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Designing an Intelligent Technical System That Provides Alerts When Dispensing Conflicting Medications

Hammida Misbah Salih*, **Saraa Daw Abudawia**

Higher Institute of Industrial Technology, Angeila, Tripoli, Libya
Corresponding email. *Sara.daw.127@gmail.com*

Abstract
The paper outlines the design of a technical system for dispensing conflicting medications to keep pace with technological advancements. This system aims to facilitate medication management and alert against dispensing drugs that interact with other medications, chronic diseases, or certain types of food, thereby helping to improve service efficiency and ensure patient safety, preventing them from unnecessary health risks by reducing human errors. Where medications are dispensed with an integrated mechanism to monitor conflicting drugs or those that interact with diseases, necessitating the development of a more comprehensive mechanism to ensure the safe dispensing of medications from the systems present in pharmacies within Libya**.** Keeping up with technological advancements and attempting to reduce the harm caused by dispensing medications that interact with each other, with the disease, or with the diet by pharmacies. The Modified Waterfall Model was used to develop and create this system, which is one of the well-known models. It was chosen for its flexibility in dealing with the system, allowing us to move to the next phase in the life cycle and revert to any previous phase according to changes in requirements**.** The system was analyzed and described in detail using the Unified Modeling Language (UML), clarifying the system's flow, structure, and classifications. Subsequently, the system was designed, and its outputs were presented as required, in terms of databases and interfaces. It can be said that the system has achieved the goals for which it was designed by executing the required main functions, which are issuing smart alerts when dispensing medications that interact with other medications, chronic diseases, or certain types of food in a smooth and well-programmed manner. This system aims to enhance patient safety by issuing automated alerts during the medication dispensing process, particularly when any potential interaction between the dispensed medication and other medications (drug interactions), chronic medical conditions, or specific types of food that affect the absorption or efficacy of the medication is detected. The system relies on a continuously updated medical database maintained by a specialized data entry professional (doctor or pharmacist). The system issues immediate alerts, contributing to the reduction of medication errors, improving the quality of healthcare, and promoting a culture of safety in healthcare institutions.
Keywords. Waterfall Model, Drug Interactions, Patient Safety, Drug Interactions.

Introduction

The significant development and advancement witnessed in computer science and what technology has offered to humanity have led to its entry into all fields. With the spread of chronic diseases such as diabetes and hypertension, patients have started taking multiple medications from different specialties, increasing the risk of undiscovered interactions. In addition to modern treatments such as cancer drugs (chemotherapy) and immunotherapy, which have complex interactions with other medications, immediate monitoring is required [1]. Given the rapid development of healthcare systems and the increasing complexity of drug therapies, as well as the difficulty of manually remembering thousands of drug interactions [2] , it has become essential to provide smart tools that help improve the accuracy of drug prescriptions and ensure patient safety. Dispensing a medication that conflicts with the patient's health condition or with other medications they are taking may lead to serious complications and could even threaten the patient's life in some cases. This paper aims to design a technical system that enables the automatic detection of drug interactions, whether they result from the interaction of one drug with another, with chronic diseases, or even with certain types of food.

Drug interactions are a major cause of medical errors. Interaction occurs when a drug's effect is altered by the presence of one or more other drugs, or by other factors like food, drink, or a specific chemical environment. If a therapeutic combination leads to unexpected changes in a patient's condition, it may be described as an interaction in a medical examination by multiple physicians. The mortality rate due to drug interactions is 3% to 5% of medical errors [2]. Even with a physician's comprehensive knowledge and ongoing updates on new drugs and their trade names, it is difficult—especially considering varying experience among physicians—to memorize all of them and know their undesirable effects, particularly rare side effects with other drugs. A drug enters the body as a foreign element to produce expected therapeutic benefits and unwanted (non-beneficial or troublesome) effects. Prescribing a drug must consider not only its benefits but also the risks it may cause. The core principle in treatment is analyzing the benefit-risk ratio when

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prescribing a drug. Thus, we need a drug interaction system to help the physician make an appropriate decision.
The aim of the research is to design a system to reduce the harm caused by dispensing medications that interact with each other, chronic diseases, or dietary restrictions by pharmacies. This will be achieved by providing alerts when dispensing medications and enabling patients to access information about their medications and any potential interactions. The system will provide real-time alerts during medication dispensing and enable patients to access information about their medications and potential interactions. The system will also leverage a continuously updated database to detect potential drug interactions.

Methods
One of the well-known models was created, which is the Modified Waterfall Model, due to its ease and flexibility in dealing with the system. The following diagram illustrates the model:

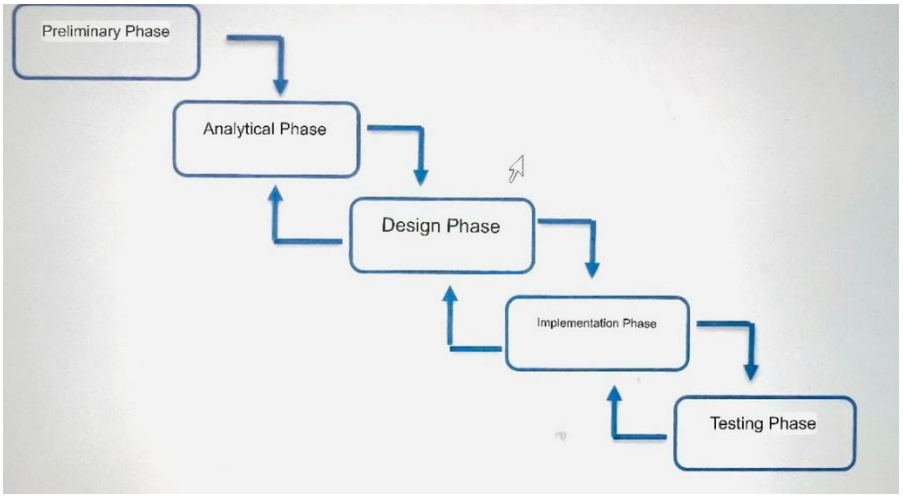

Figure 1. The shapes used for the use case diagram

Personal Interviews
The team conducted an interview with Dr. Ayman Habas Al-Warfali at Al-Sabeel Pharmacy and with Dr. Kholoud at Ousn Al-Ban Pharmacy. These interviews aim to gather the necessary information about the existing system, where a set of questions was posed, and their opinions were surveyed. Based on this information, the requirements will be completed and developed into an integrated system, in addition to presenting the initial form to the users. Among the questions posed in the personal interview are:
-What are the most common drugs that interact with each other?
What are the procedures followed in case of a drug interaction?
-What is the effect of herbs and dietary supplements on the dispensing of medications?
-How do age or other health factors affect drug interactions?
-How is it ensured that the medications being dispensed do not interact with each other?
What information is provided to patients about drug interactions when dispensing them?
-What sources do you rely on to obtain information about drug interactions?
- What tools or software do you currently

Brainstorming session
A session is held by the research team members to identify requirements and add new ideas or solutions used in the system preparation stages. During this session, opinions and ideas were exchanged regarding the data, information, and functions related to the system, benefiting from the expertise of each team member on this subject.

Use Case Diagram
The use case diagram is one of the most important diagrams that can represent the basic functions in the system. In other words, it is a diagram that describes the use cases performed by the actors. The purpose of this diagram is:
- It displays the boundaries of the system.
- The use case aims to cover the entire system.

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- Clarifying the requirements through easily understandable coding.
- It facilitates communication between the customer and the developer, as it is a simple and easy-to-understand diagram.
- A diagram that guides the development team during the development process.

Activity Diagram

An activity diagram is one of the Unified Modeling Language (UML) diagrams used to describe the dynamic aspects of the system, and it represents the design of processes in the project from one activity to another. The activity diagram works alongside the use case diagram to provide a more precise description of the system's states and functions.

Design and Implementation of the Project Phase

In the design phase, a plan is developed to design the technical system. After understanding the previous processes and procedures, we begin designing an accredited medical and pharmaceutical database that contains comprehensive information on drug interactions, dietary warnings, side effects, drug-disease interactions, and usage warnings. At this stage, we also determine the system components and the required data. The accuracy of the design at this stage ensures the system's success in achieving its objectives. The interface programming has been designed using C#, a modern and flexible programming language, designed to meet the needs of complex software development.

Input design

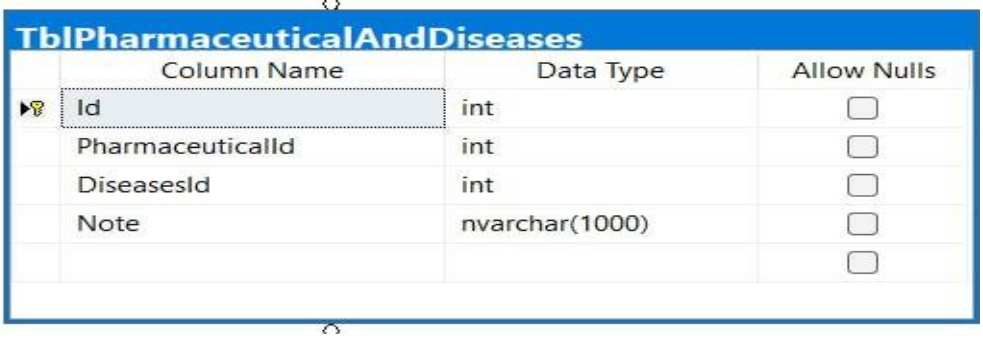
It is considered an essential part of the development process, as it focuses on how users interact with the system. The system inputs should be designed in a way that makes it easy for users to enter information and obtain the desired results effectively and smoothly.

Output design

The design of outputs in the system for dispensing contraindicated medications is a vital process aimed at presenting information and data to users clearly and effectively. The information related to drug interactions with medications, chronic diseases, and specific types of food should be presented in an organized and easy-to-understand manner, helping users identify potential risks, ensuring that user needs are met, and improving patient safety. The database used in the implementation of the project is 2022. Microsoft SQL Server is considered a programming language specifically designed for managing and querying databases. It is characterized by its simplicity and power, making it ideal for performing a wide range of operations on data, such as searching, inserting, updating, and deleting records.

Some tables that were designed

Disease and conflicting medication table


TblPharmaceuticalAndDiseases

Column Name	Data Type	Allow Nulls
Id	int	☐
PharmaceuticalId	int	☐
DiseasesId	int	☐
Note	nvarchar(1000)	☐
		☐

Figure 2. The table shows the disease-conflicting medication table

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Conflicting Medication Table

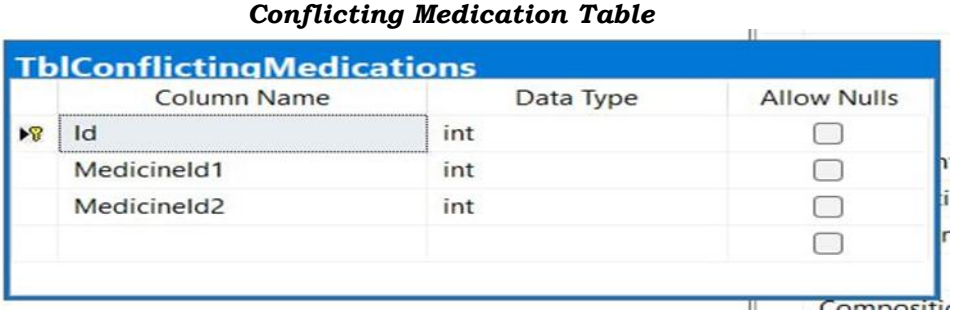

Figure 3. The table shows the Conflicting Medication table

Disease Table

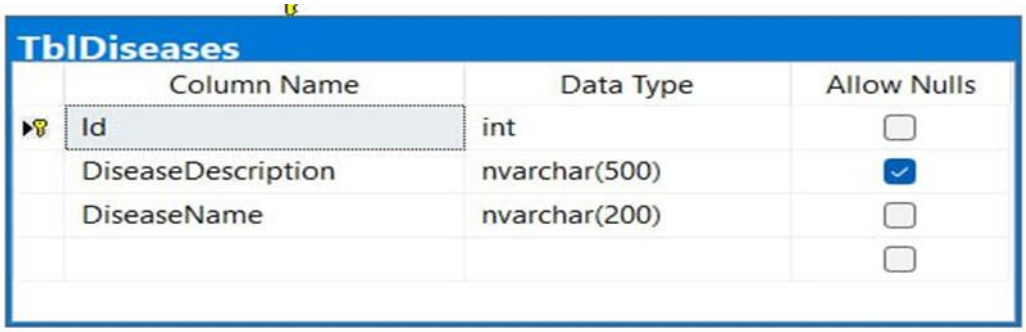

Figure 4. Table shows the disease

Conflicting Medication Data Screen

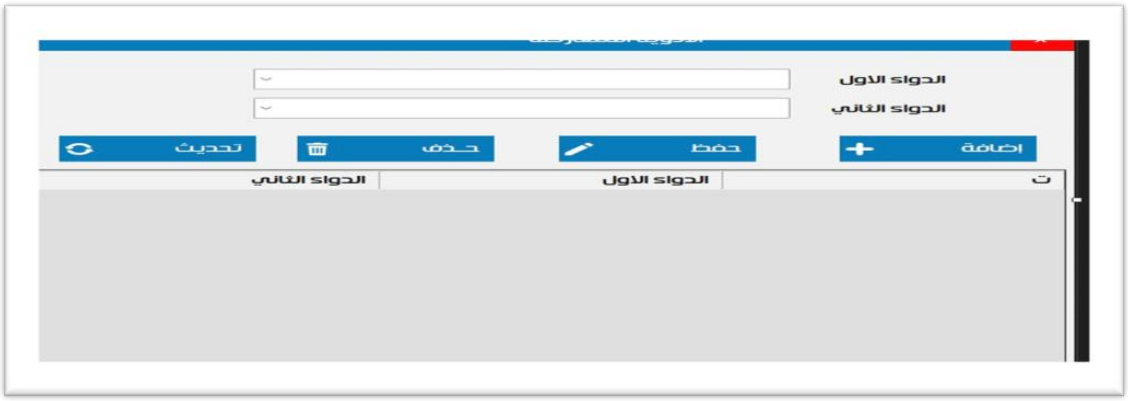

Figure 5. The table shows conflicting medication data screen

Disease and Conflicting Medication Data Screen

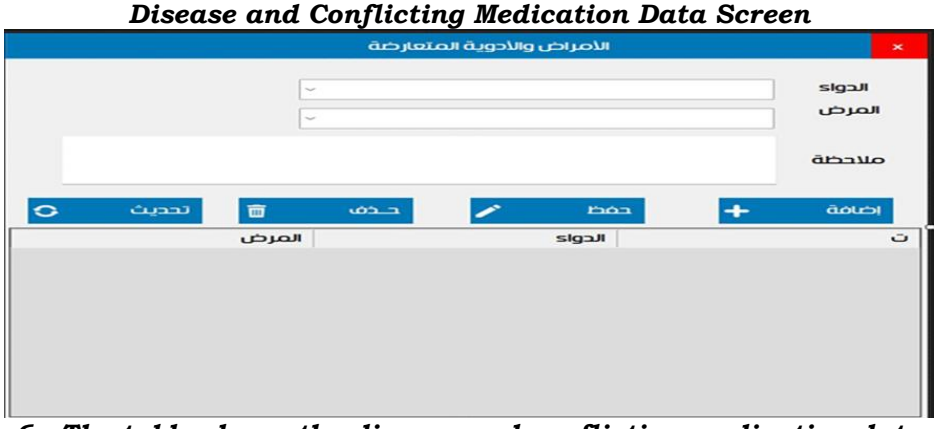

Figure 6. The table shows the disease and conflicting medication data screen

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Testing phase

The testing phase is one of the vital stages in project development, as it plays a fundamental role in ensuring the project's success and effectiveness. During this phase, the system is thoroughly examined to detect any errors or defects that may affect its performance, using a variety of tests. The results are evaluated according to the requirements document to verify the system's compliance with the specified standards.

The tests focus on ensuring that all functions and features work correctly, which helps identify any weaknesses that need improvement before the project launch. Through this process, we ensure the delivery of a high-quality final product that effectively meets users' needs, enhances the safety of dispensing conflicting medications, and contributes to improving healthcare.

System Functionality Testing Plan

It is an organized strategy aimed at evaluating the accuracy of data entry in the system by testing each function individually. The plan includes designing tests to verify the accuracy of the entered and modified information, and providing alert messages to users in case of input and modification errors, as well as alert messages during deletion, which contributes to improving data accuracy and system reliability.

Conflict Function Test

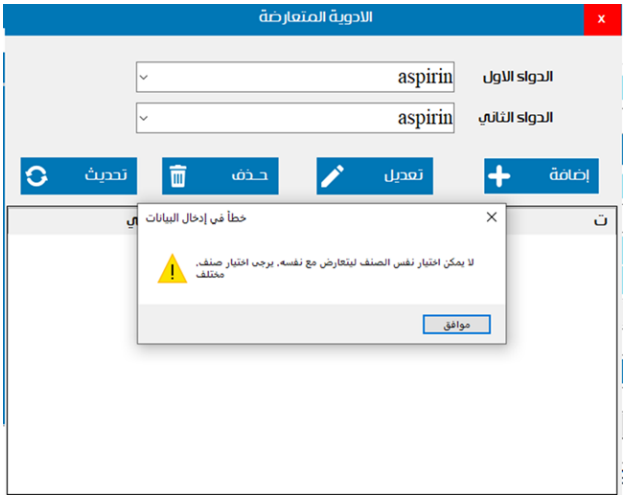

Figure 7. The table shows the conflict function Test

Conflict Dispending Function Testing

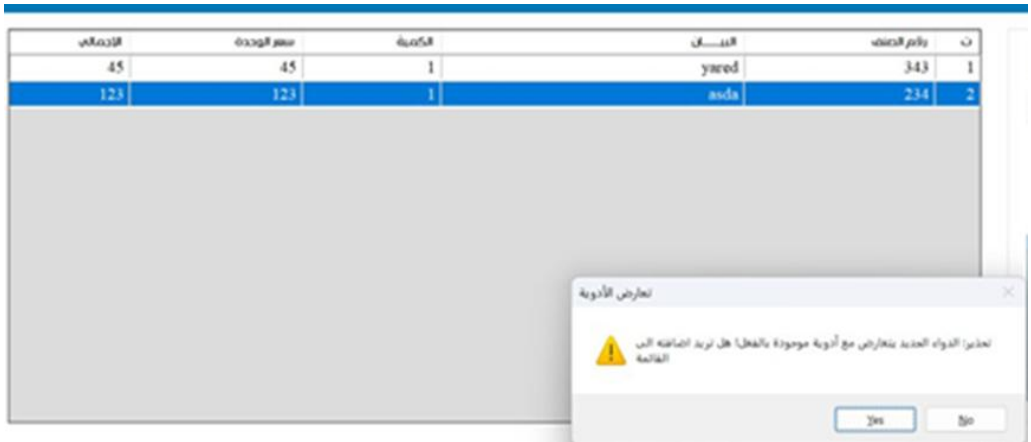

Figure 8, The table shows the function testing

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System data integration test plan
Object integrity
Constraints: No primary key field or other important fields should be allowed to accept a null or zero value. These fields represent the linking data between the drug and disease tables.
Verification: Testing all the primary fields in the database to ensure they contain correct and non-empty data.

Referential integrity
Integrative relationships
Constraints: Ensuring the presence of the data used that clarifies the relationships between the drug and disease tables.
Verification: Testing the join operations in the database to ensure the correctness of the relationships between the tables, and ensuring that each foreign key corresponds to a primary key in the relationship.

Recommendations and Future Directions
Future development of the system should prioritize the integration of patient records, enabling the archiving of medication information for easy retrieval when needed. Implementation of electronic prescriptions can enhance security and efficiency by ensuring direct transmission from healthcare providers to pharmacies, preventing reuse. To improve update efficiency, the system should leverage inferential access to interactions, eliminating the need for comprehensive database updates and enabling more agile modification processes.

Conflict of interest. Nil

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