vendor_State, Vendor_Zipcode, Vendor_Contact_Name,
Vendor_StartDate

Material Code ----> Material_Name, Material_Type, Stock_out_Level, Qty_unit

Product_ID ----> Product_Name, Unit_Price, Product_Category

Invoice_No ----> Manufacturing_Date, Purchase_Date, Expiration_Date, Quantity_ordered,
Ship_price_per_unit, Shipping_ID, Shipping_charge, Price per Unit

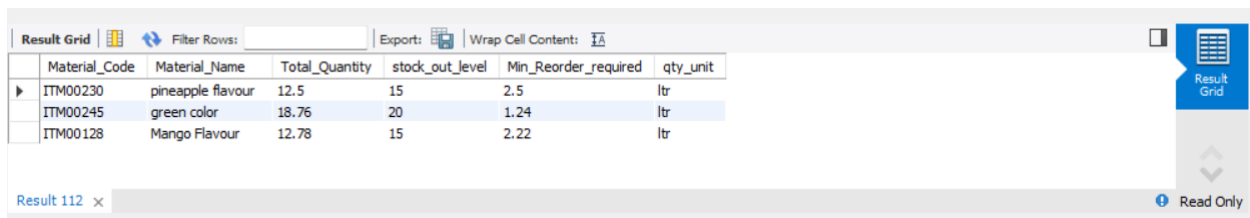
Shipping_Company_Code ----> Shipping_company, Company_address, Company_city,
Company_state, company_zip_code, company_phone

Inventory_number ----> Quantity_in_hand, Storage_Location, As_of_Date

BUSINESS QUESTIONS

1. Query to measure stock_out products

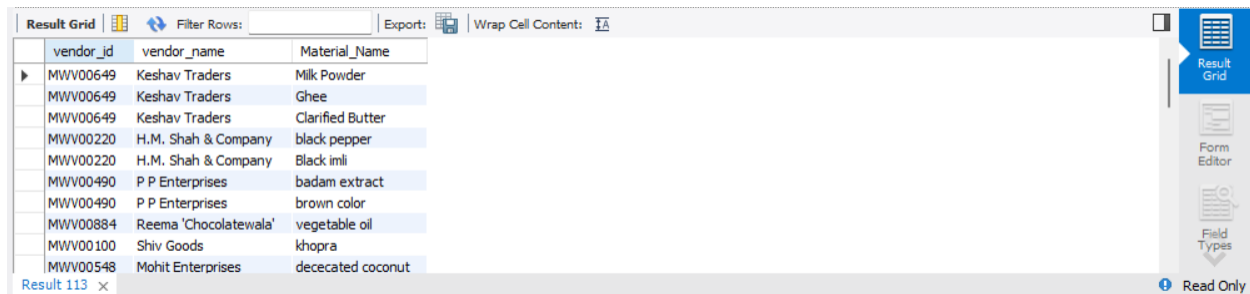
```
SELECT i.Material_Code, rm.Material_Name, SUM(i.Quantity_In_Hand) AS Total_Quantity,  
rm.stock_out_level, round(rm.stock_out_level - SUM(i.Quantity_In_Hand), 2) as  
Min_Reorder_required, rm.qty_unit  
FROM Inventory AS i  
INNER JOIN RawMaterial AS rm ON i.Material_Code = rm.Material_Code  
GROUP BY i.Material_Code, rm.Material_Name, rm.Stock_Out_Level, rm.qty_unit  
HAVING SUM(i.Quantity_In_Hand) < rm.Stock_Out_Level;
```



	Material_Code	Material_Name	Total_Quantity	stock_out_level	Min_Reorder_required	qty_unit
▶	ITM00230	pineapple flavour	12.5	15	2.5	ltr
	ITM00245	green color	18.76	20	1.24	ltr
	ITM00128	Mango Flavour	12.78	15	2.22	ltr

2. Select the vendors supplying perishable raw materials..

```
SELECT v.vendor_id, v.vendor_name, Material_Name  
FROM vendor AS v  
INNER JOIN rawmaterial_vendor AS rmv ON rmv.supplier_id = v.vendor_id  
INNER JOIN rawmaterial AS rm ON rm.material_code = rmv.material_code  
WHERE rm.Material_type = 'perishable';
```

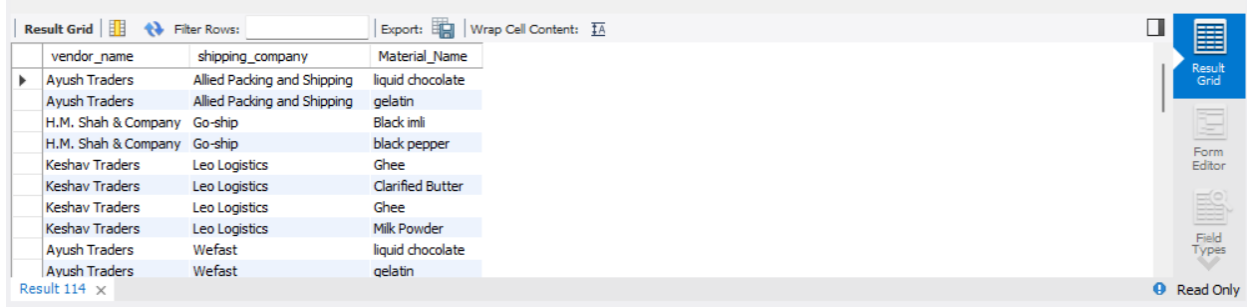


	vendor_id	vendor_name	Material_Name
▶	MWV00649	Keshav Traders	Milk Powder
	MWV00649	Keshav Traders	Ghee
	MWV00649	Keshav Traders	Clarified Butter
	MWV00220	H.M. Shah & Company	black pepper
	MWV00220	H.M. Shah & Company	Black imli
	MWV00490	P P Enterprises	badam extract
	MWV00490	P P Enterprises	brown color
	MWV00884	Reema 'Chocolatwala'	vegetable oil
	MWV00100	Shiv Goods	khopra
	MWV00548	Mohit Enterprises	deccated coconut

3. Find the names of vendors and shippers operating in the same region supplying perishable raw materials.

```
SELECT v.vendor_name, s.shipping_company, Material_Name  
FROM vendor AS v  
INNER JOIN rawmaterial_vendor AS rmv ON v.vendor_id = rmv.Supplier_ID  
INNER JOIN rawmaterial AS rm ON rm.material_code = rmv.material_code  
INNER JOIN shipping AS s ON s.Company_city = v.Vendor_City
```


WHERE rm.Material_type = 'perishable';

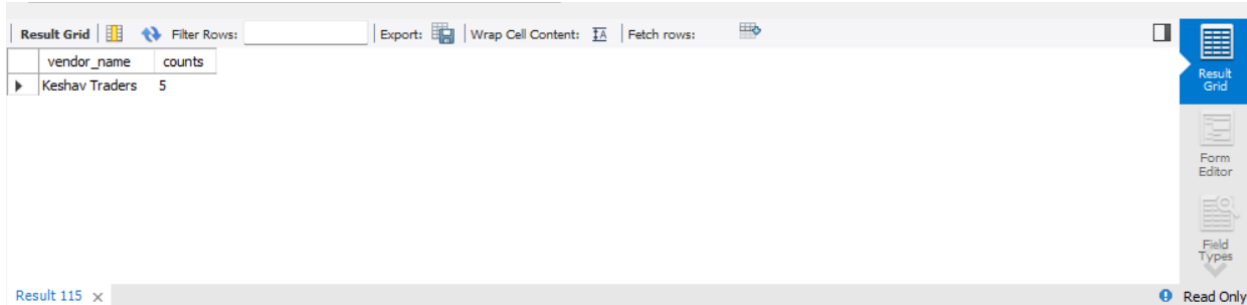


The screenshot shows a database query result grid with the following data:

vendor_name	shipping_company	Material_Name
Ayush Traders	Allied Packing and Shipping	liquid chocolate
Ayush Traders	Allied Packing and Shipping	gelatin
H.M. Shah & Company	Go-ship	Black imli
H.M. Shah & Company	Go-ship	black pepper
Keshav Traders	Leo Logistics	Ghee
Keshav Traders	Leo Logistics	Clarified Butter
Keshav Traders	Leo Logistics	Ghee
Keshav Traders	Leo Logistics	Milk Powder
Ayush Traders	Wefast	liquid chocolate
Ayush Traders	Wefast	gelatin

4. Find the name of the vendor supplying maximum number of raw materials.

```
SELECT v.vendor_name, COUNT(rm.material_name) AS counts
FROM vendor AS v
INNER JOIN rawmaterial_vendor AS rmv ON v.vendor_id = rmv.Supplier_ID
INNER JOIN rawmaterial AS rm ON rmv.material_code = rm.material_code
GROUP BY v.vendor_name
ORDER BY counts DESC
LIMIT 1;
```

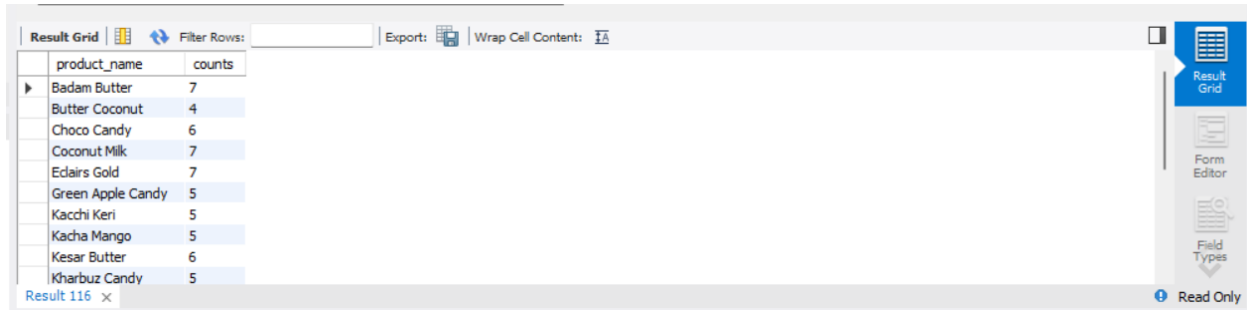


The screenshot shows a database query result grid with the following data:

vendor_name	counts
Keshav Traders	5

5. Find the products that require 3 or more raw materials.

```
SELECT p.product_name, COUNT(rm.material_name) AS counts
FROM product AS p
INNER JOIN rawmaterial_product AS rmp ON p.product_id = rmp.product_id
INNER JOIN rawmaterial AS rm ON rmp.material_code = rm.material_code
GROUP BY p.product_name
HAVING COUNT(DISTINCT rm.material_code) > 3;
```

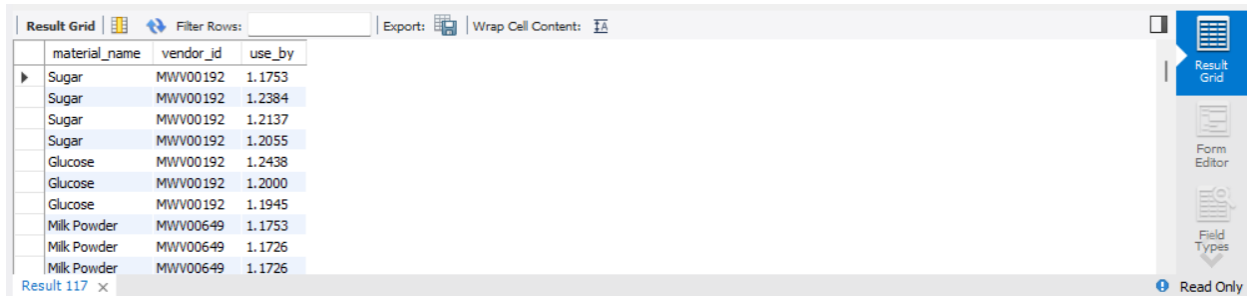


The screenshot shows a data grid with a toolbar at the top containing 'Filter Rows', 'Export', and 'Wrap Cell Content'. The grid has two columns: 'product_name' and 'counts'. It lists ten products with their respective counts. On the right side, there are buttons for 'Result Grid', 'Form Editor', and 'Field Types'. The status bar at the bottom indicates 'Result 116' and 'Read Only'.

product_name	counts
Badam Butter	7
Butter Coconut	4
Choco Candy	6
Coconut Milk	7
Edairs Gold	7
Green Apple Candy	5
Kacchi Keri	5
Kacha Mango	5
Kesar Butter	6
Kharbuz Candy	5

6. Raw Materials listed on the basis of use by date

```
SELECT rm.material_name, o.vendor_id, datediff(o.expiration_date, current_date())/365 as  
use_by from rawmaterial as rm  
INNER JOIN orders AS o ON rm.material_code = o.material_code  
where o.Manufacturing_Date > '2023-02-01';
```

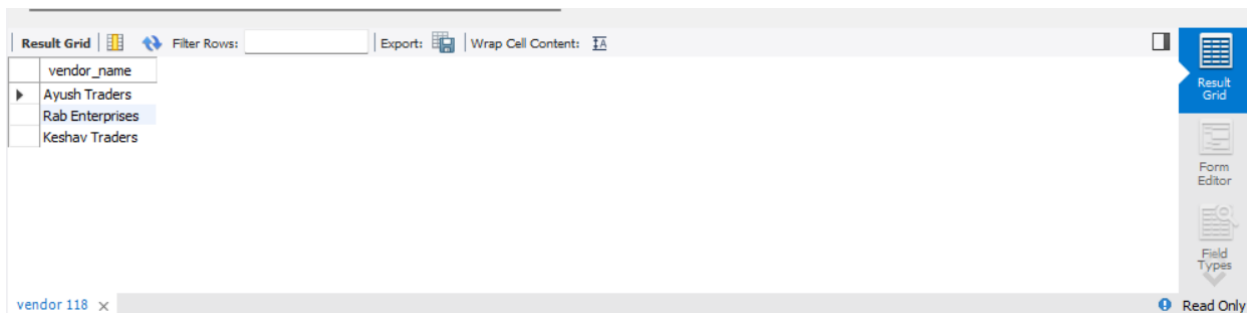


The screenshot shows a data grid with a toolbar at the top containing 'Filter Rows', 'Export', and 'Wrap Cell Content'. The grid has three columns: 'material_name', 'vendor_id', and 'use_by'. It lists ten materials with their vendor IDs and use-by dates. On the right side, there are buttons for 'Result Grid', 'Form Editor', and 'Field Types'. The status bar at the bottom indicates 'Result 117' and 'Read Only'.

material_name	vendor_id	use_by
Sugar	MWV00192	1.1753
Sugar	MWV00192	1.2384
Sugar	MWV00192	1.2137
Sugar	MWV00192	1.2055
Glucose	MWV00192	1.2438
Glucose	MWV00192	1.2000
Glucose	MWV00192	1.1945
Milk Powder	MWV00649	1.1753
Milk Powder	MWV00649	1.1726
Milk Powder	MWV00649	1.1726

7. Find the names of all Madhya Pradesh vendors who have the word “enterprises” or “traders” in their name.

```
select v.vendor_name from vendor as v  
where (v.vendor_name like "%enterprises%" or v.vendor_name like "%traders%")  
and v.Vendor_State like "M%"
```

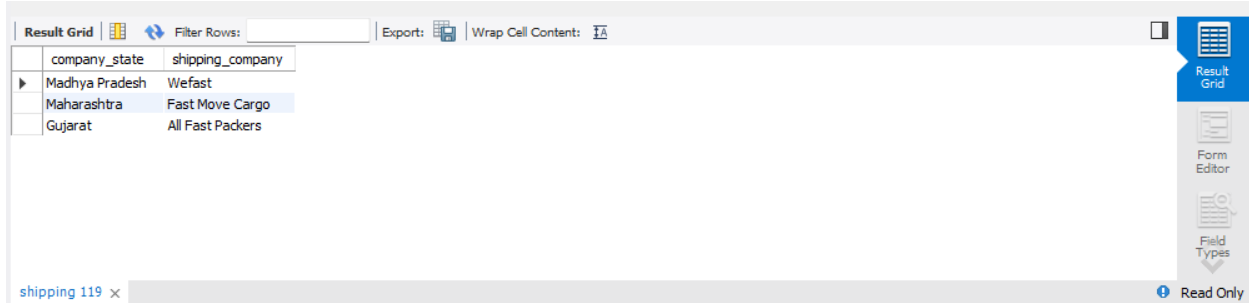


The screenshot shows a data grid with a toolbar at the top containing 'Filter Rows', 'Export', and 'Wrap Cell Content'. The grid has one column: 'vendor_name'. It lists three vendors: Ayush Traders, Rab Enterprises, and Keshav Traders. On the right side, there are buttons for 'Result Grid', 'Form Editor', and 'Field Types'. The status bar at the bottom indicates 'vendor 118' and 'Read Only'.

vendor_name
Ayush Traders
Rab Enterprises
Keshav Traders

8. Find the states in which shippers having “fast” in their names are located.

Select s.company_state, s.shipping_company from shipping as s
where s.shipping_company like "%fast%"



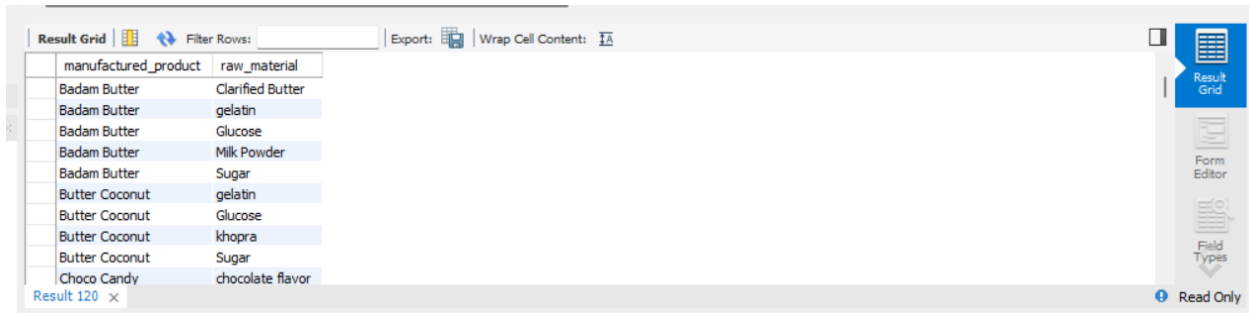
The screenshot shows a database query result grid with the following data:

company_state	shipping_company
Madhya Pradesh	Wefast
Maharashtra	Fast Move Cargo
Gujarat	All Fast Packers

The interface includes a 'Filter Rows' section, an 'Export' button, and a 'Wrap Cell Content' option. The status bar at the bottom indicates 'shipping 119' and 'Read Only'.

9. Query to list all manufactured products along with their raw materials.

```
SELECT p.product_name AS manufactured_product, rm.material_name AS raw_material
FROM product AS p
INNER JOIN rawmaterial_product AS rmp ON p.product_id = rmp.product_id
INNER JOIN rawmaterial AS rm ON rmp.material_code = rm.material_code
GROUP BY p.product_name, rm.material_name
ORDER BY p.product_name;
```



The screenshot shows a database query result grid with the following data:

manufactured_product	raw_material
Badam Butter	Clarified Butter
Badam Butter	gelatin
Badam Butter	Glucose
Badam Butter	Milk Powder
Badam Butter	Sugar
Butter Coconut	gelatin
Butter Coconut	Glucose
Butter Coconut	khopra
Butter Coconut	Sugar
Choco Candy	chocolate flavor

The interface includes a 'Filter Rows' section, an 'Export' button, and a 'Wrap Cell Content' option. The status bar at the bottom indicates 'Result 120' and 'Read Only'.

10. Arrange all the orders in descending order based on the Order Value.

```
select rm.material_name, rm.material_code, o.quantity_ordered * (o.Price per Unit) as
order_value from rawmaterial as rm
inner join orders as o on o.Material_Code = rm.material_code
order by order_value desc limit 1;
```

material_name	material_code	order_value
citric anhydrous	ITM00453	777600
citric anhydrous	ITM00453	777600
Ghee	ITM00344	309000
Glucose	ITM00974	240500
Glucose	ITM00974	215113.00000000003
rock salt	ITM00668	213900
rock salt	ITM00668	213900
rock salt	ITM00668	213900
rock salt	ITM00668	213900
rock salt	ITM00668	213900

11. Which storage location is storing the maximum “quantity-value” of raw materials

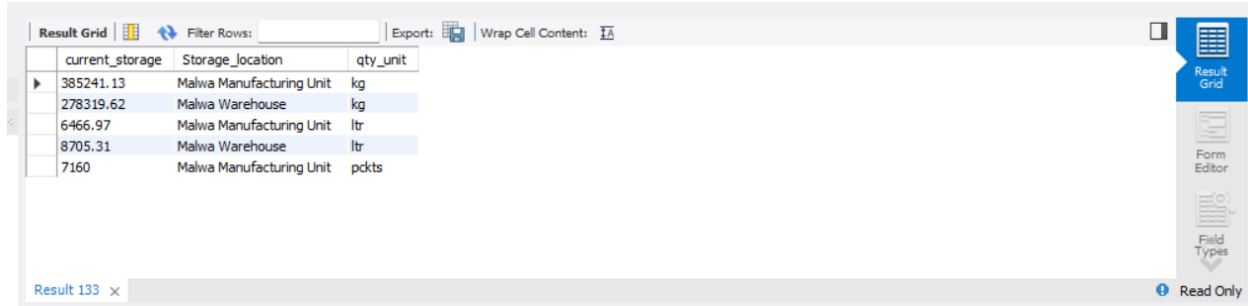
```
SELECT i.storage_location, i.Inventory_number, rm.material_name, i.quantity_in_hand AS
quantity_value
FROM inventory AS i
INNER JOIN rawmaterial AS rm ON rm.Material_Code = i.Material_Code
WHERE (i.storage_location, i.Inventory_number, i.quantity_in_hand) IN
(SELECT storage_location, Inventory_number, MAX(quantity_in_hand) AS max_quantity
FROM inventory
GROUP BY storage_location, Inventory_number)
ORDER BY quantity_value DESC ;
```

storage_location	Inventory_number	material_name	quantity_value
Malwa Warehouse	IN470	Ghee	75030.24
Malwa Manufacturing Unit	IN388	Ghee	75001.19
Malwa Manufacturing Unit	IN161	citric anhydrous	54020.67
Malwa Warehouse	IN892	citric anhydrous	50100.79
Malwa Warehouse	IN445	rock salt	45890.89
Malwa Manufacturing Unit	IN264	Clarified Butter	45600.32
Malwa Warehouse	IN384	Clarified Butter	38890.67
Malwa Manufacturing Unit	IN158	rock salt	34700
Malwa Manufacturing Unit	IN309	Milk Powder	32420.18
Malwa Manufacturing Unit	IN748	Chocolate Pwd	26729.17

From the above table it can be concluded that Malwa Warehouse is storing the Maximum quantity value of raw materials.

12. Current storage quantity of each unit in both the storage locations

```
Select round(sum(i.Quantity_in_hand),2) as current_storage , i.Storage_location , rm.qty_unit
from Inventory as i
inner join rawmaterial as rm
on rm.material_code = i.material_code
group by i.storage_location , rm.qty_unit;
```



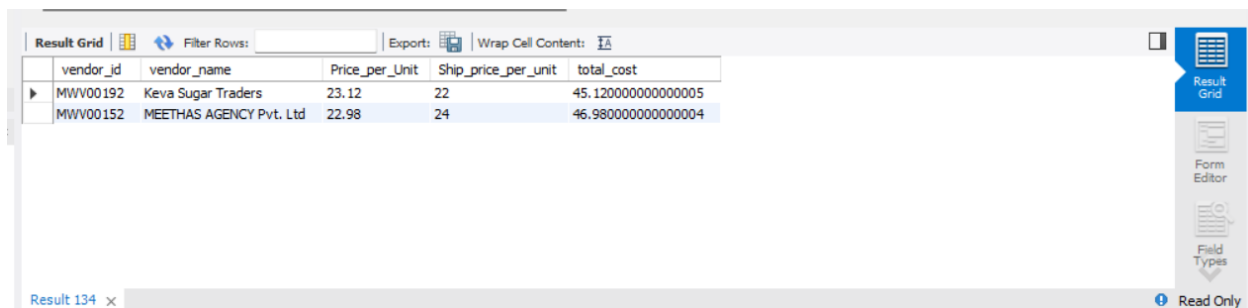
Result Grid | Filter Rows: | Export: | Wrap Cell Content: |

current_storage	Storage_location	qty_unit
385241.13	Malwa Manufacturing Unit	kg
278319.62	Malwa Warehouse	kg
6466.97	Malwa Manufacturing Unit	ltr
8705.31	Malwa Warehouse	ltr
7160	Malwa Manufacturing Unit	pkts

Result 133 x Read Only

13. Most cost efficient vendor for Raw Material - Sugar (ITM00550)

```
SELECT DISTINCT v.vendor_id, v.vendor_name, o.Price_per_Unit, o.Ship_price_per_unit,
(o.price_per_unit + o.ship_price_per_unit) AS total_cost
FROM orders AS o
INNER JOIN vendor AS v ON v.vendor_id = o.vendor_id
WHERE o.material_code = 'ITM00550'
GROUP BY v.vendor_id, v.vendor_name, o.Price_per_Unit, o.Ship_price_per_unit;
```



Result Grid | Filter Rows: | Export: | Wrap Cell Content: |

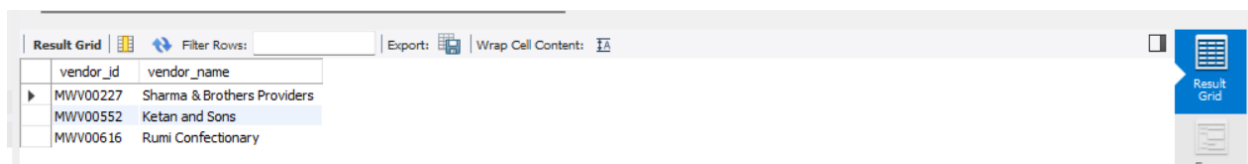
vendor_id	vendor_name	Price_per_Unit	Ship_price_per_unit	total_cost
MWV00192	Keva Sugar Traders	23.12	22	45.120000000000005
MWV00152	MEETHAS AGENCY Pvt. Ltd	22.98	24	46.980000000000004

Result 134 x Read Only

From the above table we can conclude that most cost efficient vendor is Meethas Agency Pvt.Ltd

14. List of vendors not supplying any raw materials as of now

```
SELECT vendor_id, vendor_name FROM vendor AS a
WHERE a.vendor_id NOT IN ( SELECT DISTINCT o.vendor_id FROM orders AS o
Inner JOIN vendor AS v ON v.vendor_id = o.vendor_id);
```



Result Grid | Filter Rows: | Export: | Wrap Cell Content: |

vendor_id	vendor_name
MWV00227	Sharma & Brothers Providers
MWV00552	Ketan and Sons
MWV00616	Rumi Confectionary

Result Grid

CONCLUSION

In summary, our database improvement project has achieved its objectives effectively, converting an initially disorganized raw database into a well-structured, normalized, and efficient system using SQL. This transformation has significantly enhanced data reliability, query performance, and system stability. By adhering to fundamental database design principles, we have established a robust data management infrastructure that ensures data accuracy, reduces redundancy, and simplifies data retrieval.

The optimization of our database represents a crucial milestone, enabling our organization to make more informed decisions, streamline operations, and increase overall efficiency. While the journey from disorder to coherence presented its share of challenges, the results speak for themselves. This database overhaul sets the stage for a more data-driven future, where our systems will operate with greater precision and effectiveness, ultimately benefiting our organization and its objectives.

As we move forward, there is an opportunity for further enhancement and expansion of our database capabilities. Future work may involve implementing advanced analytics and machine learning techniques to extract valuable insights from our data, as well as integrating additional data sources for a more comprehensive view. Moreover, ongoing monitoring and maintenance will be essential to ensure the continued efficiency and integrity of our database. By focusing on these areas, we can further leverage the power of data to drive our organization's success in the ever-evolving landscape of information technology.