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Contents

Scenario Analysis	2
Entity Relationship Diagram (ERD).....	2
1. Microsoft Access	2
2. List of attributes and their descriptions	2
3. List of relationships and their meaning.....	4
4. ER diagram	5
Normalization.....	7
1. Relational Schema	7
2. Unnormalized Form – UNF	8
3. First Normal Form – 1NF	8
4. Second Normal Form – 2NF	9
5. Third Normal Form – 3NF	10
Sample Data Population	11
Query Development	13
1. Medicines and their suppliers	13
2. Customer prescriptions.....	13
3. Sales transactions	15
4. Sales search by date	16
Testing and Validation.....	16
Design Decisions and Future Work.....	17
1. Design Decisions	17
2. Future Work.....	17
References:	18

Scenario Analysis

The scenario describes the development of a database system for managing the operations of a pharmacy. The system provides the process to capture and manage relevant data of medicines, suppliers, customers, prescriptions and sales. Nowadays, if data is managed manually, it can easily lead to errors, duplications and difficulties in retrieving information quickly. As a result, the database will enable the pharmacy to monitor medicines provided by diverse suppliers, store customers' information and write down prescription details. The system will also help in handling sales transactions and ensuring the right connection of data from one entity to another. By using a relational database design, the system improves data organisation, reduces redundancy and makes it easier to retrieve information when needed. This will support better management of pharmacy operations and improve efficiency in handling daily activities [1].

Entity Relationship Diagram (ERD)

1. Microsoft Access

Microsoft Access is a relational database management system created by Microsoft. This software enables users to build and manage databases by structuring data in tables and defining relationships among them. Access includes tools for table design, query execution, form creation for data input, and report generation for data analysis. It is frequently utilized for database applications of small to medium scale due to its user-friendly interface and compatibility with other Microsoft Office products [2].

2. List of attributes and their descriptions

This section describes the entities used in the database and their corresponding attributes. Each entity represents a table in the database system, and the attributes represent the fields stored within each table. Primary keys are identified to uniquely distinguish each record within the entities

Entity: Suppliers

Attribute	Description	Key
SupplierID	Identifier for each supplier	Primary Key
SupplierName	Name of the supplier company	
Phone	Contact of the supplier	
Email	Email of the supplier	
Adress	City of the supplier	

Entity: Medicines

Attribute	Description	Key
MedicineID	Identifier for each medicine	Primary Key
MedicineName	Name of the medicine	
Category	Type of the medicine	
Price	Price of the medicine	
SupplierID	Identifies which supplier provides the medicine	Foreign Key

Entity: Customers

Attribute	Description	Key
CustomerID	Identifier for each customer	Primary Key
CustomerName	Name of the ccustomer	
Phone	Contact of the customer	
Adress	Customer address	

Entity: Prescriptions

Attribute	Description	Key
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PrescriptionID	Identifier for each prescription	Primary Key
CustomerID	Identifies the customer who received the prescription	Foreign Key
MedicineID	Identifies the prescribed medicine	Foreign Key
DoctorName	Name of the doctor who issued the prescription	

Entity: Sales

Attribute	Description	Key
SaleID	Identifier for each sale	Primary Key
MedicineID	Identifies the medicine sold	Foreign Key
Quantity	Quantity of medicine sold	
SaleDate	Date when the sale occurred	

3. List of relationships and their meaning

This section describes the relationships between the entities in the database system. Relationships define how different entities such as suppliers, medicines, customers and sales interact with each other. Each relationship includes the cardinality and participation constraints which explain how many instances of one entity can be associated with another entity [3].

Relationship	Description	Cardinality	Participation
Suppliers – Medicines	A supplier can provide multiple medicines, but each medicine is supplied by only one supplier	1:M	Supplier-partial Medicine- total

Customers – Prescriptions	A customer can have multiple prescriptions issued by a doctor	1:M	Customer- partial Prescription- total
Medicines – Prescriptions	A prescription refers to a specific medicine	1:M	Medicine- partial Prescription- total
Medicines – Sales	Medicine can appear in multiple sales transactions	1:M	Medicine- partial Sale- total

4. ER diagram

The ER Diagram illustrates all entities in, including primary and foreign keys, their attributes, and the relationships between entities, with cardinality and participation constraints.

Entity Relationship diagram provides a visual representation of the database structure involved in the MediLink Pharmacy system. It depicts the major players in the system like suppliers, medicines, customers, prescriptions and sales. Every attribute of each entity is shown, and primary keys are also used to identify records on each of them. Foreign keys are also included on the diagram to create links between the tables. The ER diagram allows for the organization of the data clearly and for the relationships between entities in the database. Attached, interconnecting lines show how data from one entity is related to data from another entity. This also includes cardinality constraints, one to many relationships to specify how many instances of one entity can be associated with another. Representing participation constraints to ascertain if participation for an entity in a relationship is compulsory or elective. Since an ER diagram shows one thing in advance of making changes to it, it allows the user to grasp the logical building blocks of the database before entering it into a database management system such as Microsoft Access. Approaches like this help reduce design errors and ensure data consistency and that all necessary relations between entities are well defined [4].

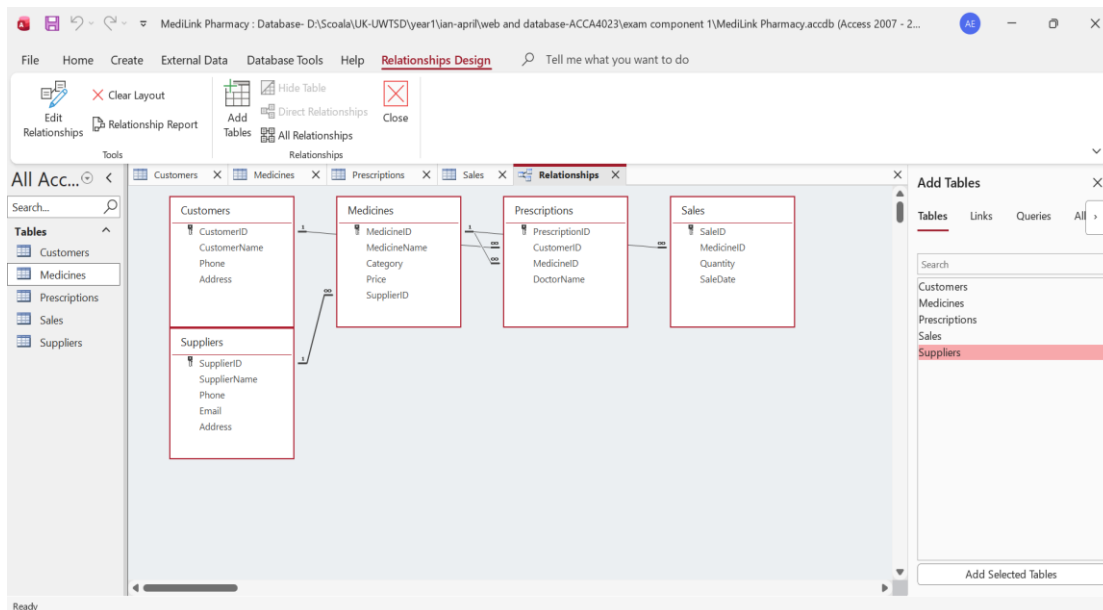


Figure 1. ER Diagram

The Entity Relationship Diagram (ERD) shown represents the structure of the MediLink Pharmacy database. It indicates all entities, their attributes, and their relationships to each other. The relationship is also provided between various tables by showing the primary keys and foreign keys of the tables. The entities have a one-to-many (1:M) cardinality, in the meaning that a record in the parent entity can relate to more than one record in its related entity. The referential integrity will be achieved so that foreign key values are always the same as the existing primary key values in the related tables. The ER diagram shows how suppliers provide medicines, customers receive prescriptions, and medicines are reflected in sales transactions. This structure not only ensures orderly data organization but also eliminates duplication within the database.

Table	Foreign Key	References, FK
Medicines	SupplierID	SuppliesID from Suppliers
Prescriptions	CustomerID	CustomerID from Customers
Prescriptions	MedicineID	Medicineld from Medicines
Sales	MedicineID	Medicineld from Medicines

Normalization

Normalization is the process of organizing database tables to reduce redundancy and improve data integrity. The database is normalized through a series of stages including First Normal Form (1NF), Second Normal Form (2NF), and Third Normal Form (3NF) [5] [9].

1. Relational Schema

The relational schema of the pharmacy database provides the arrangement of the database by defining the relationship. The data are each represented by a table, they represent any particular entity in the pharmacy system, Medicines, Suppliers, Customers, Prescriptions, and Sales. Each relation includes a primary key which gives a unique ID to each record, maintains their integrity. The foreign keys are also used to create relationships between associated tables, representing the interactions with other entities. In the Medicines table, we have a foreign key that defines which supplier provides that medicine. In a similar sense, it has Sales and Prescriptions tables referencing Customers and Medicines to ensure records on purchases and medications prescribed are recorded. This relational structure provides efficient data organization, reduces redundancy, and supports consistent retrieval of data. Relational schema clarifies the entities, attributes, and key relationships in a way that validates logical consistency and integrity of the database [6].

Based on the ER diagram created for the MediLink Pharmacy database, the following relational schema has been derived by applying ER to relational mapping rules. This relational schema represents the logical structure of the MediLink Pharmacy database and forms the basis for applying normalization rules.

- Customer(**CustomerID**, CustomerName, Phone, Address)
- Supplier(**SupplierID**, SupplierName, ContactNumber)
- Medicine(**MedicineID**, MedicineName, Price, SupplierID)
- Prescription(**PrescriptionID**, CustomerID, MedicineID, PrescriptionDate)
- Sales(**SaleID**, CustomerID, MedicineID, Quantity, TotalPrice)

Foreign key relationships: SupplierID in Medicine refers to SupplierID in Supplier, CustomerID in Prescription refers to CustomerID in Customer, MedicineID in Prescription refers to MedicineID in Medicine, CustomerID in Sales refers to CustomerID in Customer, MedicineID in Sales refers to MedicineID in Medicine.

2. Unnormalized Form – UNF

Initially, all the information about customers, medicines, suppliers, prescriptions, and sales could be stored in a single table. This structure may contain repeating groups and multiple values within a single attribute [7].

In this structure, the MedicineName field contains multiple values, which violates normalization rules because attributes must store only atomic values.

SaleID	CustomerName	MedicineName	SupplierName	Quantity	Price
1	Alexandru Ciorascu	Paracetamol1, Ibuprofen	Bayer	2	6.30
2	Leri Do	Paracetamol2	Pfizer Ltd	1	3

3. First Normal Form – 1NF

First Normal Form requires that all attributes contain atomic values and that repeating groups are removed. Each column must contain only one value, and each record must be uniquely identifiable by a primary key [7].

In this form, each row represents a single record, and every attribute contains a single value. This eliminates repeating groups and ensures that the data structure satisfies the requirements of First Normal Form.

SaleID	CustomerName	MedicineName	SupplierName	Quantity	Price
1	Alexandru Ciorascu	Paracetamol1,	Bayer	1	2
2	Alexandru Ciorascu	Ibuprofen	Bayer	1	4.30
3	Leri Do	Paracetamol2	Pfizer Ltd	1	3

4. Second Normal Form – 2NF

Second Normal Form requires that a table is already in First Normal Form and that all non-key attributes are fully dependent on the entire primary key. Partial dependencies must be removed so that attributes depend only on the primary key. To achieve this, the data is separated into different tables representing individual entities [7].

Each table represents a single entity, and non-key attributes depend entirely on the primary key.

Customer Table

CustomerID/PK	CustomerName
1	Alexandru Ciorascu
2	Leri Do

Supplier Table

SupplierID/PK	SupplierName
1	Bayer
2	Pfizer Ltd

Medicine Table

MedicineID/PK	MedicineName	SupplierID/FK
1	Paracetamol1	1
2	Ibuprofen	2
3	Paracetamol2	3

Sales Table

SaleID/PK	CustomerID/FK	MedicineID/FK	Quantity	Price
1	1	1	1	2
2	2	2	1	4.30
3	3	3	1	3

5. Third Normal Form – 3NF

A table is in Third Normal Form when it is already in Second Normal Form and when no transitive dependencies exist. This means that non-key attributes must depend only on the primary key and not on other non-key attributes. By adopting this normalized structure, redundant data is eliminated, ensuring that each attribute is dependent exclusively on its table's primary key. Consequently, this enhances data integrity within the database and facilitates more effective management of pharmacy operations [7].

After applying Third Normal Form, the MediLink Pharmacy database contains the following tables:

Customer

CustomerID, PK	CustomerName	Phone	Address
-			

Supplier

SupplierID, PK	SupplierName	Phone	Email	Address
-				

Medicine

MedicineID, PK	MedicineName	Category	Price	SupplierID, FK
-				

Prescription

PrescriptionID, PK	CustomerID, FK	MedicineID, FK	DoctorName
-			

Sales

SaleID, PK	MedicinID, FK	Quantity	SaleDate
-			

Sample Data Population

This section presents sample data that has been inserted into the database tables in Microsoft Access. The sample data demonstrates how the database stores and manages information related to suppliers, medicines, customers, prescriptions and sales.

CustomerID	CustomerName	Phone	Address	Click to Add
1	Alexandru Cior	07459263853	Birmingham ne	
2	Ana Bl	07132953855	Birmingham ol	
3	Leri Do	07888899426	London new st	
4	Don Don	07777799665	London old str	
5	BB Ali	07888899563	Birmingham ea	
*	(New)			

Figure 2. Customers

MedicineID	MedicineName	Category	Price	SupplierID	Click to Add
1	Paracetamol1	Painkiller	\$2.00	1	
2	Paracetamol2	Painkiller	\$3.00	2	
3	Ibuprofen	Painkiller	\$4.30	3	
4	Amoxiciline	Antibiotics	\$5.00	4	
5	Amoxiclave	Antibiotics	\$6.20	5	
*	(New)		\$0.00	0	

Figure 3. Medicines

views | Clipboard | Sort & Filter | Records | Find

All Acc... <

Search...

Tables

- Customers
- Medicines
- Prescriptions
- Sales
- Suppliers

Prescription	CustomerID	MedicineID	DoctorName	Click to Add
1	1	1	Dr. Alexandru	
2	2	2	Dr. Josh	
3	3	3	Dr. Mohamed	
4	4	4	Dr. Ahmed	
5	5	5	Dr. Ali	
*(New)	0	0		

Figure 4. Prescriptions

All Acc... <

Search...

Tables

- Customers
- Medicines
- Prescriptions
- Sales
- Suppliers

SaleID	MedicineID	Quantity	SaleDate	Click to Add
1	1	10	3/1/2026	
2	2	15	3/2/2026	
3	3	8	3/8/2026	
4	4	12	3/7/2026	
5	5	20	3/6/2026	
*(New)	0	0		

Figure 5. Sales

All Acc... <

Search...

Tables

- Customers
- Medicines
- Prescriptions
- Sales
- Suppliers

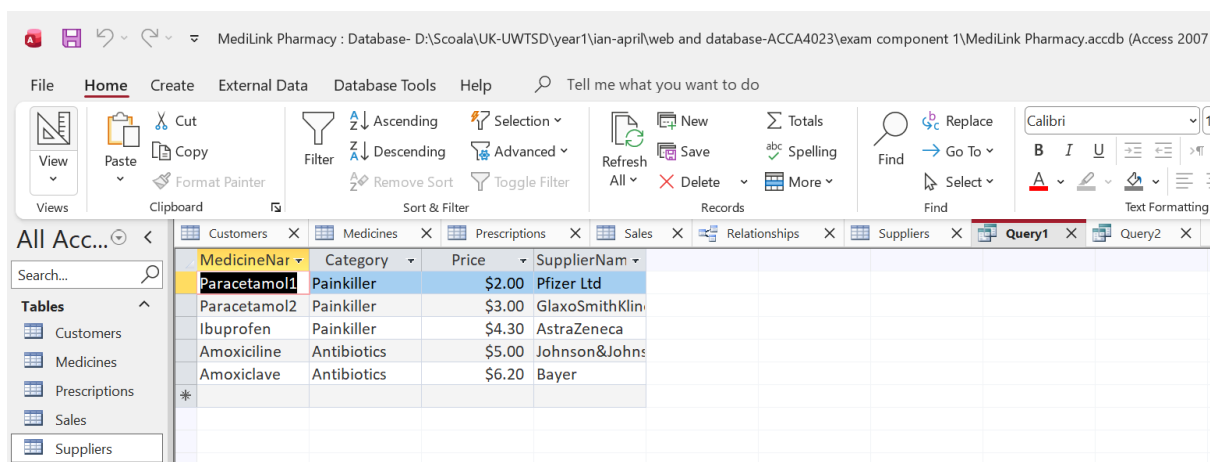
SupplierID	SupplierName	Phone	Email	Address	Click to Add
1	Pfizer Ltd	01304616161	info@pfizer.co	Sandwich	
2	GlaxoSmithKline	02080475000	info@gsk.com	Brentford	
3	AstraZeneca	00112233441	info@astrazen	Cambridge	
4	Johnson&Johnson	01234567890	info@jj.com	Birmingham	
5	Bayer	00123456789	info@bayer.cc	London	
*(New)					

Figure 6. Suppliers

Query Development

1. Medicines and their suppliers

This query retrieves a list of medicines together with their corresponding suppliers. It joins the Medicines and Suppliers tables using the SupplierID foreign key to display the medicine name, category, price and supplier name.



The screenshot shows the Microsoft Access interface with the 'Query1' query open. The query results are displayed in a table with the following data:

MedicineName	Category	Price	SupplierName
Paracetamol1	Painkiller	\$2.00	Pfizer Ltd
Paracetamol2	Painkiller	\$3.00	GlaxoSmithKlin
Ibuprofen	Painkiller	\$4.30	AstraZeneca
Amoxiciline	Antibiotics	\$5.00	Johnson&Johns
Amoxiclave	Antibiotics	\$6.20	Bayer

Figure 7. Query 1

2. Customer prescriptions

This query displays the medicines prescribed to each customer. It connects the Customers, Prescriptions and Medicines tables using their primary and foreign key relationships.

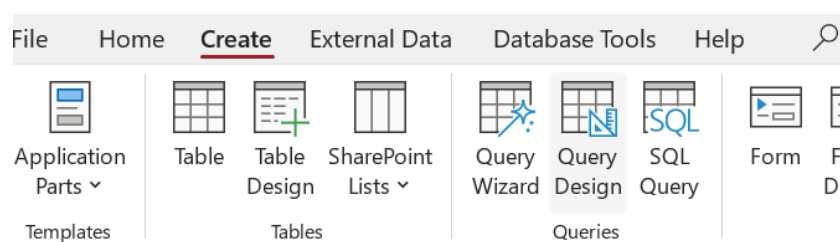


Figure 8. Creating query

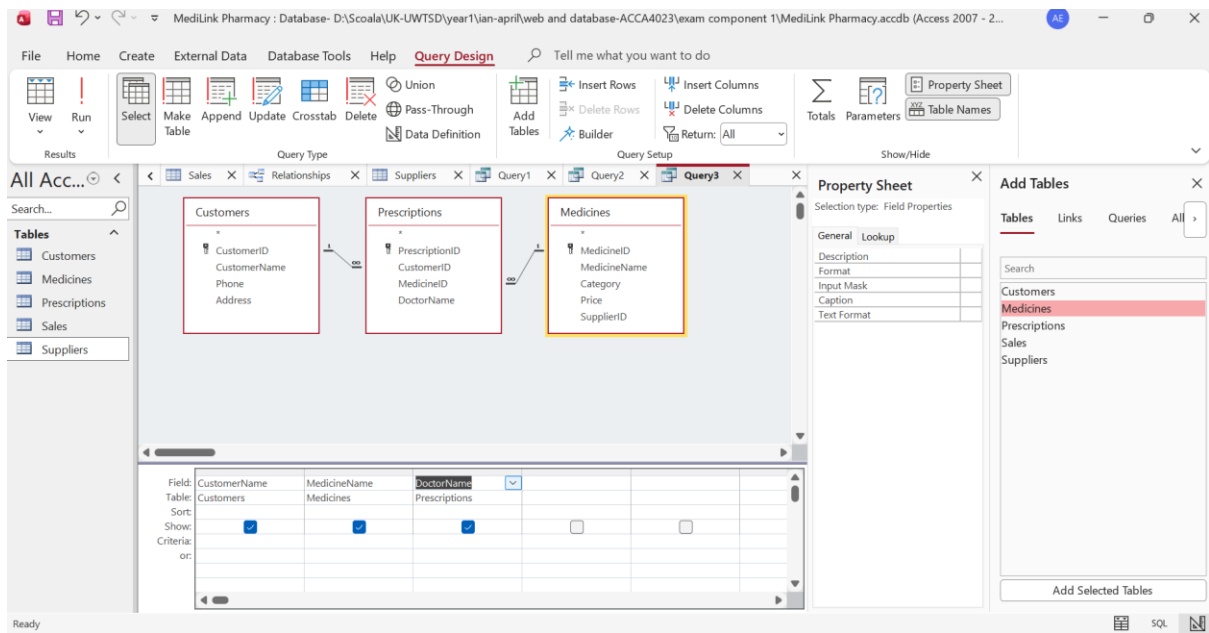


Figure 9. Step 2 for query after RUN

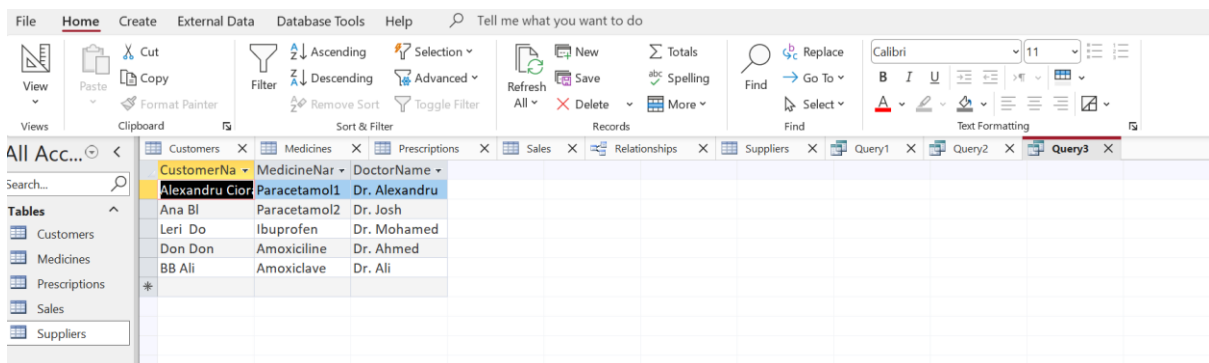


Figure 10. Query 2

This query shows the sales transactions recorded in the database. It retrieves information about the medicines sold, including the quantity and the date of sale.



Figure 12. Query 3

4. Sales search by date

This query allows the user to search for sales transactions based on a specific date.

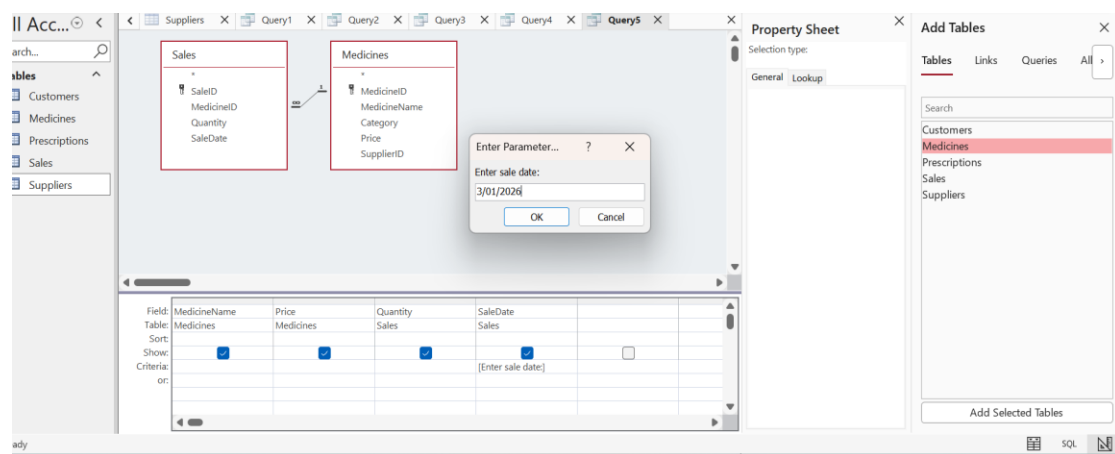


Figure 13. Enter date

MedicineName	Price	Quantity	SaleDate
Paracetamol1	\$2.00	10	3/1/2026

Figure 14. Query 4

Testing and Validation

The database system was tested to ensure that all functional requirements were properly met. Tables, relationships, and queries were created in Microsoft Access and subsequent tests were performed. Each table involved sample data that included suppliers, medicines, customers, prescriptions, and sales records. By doing this I was able to test the system with actual data. The integrity of the relationships between tables was checked by enforcing referential integrity to

ensure that foreign key values were consistent with existing primary key values stored in the corresponding tables. For example, each medicine should have a relationship with a valid supplier and prescription records should be related to both customers and medicines. In addition, multiple queries were run to validate that the data retrieval from several tables was being performed correctly. The outcomes of these queries substantiated the expected functioning of the entity relationships and verified the database's ability to output accurate information about medicine suppliers, customer prescriptions, and sales transactions.

Design Decisions and Future Work

1. Design Decisions

While developing the database model in the MediLink Pharmacy database a few design choices were implemented to ensure the efficient, disciplined and maintainable system structure of system was ensured. The database design is based on relational database with all the important entities, including suppliers, medications, customers, prescriptions, and sales, in independent tables. This way, redundancy is avoided and the system becomes less redundant. Every table has primary keys that identifies those records clearly and foreign keys that link the related entities. The referential integrity is preserved by keeping the correct associations between a table and information, such that have a consistent mapping between the variables. For example, each medication record is linked to its supplier, so prescriptions are linked to customers and medications. One of the major struggles was to establish correct relationships between the tables and queries that gave the expected results. It required careful foreign key manipulation and repeated testing to see which and which records could be accessed from these various tables effectively.

2. Future Work

The database system currently in place does effectively manage pharmacy information, but there are many improvements that can be made to the database in the future. This may include adding automated inventory management capabilities which would track medicine stock levels and would alert the

pharmacy staff to stock shortages. An uncomplicated way to add intuitive forms also gives pharmacy employees a means of inputting and modifying data with little or no involvement with database tables. It might additionally be beneficial to prepare reports summarizing sales, prescriptions, and supplier interactions. This would improve the system's practicality and efficiency in managing everyday pharmacy operations [8] [9].

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