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DESIGN AND IMPLEMENTATION OF A RELATIONAL DATABASE SYSTEM

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1. Introduction

The purpose of this study is to use MS Access and develop a relational database for **MediLink Pharmacy**. This company has been recognized as a growing community chain and wants to transition from manual records to an automated system. Furthermore, the manual management of prescriptions, stock, and customer data has been reported to have led to errors and operational inefficiencies. This database will be built using **MS Access** with a primary objective to centralize data related to medicines, suppliers, customers, and sales transactions to improve reporting accuracy and regulatory compliance.

2. Database Designs

In order to meet the requirements of MediLink Pharmacy's CEO, 6 primary entities have been identified. These entities are as follows:

- Customers: for storing unique patient records.
- Medicines: for tracking pharmaceutical inventory.
- Suppliers: for managing procurement sources.
- Prescriptions: for linking patients with their required medications.
- Prescription details: for recording the dosage information prescribed to the customer (patient)
- Transactions: for recording sales and monitoring data.

Each of the above-mentioned entities have been used with following attributes:

Entity	Attributes		
	Primary Key	Foreign Key	Other Attributes
Suppliers	SupplierID	None	CompanyName, ContactPhone, Address
Medicines	MedicineID	SupplierID	Name, Category, UnitPrice, StockLevel
Customers	CustomerID	None	FirstName,

			LastName, DOB, Phone
Prescriptions	PrescriptionID	CustomerID	DateIssued, DoctorName
Prescription_Details	DetailID	PrescriptionID, MedicineID	QuantityPrescribed, DosageInstructions
Sales_Transactions	TransactionID	MedicineID, CustomerID	SaleDate, QuantitySold, TotalPrice

Table 1: Entities and Attributes
(Created by Learner)

3. Entity Relationship Diagram

Entity Relationship Diagram (ERD) is visual representation of the interaction between various entities as part of the MediLink Pharmacy database system. The ERD illustrates the rational relationships between Customers, Prescriptions, Medicines, Suppliers and Sales Transactions. Every entity has a distinct primary key that makes individual records in the system to be identified in a unique manner (Aji, 2025).

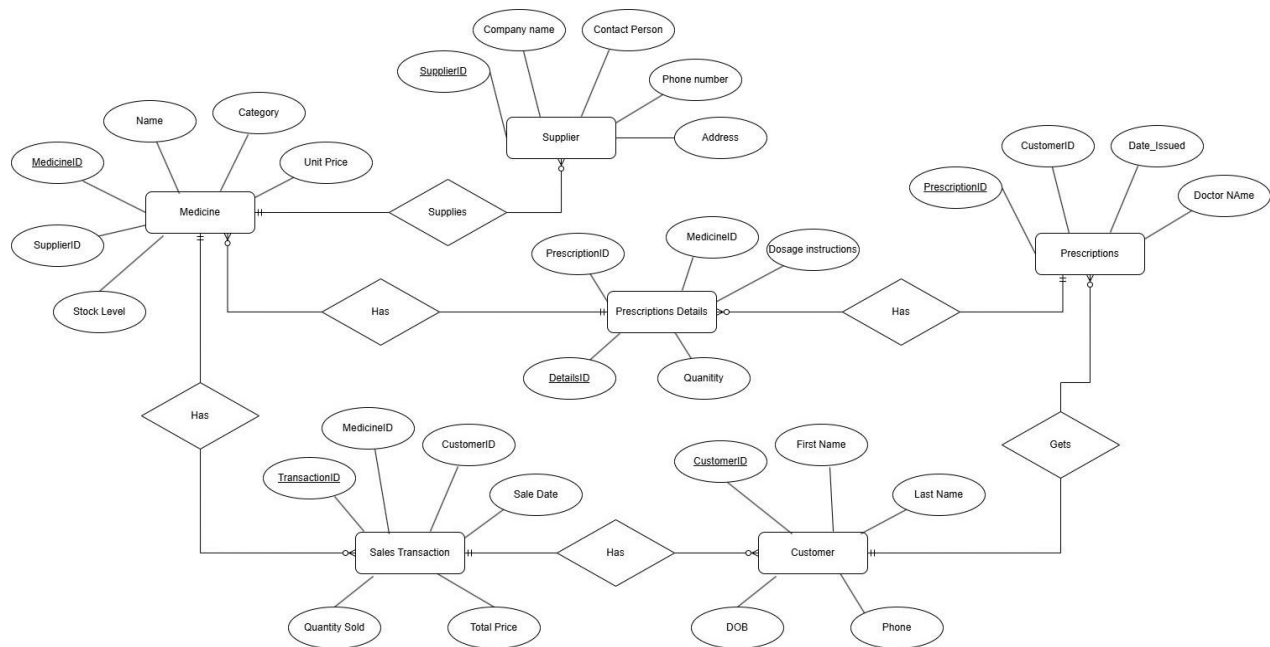


Figure 1: Entity Relationship Diagram
(Created using draw.io)

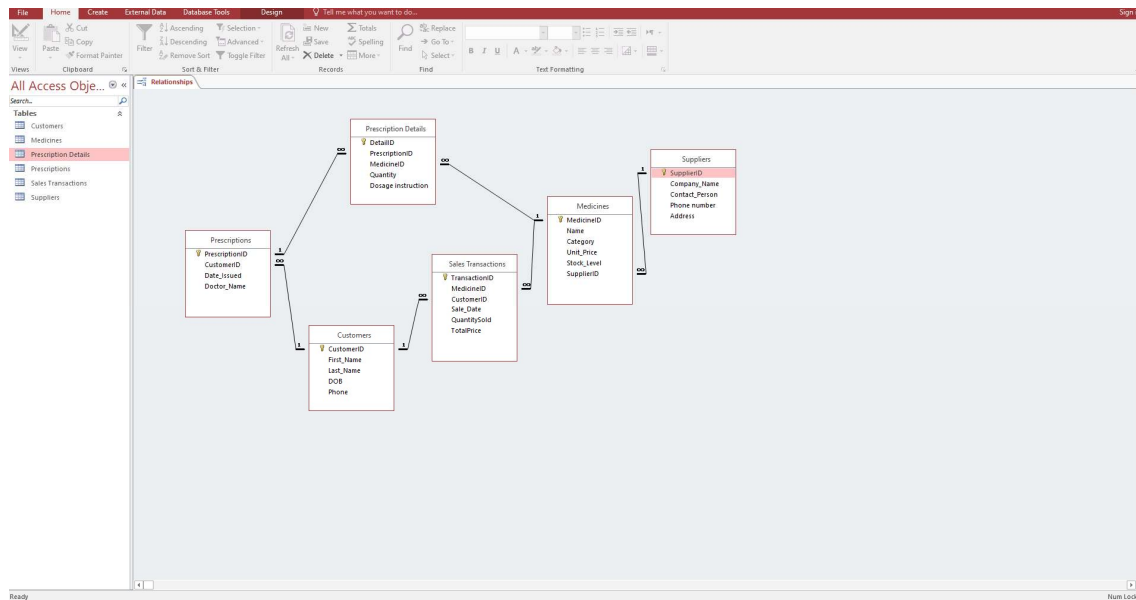


Figure 2: ERD
(Created in MS Access)

The relationships are mostly of a one-to-many type. An example is that a single supplier can provide a variety of medicines but a single medicine is related to one supplier. Equally, a customer will be able to receive several prescriptions at different times which will represent the long-term medical support of patients. The Prescription_Details junction table has been developed by the

many-to-many relationship between medicines and prescription. This table enables the association of several medicines with one prescription and the reverse to be true and flexibility as well as adherence to the principle of relational database design.

This ERD is used as the conceptual basis to implement database structure in Microsoft Access and to facilitate the purpose of enhancing the data organization, retrieval and reporting features.

4. Relationship model

The connections were worked out with the help of Microsoft Access after the conceptual design. A referential integrity was implemented to preserve consistency between tables, which were connected. As an illustration, a prescription record cannot be generated unless the customer linked to the prescription is found in the Customers table. Similarly, those medicines, which are included in the Prescription_Details table, should be present in the Medicines table.

Where necessary, cascade update options were set to make sure that any change in the value of the primary keys is automatically updated in the related tables. This can be used to ensure data integrity and reduce the chances of orphan records (Abdy and Ramadhany, 2026). The relational window in MS Access gave a clear picture on the relationship that exists between the tables thus helped to locate potential problem in the design stage.

5. Query Development and Functional Usage

A number of practical questions were formulated which illustrated how the database system can be of help in the conducting daily operational activities in MediLink Pharmacy. These questions give informative information that assists the management in the decision making and operational planning.

Query 1: Alert for low stock

The low stock alert query was implemented to detect the medicines which are below a predetermined safety threshold. This question will help pharmacists to understand what products need replenishment very fast. Through this, it is possible to avoid the stock shortages whereby there is steady supply of the necessary medicines to the customers (Ajayi et al. 2025).

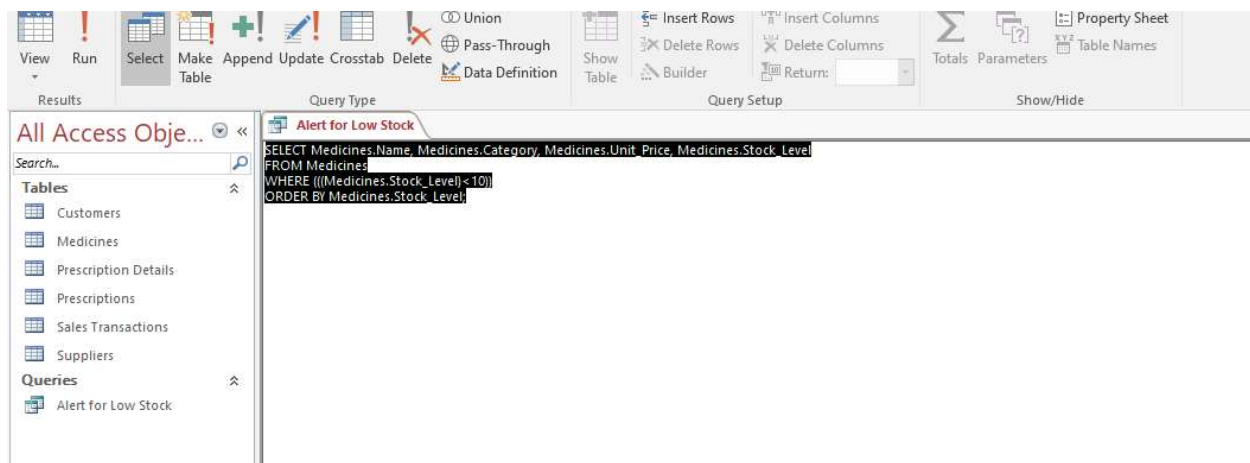


Figure 3: Query 1 Alert for low stock
(MS Access)

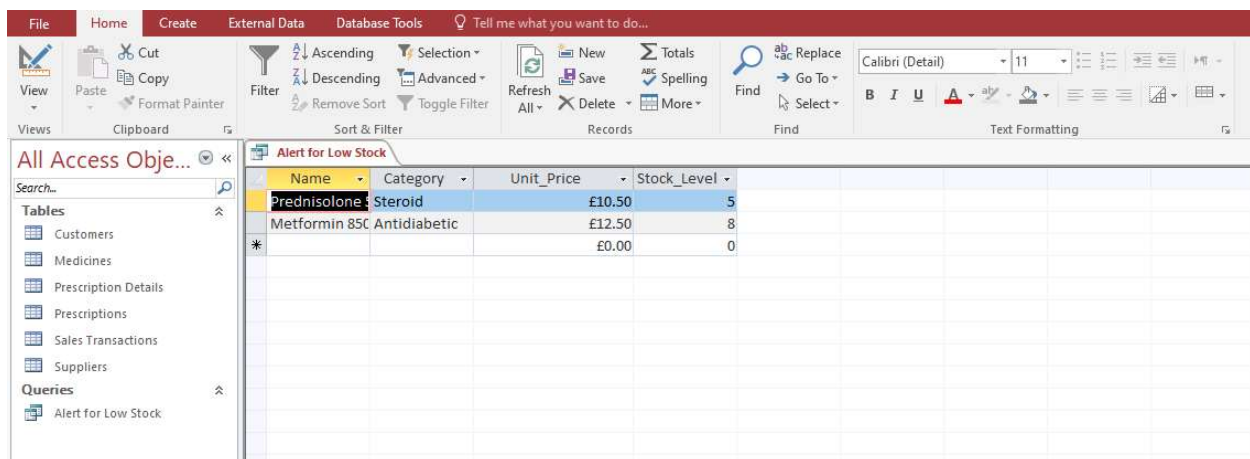


Figure 4: Output of Query 1

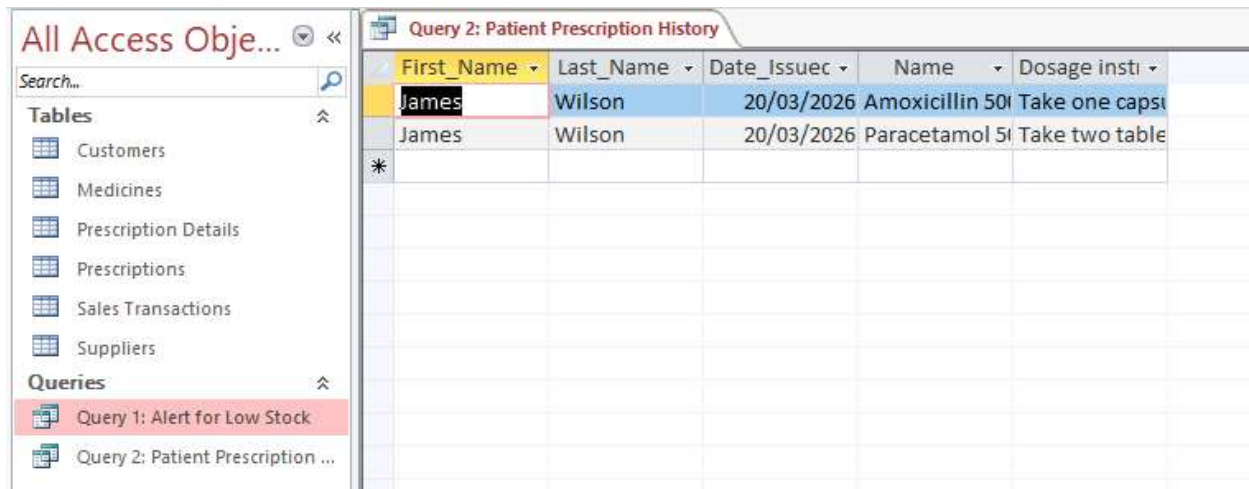
Query 2: Patient's Prescription history

This parameter query will enable pharmacy staff to access the entire history of a prescription of a given patient. The query is used to check on the information about dosages and to trace on the past dispensed drugs. This functionality is necessary to ensure the safety of patients and adhere to the healthcare regulations.



Figure 5: Query 2, Patient's Prescription history

(MS Access)

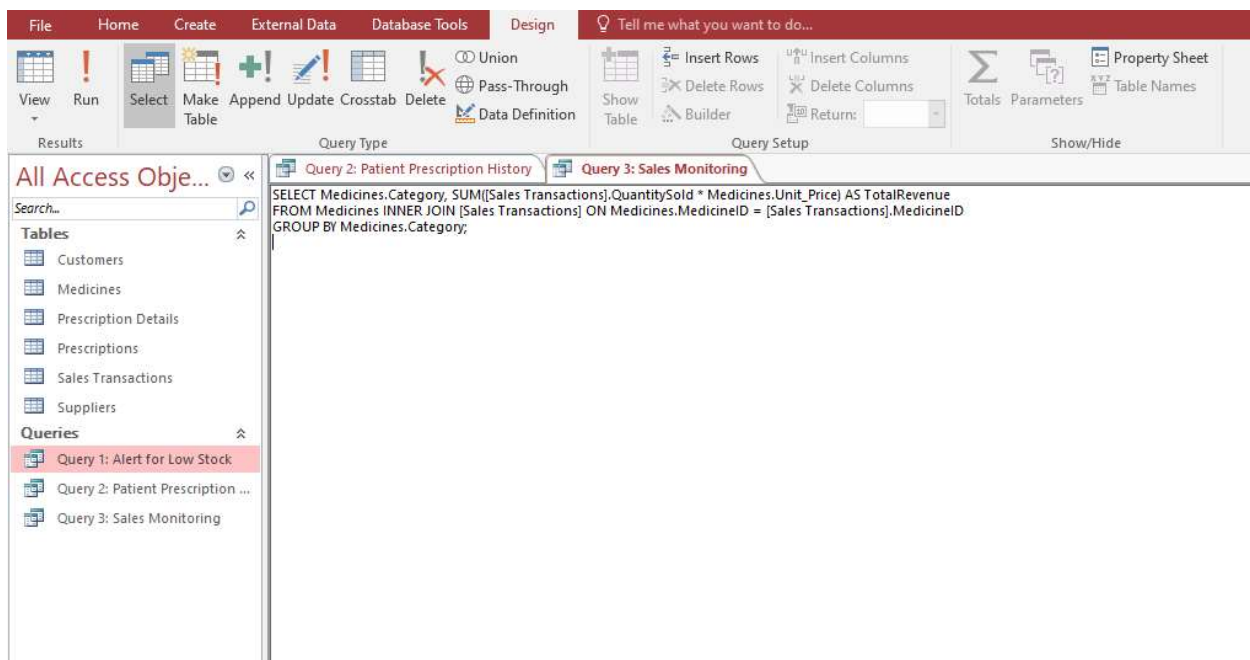


First_Name	Last_Name	Date_Issuec	Name	Dosage_insti
James	Wilson	20/03/2026	Amoxicillin 500	Take one capst
James	Wilson	20/03/2026	Paracetamol 500	Take two table
*				

Figure 6: Output of Query 2

Query 3: Sales monitoring

To analyse the sales performance with a specified period, a summary query was adopted. This query totals transaction and brings to the fore sales trends. Strategic business decisions like promotional planning and forecasting demands can be supported by the information it generates.



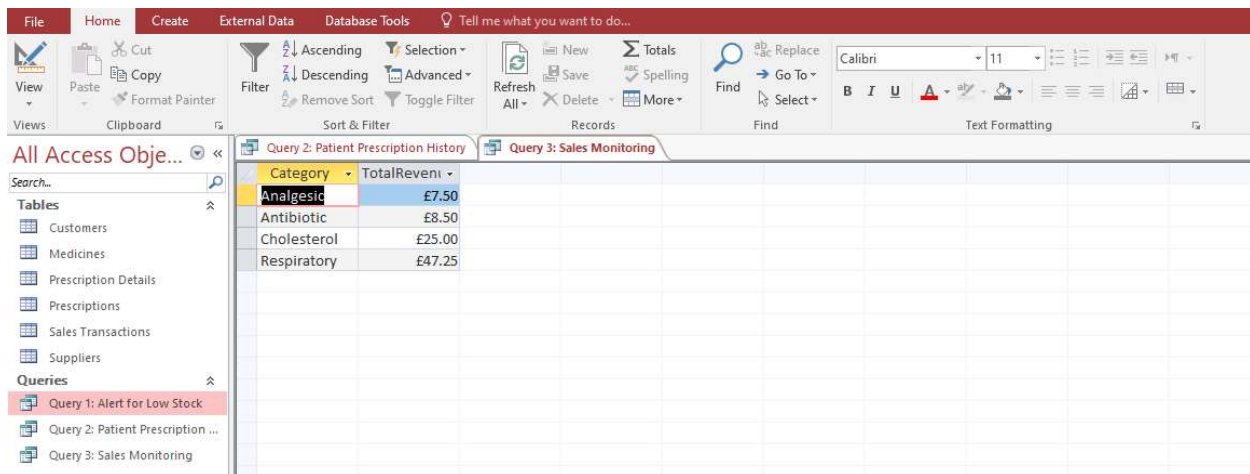
Query 3: Sales Monitoring

```

SELECT Medicines.Category, SUM([Sales Transactions].QuantitySold * Medicines.Unit_Price) AS TotalRevenue
FROM Medicines INNER JOIN [Sales Transactions] ON Medicines.MedicineID = [Sales Transactions].MedicineID
GROUP BY Medicines.Category;

```

Figure 7: Sales Monitoring Query
(MS Access)

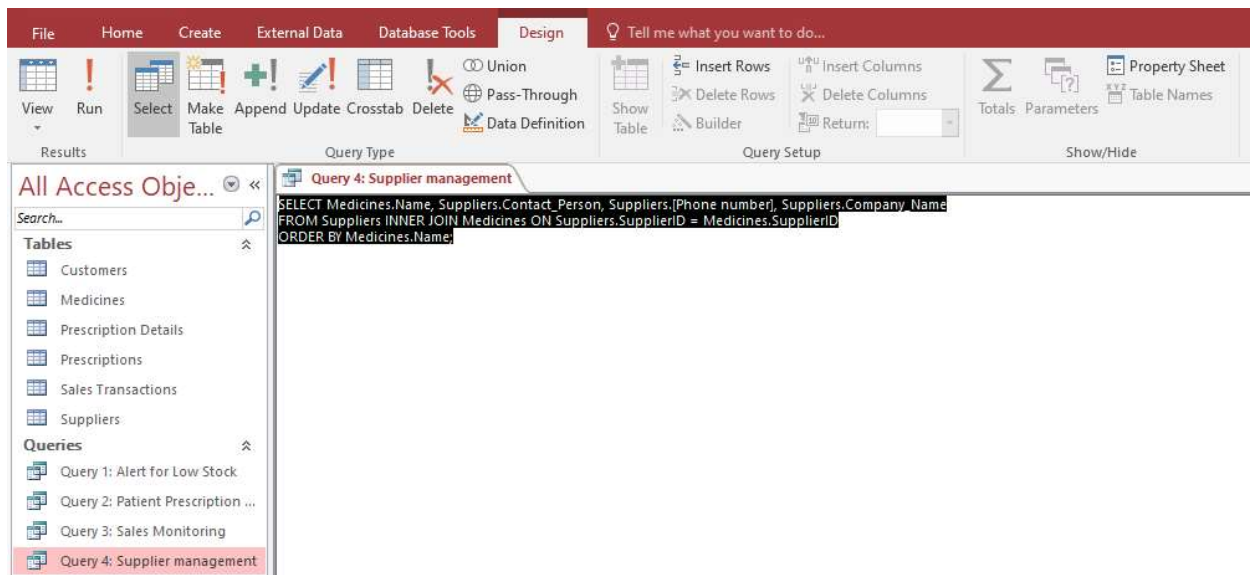


Category	TotalRevenue
Analgesic	£7.50
Antibiotic	£8.50
Cholesterol	£25.00
Respiratory	£47.25

Figure 8: Output
(MS Access)

Query 4: Supplier Management: medicine wise Supplier Contact List

The other query that proved helpful was created to create a list of supplier contacts that are medicine-wise. This query will help the staffs to find the right supplier within a short time when they are reordering the stock. It also enhances the efficiency of procurement by saving time incurred in locating information of the suppliers (Tera, 2023).



```

SELECT Medicines.Name, Suppliers.Contact_Person, Suppliers.[Phone number], Suppliers.Company_Name
FROM Suppliers INNER JOIN Medicines ON Suppliers.SupplierID = Medicines.SupplierID
ORDER BY Medicines.Name;
    
```

Figure 9: Supplier management
(MS Access)

Name	Contact_Person	Phone number	Company_Name
Amoxicillin 500mg	Sarah Jenkins	020 7946 0001	PharmaDirect UK
Lipitor 20mg	Elena Rodriguez	0118 496 0555	BioHealth Ltd
Metformin 850mg	David Smith	0161 496 0123	MediCore Logistics
Omeprazole 20mg	Julia Chen	0121 496 0444	Apex Pharma
Paracetamol 500mg	Elena Rodriguez	0118 496 0555	BioHealth Ltd
Prednisolone 5mg	Marcus Vane	020 8946 0999	Global Meds Inc
Ventolin Inhale	Sarah Jenkins	020 7946 0001	PharmaDirect UK

Figure 9: Output
(MS Access)

6. Normalization Process

These alterations in the database made it normalized to the 3rd normal form (3NF) in order to minimize redundancy and enhance data consistency.

All the repeating groups had been eliminated in the First Normal Form (1NF) and every field was required to store atomic values. This implies that there are no multi-valued attributes and only one piece of information is stored in each column (Hardini et al. 2025).

The partial dependencies were removed in the Second normal form (2NF) where all the non-key attributes are completely dependent on the primary key. In the case of supplier information, it was rather divided into a separate table instead of being stored with the information about medicines.

Transitive dependencies in the Third Normal Form (3NF) were eliminated. This makes sure that non key attributes are solely based on the primary key rather than other non-key attributes. Indicatively, the contact information of the suppliers is stored in the Suppliers table and not in the Medicines table. This method of structuring raises efficiency in the database as well as making them easier to maintain in the future.

7. Implementation Evidence

The implementation process entailed development of tables, defining the type of data in the fields, development of relationships and filling the database with the realistic sample data. The

relationships window, table design view and sample data entries were taken as screenshots, in order to show visual proof of the system development (Terai, 2023).

Table was filled with five or more sample records of normal pharmacy transactions. Validation rules were also used in some cases to provide correct data entry. In one case, stock organization was limited to numbers and date fields were set to a valid date format.

8. System Validation and Testing

The database system was also put to test with functional requirements to ensure that it satisfies the needs of the users. Some of the test cases were the addition of new customers, recording prescription details, sales transactions and performing queries.

The outcomes have shown that the system was able to ensure the integrity of data and generate correct query responses (Ajayi et al. 2025). There was a way of relationships that did not allow the entry of invalid data and queries provided timely and relevant information to be used to make decisions. All in all, the tests showed the implemented solution facilitates the operational goals of MediLink Pharmacy.

9. Reflection and Future Improvements

The relationship between prescriptions and medicines was among the key issues that were to be dealt with during the development process. Effort towards normalisation and flexibility Since a single prescription can contain several medications, introducing the Prescription_Details junction table was necessary.

The other issue was the establishing of the relationships properly in the Microsoft Access in order to impose referential integrity without inhibiting the data entry. Stress testing and numerous design modifications took a wise approach to reach a successful compromise between validation and usability of the data (Abdy and Ramadhany, 2026).

There are some improvements that can be made in the system in the future. They comprise the incorporation of barcode scanning tech to automate the sales processing and minimize human error. Also, automated stock-out warnings and sophisticated reporting dashboards may be used to enhance operational efficiency to a greater extent. The system would also be more scalable by expanding the database to facilitate online ordering and the uploading of electronic prescription.

10. Conclusion

The MediLink Pharmacy relational database system effectively illustrates the way the business operations can be enhanced with the help of the properly designed database. Automating the

pharmacy record-keeping process is a solution that will not only help the pharmacy to better the accuracy of their records, their control of the stock, as well as the level of customer service that they provide.

Related principles of relational database such as entity relationship modelling and normalization were applied, which made the system efficient, reliable, and in a position to support future growth. In general, the adopted database offers an effective base of the pharmacy management process modernization and facilitated informed decision-making.

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Appendix

The screenshot shows the Microsoft Access interface with the 'Customers' table selected. The ribbon includes 'File', 'Home', 'Create', 'External Data', 'Database Tools', 'Fields', 'Table', and 'Tell me what you want to do...'. The 'Home' ribbon is active, showing options for Views, Clipboard, Sort & Filter, Records, Find, and Text Formatting. The 'All Access Objects' task pane on the left lists various tables, with 'Customers' highlighted. The main window displays the 'Customers' table with the following data:

CustomerID	First_Name	Last_Name	DOB	Phone	Click to Add
C901	James	Wilson	12/05/1975	07700 900111	
C902	Linda	Thompson	24/08/1988	07700 900222	
C903	Robert	Davies	03/01/1952	07700 900333	
C904	Sophie	Bennett	15/11/1995	07700 900444	
C905	Michael	O'Neill	30/06/1964	07700 900555	

Costumers' data

The screenshot shows the Microsoft Access interface with the 'Medicines' table selected. The ribbon includes 'File', 'Home', 'Create', 'External Data', 'Database Tools', 'Fields', 'Table', and 'Tell me what you want to do...'. The 'Home' ribbon is active, showing options for Views, Clipboard, Sort & Filter, Records, Find, and Text Formatting. The 'All Access Objects' task pane on the left lists various tables, with 'Medicines' highlighted. The main window displays the 'Medicines' table with the following data:

MedicineID	Name	Category	Unit_Price	Stock_Level	SupplierID	Click to Add
M101	Amoxicillin 500	Antibiotic	£8.50	45	S001	
M102	Paracetamol 500	Analgesic	£1.25	120	S003	
M103	Metformin 850	Antidiabetic	£12.50	8	S002	
M104	Ventolin Inhaler	Respiratory	£15.75	22	S001	
M105	Lipitor 20mg	Cholesterol	£25.00	15	S003	
M106	Omeprazole 20mg	Gastro	£7.20	60	S005	
M107	Prednisolone 5mg	Steroid	£10.50	5	S004	

Medicines data

The screenshot shows the Microsoft Access interface with the 'Prescriptions' table selected. The ribbon includes 'File', 'Home', 'Create', 'External Data', 'Database Tools', 'Fields', 'Table', and 'Tell me what you want to do...'. The 'Home' ribbon is active, showing options for Views, Clipboard, Sort & Filter, Records, Find, and Text Formatting. The 'All Access Objects' task pane on the left lists various tables, with 'Prescriptions' highlighted. The main window displays the 'Prescriptions' table with the following data:

PrescriptionID	CustomerID	Date_Issued	Doctor_Name	Click to Add
PR501	C901	20/03/2026	Dr. Aris	
PR502	C903	21/03/2026	Dr. Smith	
PR503	C902	22/03/2026	Dr. Murphy	
PR504	C905	23/03/2026	Dr. Smith	
PR505	C901	24/03/2026	Dr. Taylor	

Prescription data

DetailID	Prescription	MedicineID	Quantity	Dosage inst	Click to Add
D1001	PR501	M101	21	Take one caps	
D1002	PR501	M102	16	Take two table	
D1003	PR502	M103	56	Take one table	
D1004	PR503	M104	1	Use two puffs	
D1005	PR504	M105	28	Take one table	
			0		

Prescription Details data

TransactionID	MedicineID	CustomerID	Sale Date	QuantitySol	TotalPrice	Click to Add
T001	M102	C901	20/03/2026	2	£2.50	
T002	M101	C903	21/03/2026	1	£8.50	
T003	M105	C902	22/03/2026	1	£25.00	
T004	M104	C905	23/03/2026	3	£47.25	
T005	M102	C904	24/03/2026	4	£5.00	
				0	£0.00	

Sales transactions data

SupplierID	Company_N	Contact_Pet	Phone num	Address	Click to Add
S001	PharmaDirect	Sarah Jenkins	020 7946 0001	12 High Street,	
S002	MediCore Logi	David Smith	0161 496 0123	45 Industrial Es	
S003	BioHealth Ltd	Elena Rodriguez	0118 496 0555	7 Reading Busi	
S004	Global Meds Ir	Marcus Vane	020 8946 0999	102 Canary Wh	
S005	Apex Pharma	Julia Chen	0121 496 0444	88 Bullring Pla	

Supplier data