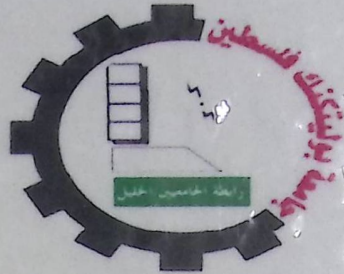


Palestine Polytechnic University

College of Administrative Sciences and Informatics

Department of Information Technology



Radio Frequency Identification Based Library management System

Samiha Monther Siaj

Shadia Waleed Abu-shama

Tasneem Hasan Abu-ajamyeh

Supervisor

Mohammad Jabari

A final project submitted in partial fulfillment of the requirements
for the bachelor degree in information technology

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We owe our deepest gratitude to our supervisor, Mohammad Jabari, whose encouragement, guidance and support from the initial to the final level enabled us to develop an understanding of the project's subject. And sure to God, who made all things possible.

Lastly, we offer our regards and blessings to all of those who supported us in any respect during the completion of the project.

Project Team



Dedication

This project is dedicated to our Parents who have never failed to give us all kinds of support; for giving us all what we needed during the time we developed our system and for teaching us that even our greatest ambitions can be achieved through hard work.

To all our friends and teachers who never gave up helping us to reach what we needed to reach.

Project Team

Abstract

Library Management Systems are systems used to manage all processes handled by a library like adding books, search issues, issuing books and returning them. A lot of problems appear as a result of the used conventional system from typos in data entry, that result in losing the integrity of data and creating uncertain environment for the librarian, to some possible human mistakes in calculations.

The proposed system which is RFID based library management system supposed to handle these processes in a more effective and time saving way. This way is intended to be accomplished by turning all traditionally processed issues into RFID processes.

Radio Frequency Identification which abbreviated RFID is a wireless technology that is used to uniquely identify items- in this case the items are the books. Depending on this aspect, we will implement a number of these processes using the proposed technology which are adding a book, removing a book, searching, shelf management and inventory management.

By implementing the RFID technology we expect most of the problems that come along with working with traditional library systems to be solved.

المخلص

أنظمة إدارة المكتبة هي أنظمة تستخدم لإدارة جميع العمليات المتعلقة بالمكتبة مثل إضافة كتب ، وقضايا البحث المختلفة ، وإعارة الكتب واسترجاعها . هناك الكثير من المشاكل التي تظهر كنتيجة لاستخدام الأنظمة التقليدية في إدخال البيانات ، والتي تؤدي إلى فقدان سلامة البيانات وخلق بيئة غير واضحة لمسؤول المكتبة ، إضافة إلى احتمالية حدوث بعض الأخطاء البشرية في العمليات الحسابية .

النظام المقترح هو نظام التعريف بترددات الراديو (RFID) لإدارة نظام المكتبة والذي يفترض بيه أن يتعامل مع عمليات المكتبة بطريقة أكثر فاعلية وموفرة للوقت . وهذه الطريقة تتحقق من خلال تحويل كل العمليات من عمليات تقليدية إلى عمليات باستخدام تقنية التعريف بترددات الراديو .

تكنولوجيا التعريف بترددات الراديو هي تكنولوجيا لاسلكية تستخدم لتعريف العناصر بشكل فريد وفي حالتنا هذه العناصر هي الكتب . واعتمادا على ذلك سوف ننفذ عددا من العمليات وهي إضافة كتاب ، حذف كتاب ، بحث ، إدارة الرف ، وإدارة المخزون باستخدام التقنية المقترحة .

من خلال تنفيذ تكنولوجيا التعريف بترددات الراديو (RFID) في نظام المكتبة نحن نتوقع أن تحل معظم المشاكل المرافقة لاستخدام النظام التقليدي .

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CHAPTER ONE

Introduction

1.1 Introduction

1.2 Problem Statement

1.3 Objective

1.4 Methodology

1.5 Scope

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1.5.1 Functional Requirements

1.5.2 NON- Functional Requirements

1.6 Time Schedule / Gantt chart

1.7 Research Importance

1.8 The Books

1.9 Project Scope

CHAPTER ONE

Introduction

1.1 Introduction

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1.5 System Requirements

1.5.1 Functional Requirements

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1.6 Time Schedule / Gantt chart

1.7 Research Importance

1.8 The Risks

1.9 Project Scope

1.1 Introduction

The world's new modern tendency is directed towards replacing human actions with technological systems, to make it faster, easier, and more reliable. Recently, the greatest projects around the world are based upon the idea of reducing the amount of money, time and efforts used to accomplish a specific task. For example, using Barcode technology in tracking items being sold in shops and supermarkets, or using digital data instead of all these piles of hand-written data or it's even now applicable to replace entire job specifications with one complete automated system.

One of these technologies that are known as reliable is Radio Frequency Identification (RFID). In the RFID journal they identified it as "A method of identifying unique items using radio waves. Typically, a reader communicates with a tag, which holds digital information in a microchip".

1.2 Problem Statement

Library Management system including all of its operations from checking in/out books to shelf management are well understood operations but mostly applied in a traditional way using the known conventional methods. Having all these books placed in the library makes the operations related to inventory management, counting books or even checking books in and out time and effort consuming.

Through converting these operations into RFID based ones; we will try to reduce the disadvantages and obstacles created by the use of conventional methods.

1.3 Objective

The main objective of this project is to develop a RFID based library management system, which can be used by Palestine Polytechnic University (PPU) library to help librarian and students to deal with more efficient process.

The project objective can be achieved through specifying the following major steps:

- **Studying and analyzing the existing library system implemented at the Palestine Polytechnic University library.**
- **Specifying the operations done in the library that can be enhanced by converting it into RFID based processes.**
- **Integrating the completed –enhanced- process with the old system.**

Depending on the steps mentioned above, we may break them down into concrete functions or deliverables as follows:

- **Studying and analyzing the existing library system implemented at the Palestine Polytechnic University library.**
 1. Studying the existing database being used in the library, since a database is being used with records about each book.
 2. Since the book is the basic element in the proposed system, we need to know how many books do we have, and in what subjects.
 3. Identifying the disadvantages that appear along with the use of the conventional methods.
- **Specifying the operations done in the library that can be enhanced by converting it into RFID based processes.**
 1. Studying the flow of the library process.
 2. Detecting a number of processes to be enhanced. Detected processes only will be converted into RFID based ones.

- **Integrating the completed –enhanced- process in the old system.**
 1. Determining the programming language that will be used in the construction of the application.
 2. Programming the application to be a part of the library management system; hence compatible with the existing database.

1.4 Methodology

The project team will use the traditional method of software engineering, which is called System Development Life Cycle (SDLC), in the analysis and development of the system.

We will start by studying the existing library management system and detecting a number of processes to be enhanced through converting them into RFID based ones.

1.5 System requirements

This section lists both functional and non functional requirements of the system.

1.5.1 Functional Requirements:

- checking out books, and checking them back in again
- Inventory Management.
- Antitheft.
- Shelf Management.

1.5.2 Non functional requirements

- Compatibility
- Usability

Weeks	1	2	3	4	5	6	7	8	9	10	11
T1	█										
T2						█					
T3							█				
T4									█		
T5	█										

Table (2) Gantt chart1 (First semester)

Below is a brief description of key activities stated in Table (3)

	Key Activities	Duration	Description
T1	Design (final)	3 weeks	Demonstrates the final design draft.
T2	programming	8 weeks	Coding by Visual Basic .Net
T3	Installation	2 week	Technical details and shows the Installation Environment.
T4	Implementation	3 week	Running the complete system .
T6	Documentation	All the time	
	Total	16 weeks	

Table (3) system Scheduling (Second semester)

Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
T1	█															
T2					█											
T3												█				
T4															█	
T6	█															

Table (4) Gantt chart (Second Semester)

1.7 Research Importance

1.7.1 For the research team

- This research is a requirement for the completion of the bachelor degree in Information Technology.
- Inception of practical experience, gaining knowledge and improving skills of the team members.

1.7.2 For the Librarian

- Time and effort saving.
- Reducing the human-efforts that are used in the traditional system.
- Long term cost reduction.
- Easier shelf management process.
- Easier information referencing through update operations.

1.7.3 For the University

Keeping the university up to date with projects that use The state-of-the-art in enhancing its environment, done by their own students.

1.8 The Risks

During the different phases of the project, some risks may appear and cause delays or even threatening the progress or the project's outcomes. Below some expected risk events are listed:

1. The system is concentrated on the ID read by the reader, so if any of the readers broke down it will cause some of the system processes to stop.
2. Lack of knowledge of the librarian in the readers' components and their functionality.
3. Reader malefaction.
4. Loss of the reader itself or one of its components.
5. Absences of one or more of the team members.
6. Lack of time and time scheduling issues between members.
7. unexpected results
8. Installation Problems.

1.9 Project Scope

The proposed system will operate within Palestine Polytechnic University library located in Abu-roman.

CHAPTER TWO

Background

2.1 Introduction

2.2 RFID System Components

2.2.1 .RFID Readers

2.2.2 RFID Tags

2.2.3 Software application

2.2.4 Antenna

2.1 Introduction

RFID is the abbreviation of Radio Frequency IDentification. It is a technology that enables the electronic labeling and wireless identification of objects using radio frequency communications. In the RFID journal they identified it as “A method of identifying unique items using radio waves. Typically, a reader communicates with a tag, which holds digital information in a microchip“. (RFID Journal, 2008)

2.2 RFID system

A typical RFID system consists of the following components: (RFID Journal)

1. Tags

It's the part into which identification data can be embedded. These are the components that identify the items to which they are attached. RFID tags are also called transponders or more generally (contactless data carriers).

2. Readers

The device that communicates wirelessly to the tags (contains an antenna and a transceiver or decoder, as well as memory and some processing capability).

3. Software application

It's the part that reads/writes data to/from tags through the reader. The application software (in a workstation or pc) initiates all communications between the reader and the tags. Both the reader and the tags are equipped with antennas that receive and emit electromagnetic wave.

4. Antenna

Its an important component to transport the signal and receive it. See In figure (2.1) the RFID.

The antenna creates the magnetic field by which it can detect the frequencies available in the range, and that's what supplies the passive tags with power to transmit its ID.

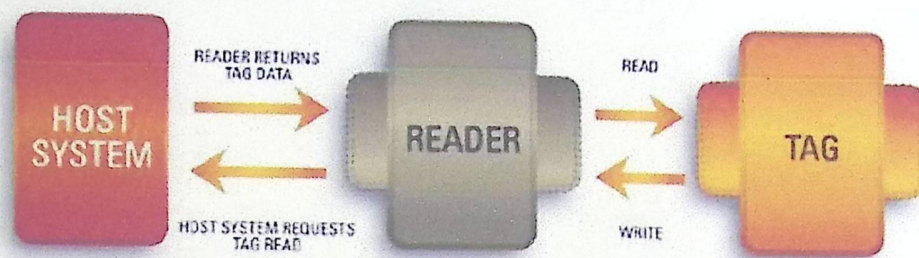


Figure (2.1): RFID System

Source: "<http://www.stronglink.cn/images/rfidnews.jpg>"

2.2.1 RFID Readers

RFID readers are devices that convert radio waves from RFID tags into a form that can be passed to middleware software.

An RFID reader accomplishes two tasks:

- It receives commands from the application software
- It communicates with tags

Readers may be handheld or mounted on a particular object as you can notice from Figure (2.2) and (2.3). In the case of handheld readers, the workstation (loaded with the application software), the reader and the antenna are all part of one device. Data exchanged with tags may be stored and transferred to a main processing unit at a later stage depending on the application.

An RFID reader is practically a bridge between the application software and the antenna that radiates radio waves towards the tags. (e-How Contributor, 2010)



Figure (2.2): Hand Held RFID Reader

"Source: http://www.rfidjournalevents.com/virtual_agenda.php?eid=8"



Figure (2.3): RFID Reader

"Source: <http://www.stronglink.cn/images/rfidnews.jpg>"

2.2.2 RFID Tags

RFID tags are made up of an electronic circuit and an antenna integrated all into one. The electronic circuit of an RFID tag generally has a memory where data may be stored. The memory is physically – and logically – divided

into cells. Some of these cells store data that may be read only, such as unique serial numbers placed on products. Other cells of an RFID tag may be both written to and read repeatedly.

RFID tags may be active or passive depending on whether they have an on-board power source or not. (GeorgeL,2010)

- **Active tags**

Active tags reduce the power requirements of the reader and can transmit information over relatively far ranges.

They contain a battery that can last from two to seven years. The down-sides of such tags are their cost and their size, which reflects their complexity. Generally speaking, the more functions an RFID tag can perform, the more complex and bigger it will be. (Eric Novinson, 2010)

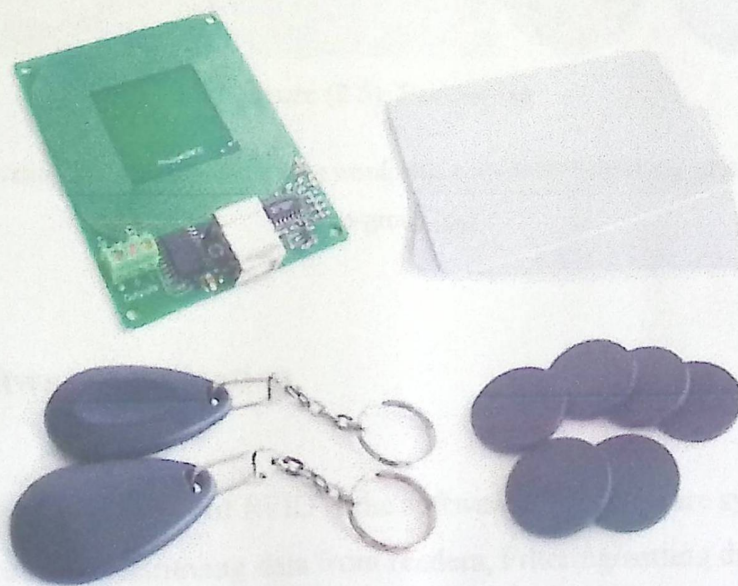


Figure (2.4): Active Tags

"Source: <http://www.crunchgear.com/wp-content/uploads/2009/04/rfid.jpg>"

- **Passive tags**

Passive tags are less complex than active tags, because the reader provides them with their operating power. They are small, light, and inexpensive and can last up to 20 years. Their range of transmission is relatively short and RFID systems with passive tags require a highly powered reader. (Matt Allbritton, 2010)

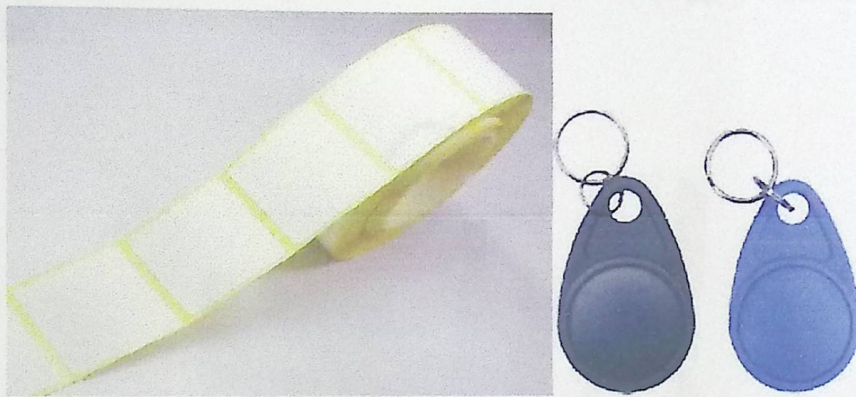


Figure (2.5): Passive tag

"Source: http://rfidparadiseofparadises.files.wordpress.com/2009/10/rfid-tag_philadelphia_quelle-metro-group.jpg"

2.2.3 Software application

The other component of RFID is the software or middleware systems. RFID middleware is for Retrieving data from readers, Filtering/sorting data that flows to the application software, Generating objects movement notifications, Monitoring tag and reader network performance, Capturing history, Analyzing tag-read events for application tuning and optimization.

As previously mentioned the application must include a database system to capture the history of the objects' movements.

Next we will discuss some applications or solutions of RFID problems and solutions from RFID technology. (Helen Akers,,2010)

2.2.4 Antenna (Palmer Owyong, 2010)

The final component of the RFID system is the antenna, which is the element that enables the tag to send and receive data. Passive tags when it receives the radio frequency it create a magnetic field to enable the tag to transmit data to the reader.

RFID tags have many types in different criteria read only, rewritable, programmable.

Antenna is used in wireless networks where RFID is used as a solution; the coverage of the wireless network is the space that the tagged object can be tracked in

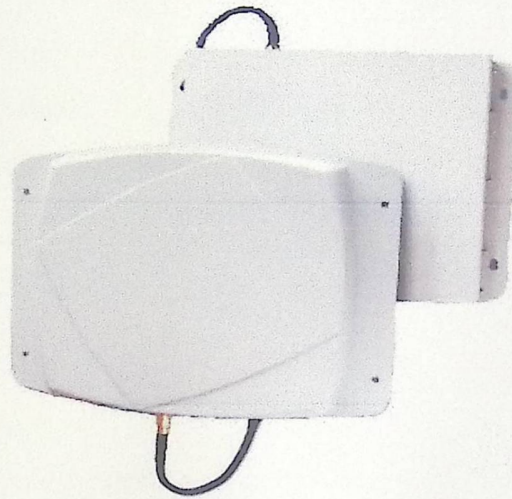


Figure (2.6): Antenna

"Source:http://www.gaorfidassettracking.com/RFID_Asset_Tracking_Products/images/rfid_antenna_326002.jpg"

CHAPTER THREE

System Requirements

3.1 Introduction

3.2 Major alternative for RFID

3.3 Requirements

3.4 Feasibility Study

3.5 Constraints

3.6 Limitation

3.7 Risks

Advantages of Bar Code

- Relatively simple
- Cost-effective: Most of the products are labeled with barcodes when manufactured
- Easy Access to Information: it provides faster access to information compared to the traditional system.
- Easy of implementation
- Accurate

Disadvantages of Bar-Code

- Bar code needs to be undamaged
- Bar code needs to be read when scanned
- Bar code needs good lighting and a relative short distance between the scanner and the label

3.1 Introduction

In this chapter we will introduce some alternatives to the technology we're using to solve the problems demonstrated (RFID), risks, limitations, constraints and project's time schedule. After that we will discuss the system requirements, both functional and non-functional requirements. Then we will list the system feasibilities.

3.2 Major Alternative for RFID

3.2.1 Bar Code

Bar code is defined in most references as "a method of automatic identification and data collection". And can be described as "a Series of black bars and white space of varying widths are printed on labels to uniquely identify items. The barcode labels are read with a scanner, which measures reflected light and interprets the code into numbers and letters that are passed on to a computer".

Advantages of Bar Code

- Relatively simple
- Cost-effective: Most of the products are labeled with barcodes when manufactured.
- Faster Access to Information: it provides faster access to information compared to the traditional system.
- Ease of Implementation
- Accuracy

Disadvantages of Bar-Code

- Bar code labels can be easily damaged
- Bar code labels can't be read when scratched.
- Bar code labels need line-of-sight when read and a relative short distance between the reader and the label.

3.2.2 The Advantages of RFID over Bar Code in general

RFID offers an alternative technology to bar code technology. These two technologies are similar, but they are different when it comes to data collection and auto identification technologies, and their applications are also often different. Sometimes it is necessary to use both technologies, while other times one technology is superior to the other in certain applications.

The two key points that make the RFID technology is superior to the Bar-Code technology are:

- Line of Sight:

RFID does not require a direct line of sight when reading the tags. It can read any tag in the range of the reader's antenna, while Barcode needs a direct line between the scanner and the label to read.

- Speed:

Barcode scanner reads one label at most at once while RFID reader can read up to 30 tags per second in some cases.

Table (5) below clarifies the main advantages RFID gained over Barcode.

	RFID	Bar Code
Forms	RFID comes in tag or label form, which are electronic and encoded. RFID involves a small transponder, typically copper.	Bar codes are printable; that's why manufacturers simply print them on the items to be sold
Cost	The least expensive RFID tag costs \$0.07	Bar codes are practically free, but they require electronic readers.
Line of Sight	RFID depends upon a radio signal; thus, line of sight is not required. Because of this, RFID can be read at longer ranges, and faster, than can bar codes.	Bar codes require the line of sight. The electronic reader must "see" the bar code

Read\Write	The advantage also goes to the RFID technology here. RFID technology offers not only reading capabilities for tags, but also writing, modifying and updating capabilities.	Once bar codes are printed , its impossible to change or re-configure them again.
Durability	RFID tags tend to be protected much more thoroughly, and they can even be attached internally, allowing them to be read in the harshest of environments	bar code labels are not durable at all. They can be damaged or removed easily, and if they become greasy or dirty, they cannot be read at all.
Security	RFID tags offer improved security over bar codes. RFID tags cannot be replicated easily, and the data that they contain can be password protected or encrypted, or may even include what is known as a kill	bar codes offer low level security and can be counterfeited or reproduced much more easily.

	feature!!	
Event Triggering	Another advantage that RFID tags offer over standard bar codes is the ability for event triggering. RFID tags can be utilized in order to trigger specific events such as alarms or door openings	This is not an ability that bar codes offer at all.

Table (5): comparison between RFID and Barcode

3.3 System requirements

This section lists both functional and non functional requirements of the system.

3.3.1 Functional requirements

- Checking out books and checking them back in again.
- Inventory management.
- Adding items to the library's collection.
- Shelf management, with lost book.
- Searching for specific books.

3.3.2 Non functional requirements

- Compatibility: The new system's database must be compatible with the old existing database.
- Usability: The librarian will interact with the system to check or add book through a user-friendly graphical user interface, or generating

reports that contain both textual and visual representation of the results.

- Providing a high-secured database and a maintainable system.

3.4 Feasibility Study based on Quality

This section shows the feasibility for system development and operations.

3.5.1 Development requirements

1. Development hardware resources

Table (6) below shows the hardware resources that are needed during the development phase along with their costs.

Hardware Component	Cost
Sony Vaio , Intel Core i5 - 520M / 2.40GHz , RAM 4 GB HDD 500GB , Win 7 Pro , 14.1" Widescreen TFT 1280 x 800.	800 \$
Total	800 \$

Table (6): Hardware Development resources and costs

2. Development software resources

Table (7) below shows the software resources that are needed during the development phase along with their costs.

Software Component	Cost
Windows 7 professional	159 \$
Visual studio 2005	299 \$
SQL Server 2005	49\$
Microsoft Office 2007	103 \$
Total	610 \$

Table (7): Software Development Resources and Costs

3. Development human resources

The cost of development is zero because the developers of the system are the project group team and the system development is part of their graduation requirements.

3.5.2 Operational requirements based on library system

1. Operational hardware resources

This system will be hosted on a server that is already located at the computer center, table (8) below shows the hardware resources that are needed during the implementation phase along with their costs.

Hardware Component	Cost
RFID Reader (Fixed US freq band, 2-port RFID Reader).	1600 \$
Antenna (RFID ANT 1 port wide band-right)	175.00 \$
RFID Tags	0.07 \$
Total	1775.07 \$

Table (8): Operational Hardware Resources and Costs

2. Operational software resources and costs

Table (9) below shows the software resources that are needed during the operation phase along with their costs.

Software Component	Cost
.Net Frame Work	0 \$
SQL Server 2005	1.849 \$
Total	1.849 \$

Table (9): Operational Software Resources and Costs

3. Operational human resources

The human operational cost is zero, because the librarian is an employee at Palestine polytechnic university and he's already paid salaries for his jobs.

3.5.3 Total cost

Table (10) below shows the total costs for the hardware, software, and human resources that are required for both system development and implementation.

Development Costs	Operational Costs	Total
1410\$	1776.919\$	3186.919\$

Table (10): Total Costs

3.6 Constraints

1. The team must work within a limited budget.
2. This system must use the existing system database.
3. The Project must be submitted during a pre-defined period of time and up to a specific date.
4. The system must be able to be maintained according to organized test plan.
5. Use of short range reader.
6. The team faced a lot of obstacles during the idea-identification phase.

3.7 Limitations

1. The coverage range of available readers is limited to 80 cm only.
2. There are no licenses offered for applying it in public places yet –but it can be obtained.

3.8 Risks and Solutions

1. The system is concentrated on the ID read by the reader, so if any of the readers broke down it will cause all the system to go down (hardware malefaction.).

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3.8 Risks and Solutions

1. The system is concentrated on the ID read by the reader, so if any of the readers broke down it will cause all the system to go down (hardware malefaction.).

2. Lack of knowledge of the system administrator in the readers' components and their functionality.

Solutions:

- ✓ Prepare a manual or list of instructions for the system users, besides providing some training courses for users interacting with the system.
 - ✓ Perform right and careful requirement analysis from the beginning.
 - ✓ Provide instant backup copies of the data stored.
 - ✓ Providing enough security to save equipment from theft.
3. Absences of one or more of the team members.
 4. Lack of time and time scheduling issues between members.

Solution:

- ✓ Trying to solve team's internal conflicts as much as possible.

5. Unexpected results.

Solution:

- ✓ Periodic system maintenance and testing, with continuous work on preparing any damaged parts of the system.

6. When having storage issues, we may add memory of any size.

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CHAPTER FOUR

System Specification

4.1 Introduction

4.2 General Description of the system

4.3 analysis Models

4.3.1 Use Case

4.3.2 Sequence Diagram

4.3.1 Use Case

The Use Case is used to describe the system as whole. As shown in Figure (5), the system has a database, a librarian and the reader.

4.1 Introduction

In this chapter we will introduce the system specifications, through providing a general description of the system and then using analysis models to clarify the processes.

4.2 General Description

The proposed system supposed to provide the library with some enhanced library processes using RFID technology. These processes include the books' processing like adding and deleting, shelf management, searching and inventory management. These processes are going to be performed using an RFID system with a tag placed on each book and a reader through which the librarian can perform the needed processes.

4.3 Analysis Models

4.3.1 Use Case

The Use Case is used to describe the system as whole. As shown in Figure (6), the system has a database, a librarian and the reader.

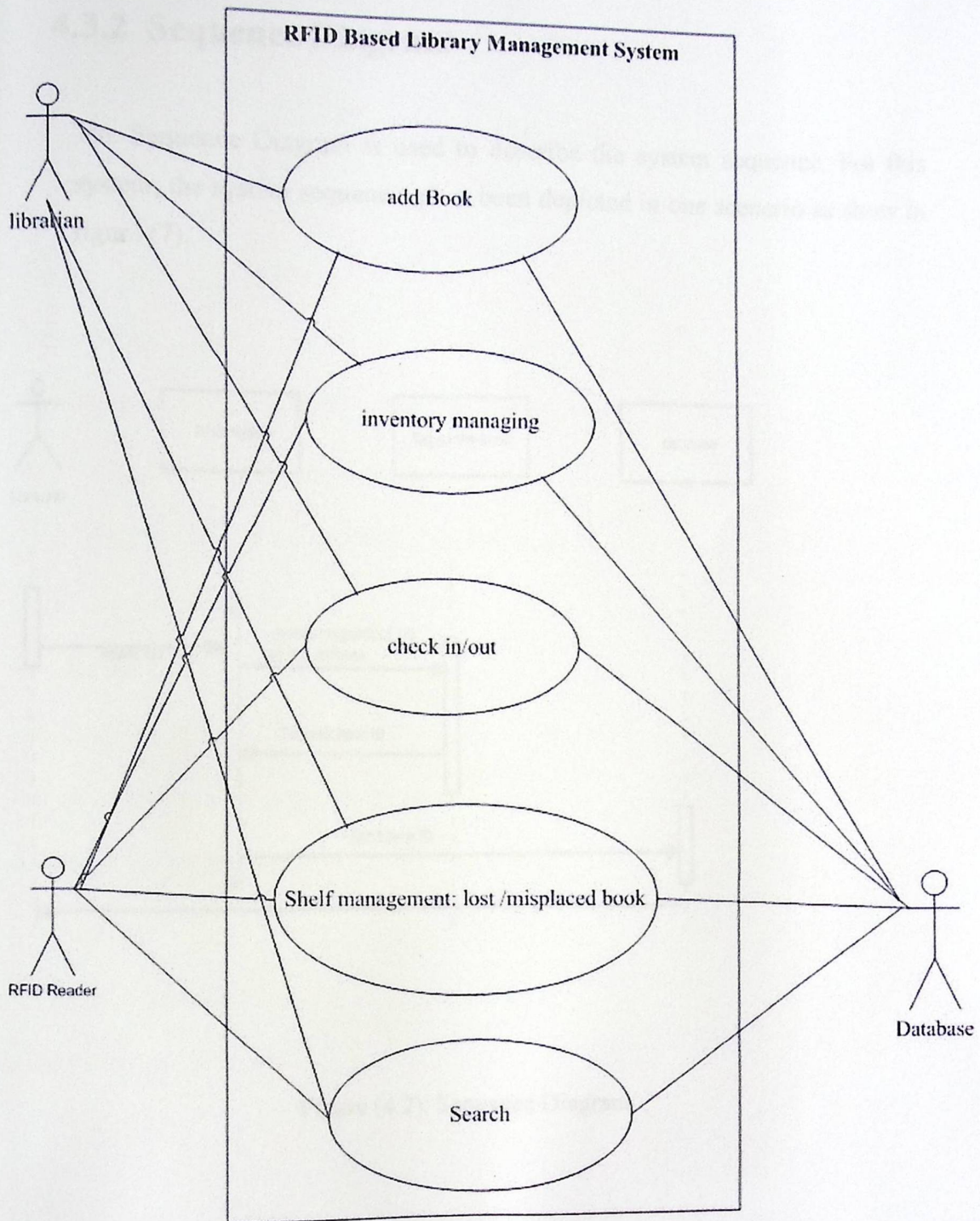


Figure (4.1): Use Case

4.3.2 Sequence Diagram

The Sequence Diagram is used to describe the system sequence. For this system, the system sequencing has been depicted in one scenario as show in figure (7).

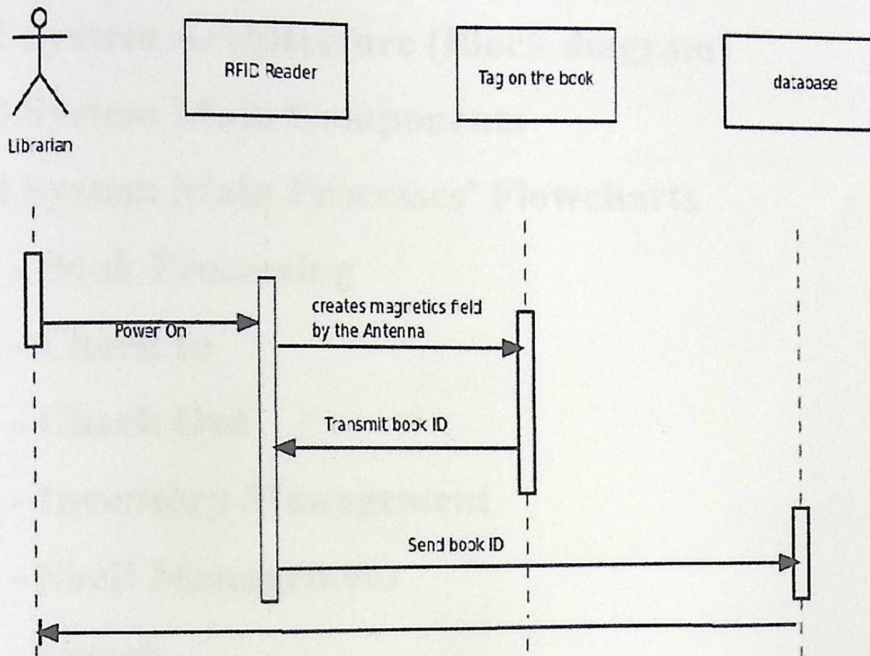


Figure (4.2): Sequence Diagram

The scenario:

- The librarian must power on the reader
- After the reader is on , it creates a magnetic field by the antenna
- The tag placed on the book into that magnetic field transmits the book ID.
- The reader then sends the book's ID to the Database to be used in the application to perform the needed management operations.

CHAPTER FIVE

System Design

5.1 Introduction

5.2 System Architecture (Block diagram)

5.3 System Main Components

5.4 System Main Processes' Flowcharts

- Book Processing**
- Check In**
- Check Out**
- Inventory Management**
- Shelf Management**
- Search**

5.5 Fault Tolerance

5.6 Interface design

5.1 Introduction

This Chapter will illustrate the system's main components. It will analyze the system and clarify its relationship with the surrounding systems. After that we will divide the system into several processes according to the pre-specified functional requirements. Each process will be detailed further using algorithms and flowcharts. It will also show the general schema of the database with a detailed view of the most referenced tables.

5.2 System Architecture

The block diagram (5.1) below illustrates the general architecture of the RFID based library system. It shows how the reader is connected to the librarian PC and the referencing to the database.

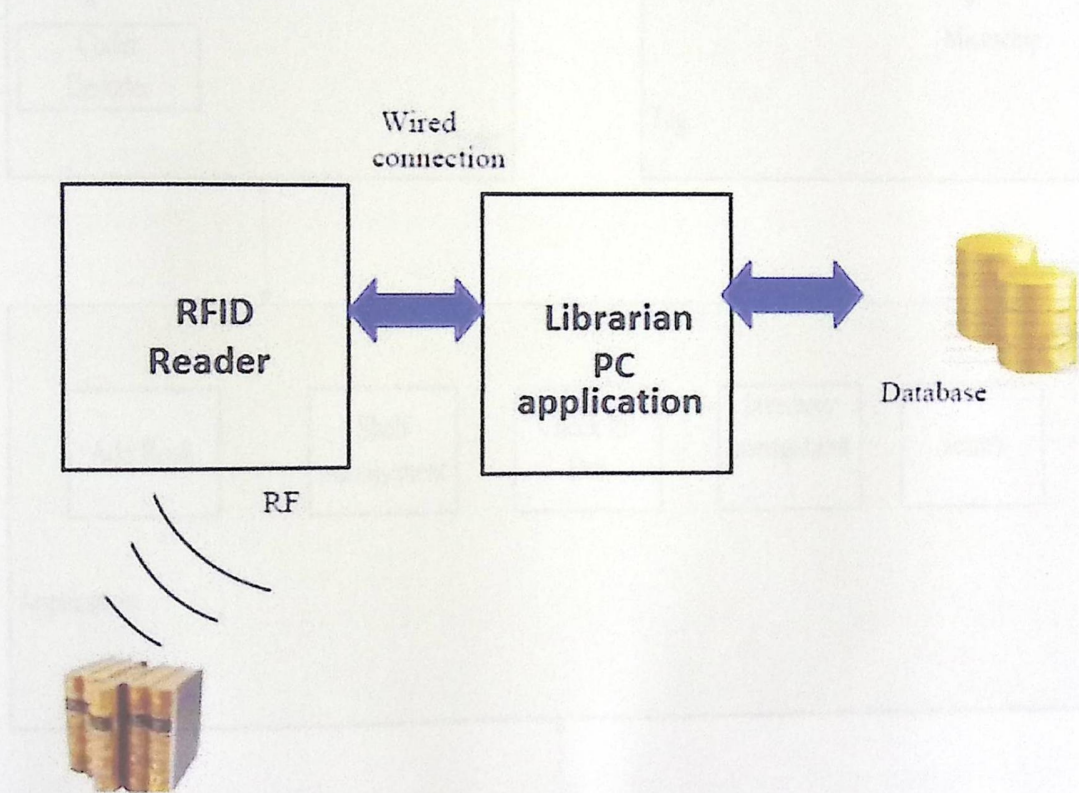


Diagram (5.1): Block Diagram

The Block diagram listed below as diagram (5.2) illustrates in more internal details the system's main components, namely

- Database
- Reader
- Tag
- Application Software

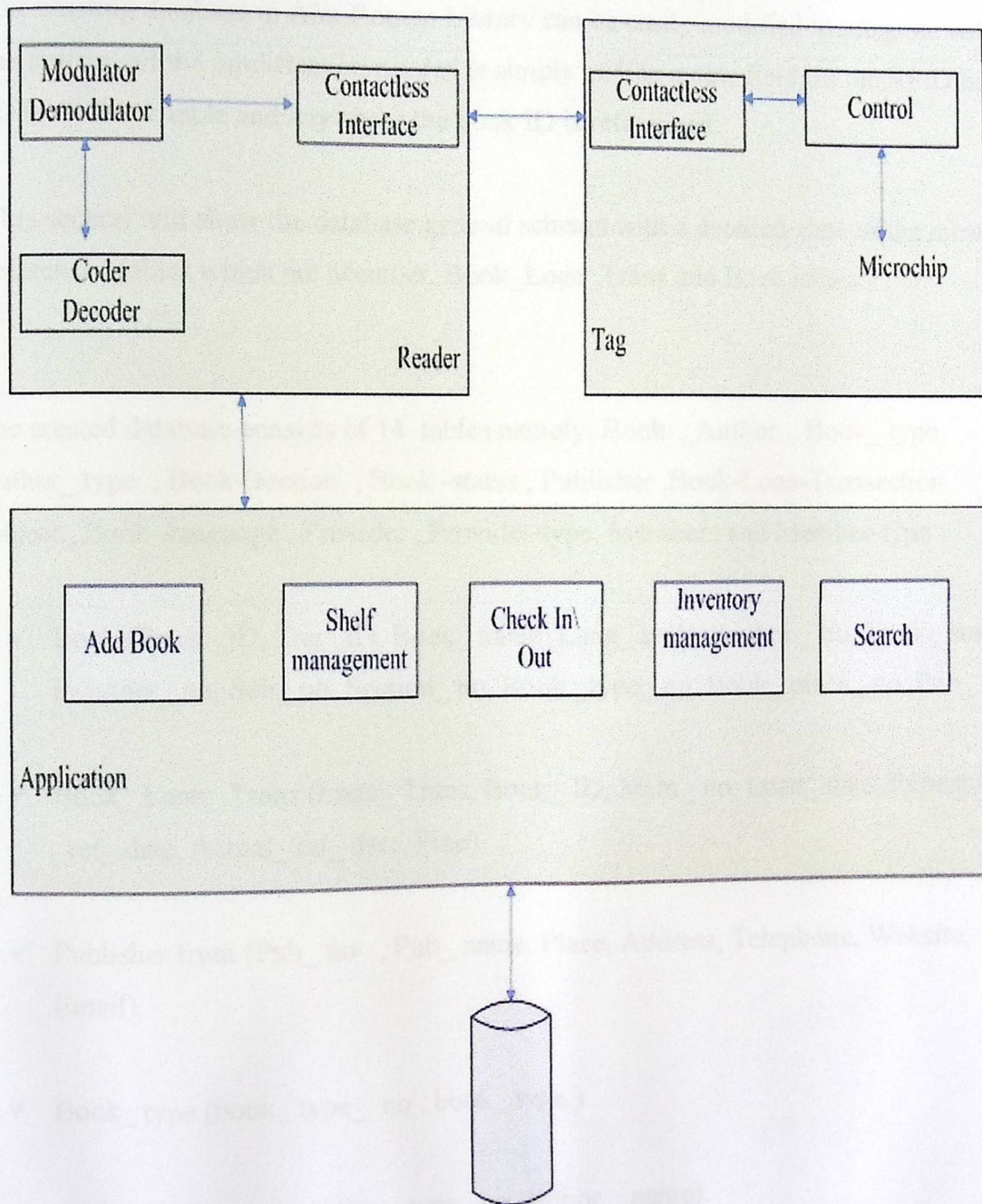


Diagram (5.2): System Main components

5.3 System Main Components

- **Database**

The database used in the system is a new database established for the purpose of testing. As addressed before the system will be developed in a way that is compatible with the existing database.

The existing database in Abu-Roman Library can be easily modified to integrate with the system, all the modification needed is simply adding a new field for the RFID tag ID in the book table and anywhere the book ID is referenced.

This section will show the database general schema with a detailed view of the most referenced tables which are Member, Book_Loan_Trans and Book tables.

The created database consists of 14 tables namely; Book , Author , Book_type, Author_type , Book-section , Book-status , Publisher ,Book-Loan-Transaction ,Subject , Book-language , Provider , Provider-type, Members and Member-type .

- ✓ Book (Book_ID, Tag_ID, Book_name, Lang_code, Author_no, Book_status, Provider_no, Sub_no, Section_no, Book_type_no, Book_place_no, Pub_no)
- ✓ Book_Loan_Trans (Loan_Trans, Book_ID, Mem_no, Loan_date, Expected_ret_date, Actual_ret_date, Fine).
- ✓ Publisher from (Pub_no , Pub_name, Place, Address, Telephone, Website, Email).
- ✓ Book_type (book_type_no , book_type)
- ✓ Author (author_no, author_type_no, author_name).
- ✓ Author_type (author_no, author_type_no).

- ✓ Book_section (section, section_no).
- ✓ Book_status (book_status_no, book_status).
- ✓ Subject (subject_no, subject).
- ✓ Book_language (language, Lang_code).
- ✓ Provider (provider_no, provider_type_no, provider_name).
- ✓ Provider_type (provider_no, provider_type_no).
- ✓ Members (Mem_no , Mem_name , Mem_sex , marital_status, date_of_birth , address , telephone , mobile , email , subscription_date ,end_date , Mem_type_no) .
- ✓ Member_type (Mem_type_no, Mem_type, Max_loan).

Figure (5.3) below illustrates the general database schema and the relationships among them.

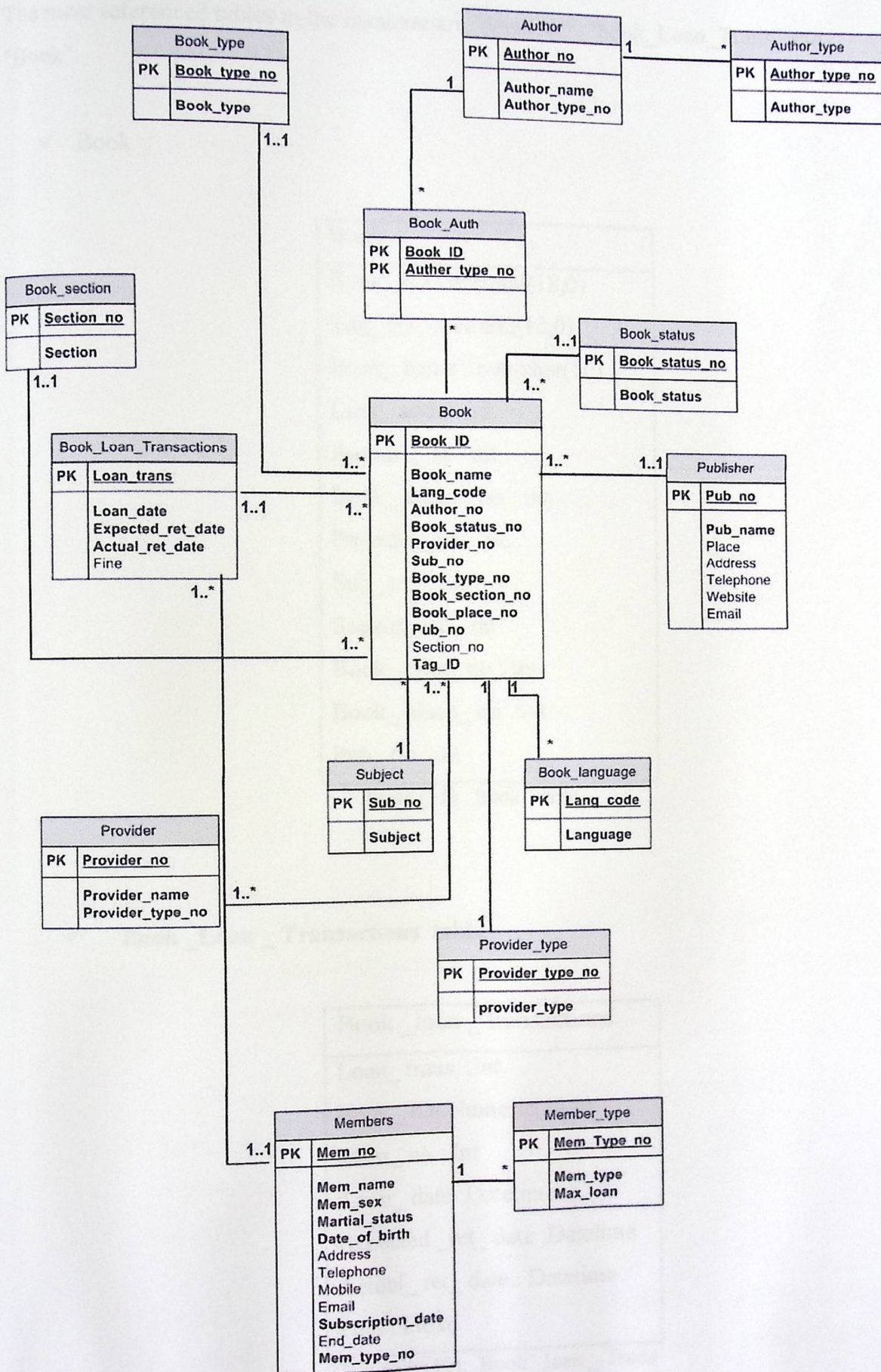


Figure (5.3): The general Database Schema

The most referenced tables in the database are "Member", "book_Loan_Trans" and "Book".

✓ Book

Book
Book_ID : decimal(18,0)
Tag_ID : numeric(18,0)
Book_name : nvarchar(50)
Lang_code : int
Author_no : int
Book_status_no : int
Provider_no : int
Sub_no : int
Section_no :int
Book_type_no : int
Book_place_no :int
Pub_no : int

Table (11): book Table

✓ Book_Loan_Transactions table

Book_loan_transactions
Loan_trans :Int
Book_ID: Numeric(18,0)
Mem_no : Int
Loan_date :Datetime
Expected_ret_date :Datetime
Actual_ret_date : Datetime
Fine : Float

Table (12): Book_loan_Trans

✓ Member

Member
Mem_no : Int
Mem_name : Nvarchar(50)
Mem_sex :Nchar(10)
Martial_status :Nchar(10)
Date_of_Birth :Datetime
Address: Nvarchar(50)
Telephone : Nvarchar(50)
Mobile : Nvarchar(50)
Email : Nvarchar(50)
Subscription_Date :Datetime
End_Date :Datetime
Mem_type_no : Int

Table (13): Member

- **Application Software**

It is the application that the end user (librarian) will deal with. It consists of a number of forms through which the librarian can achieve the main functions of the library system.

The application software also works as a mediator application through which the librarian can communicate with the reader that itself communicates with the tags. This closed circle of the application, reader and tags is what set up the actual system.

The application is designed in a way that collect all of the system processes in a meaningful way and applicable through user-friendly interfaces, so it can achieve the goals intended from all the pre-defined functional requirements.

The Diagram (5.4) below shows the main processes of the application and how each process refers to the database.

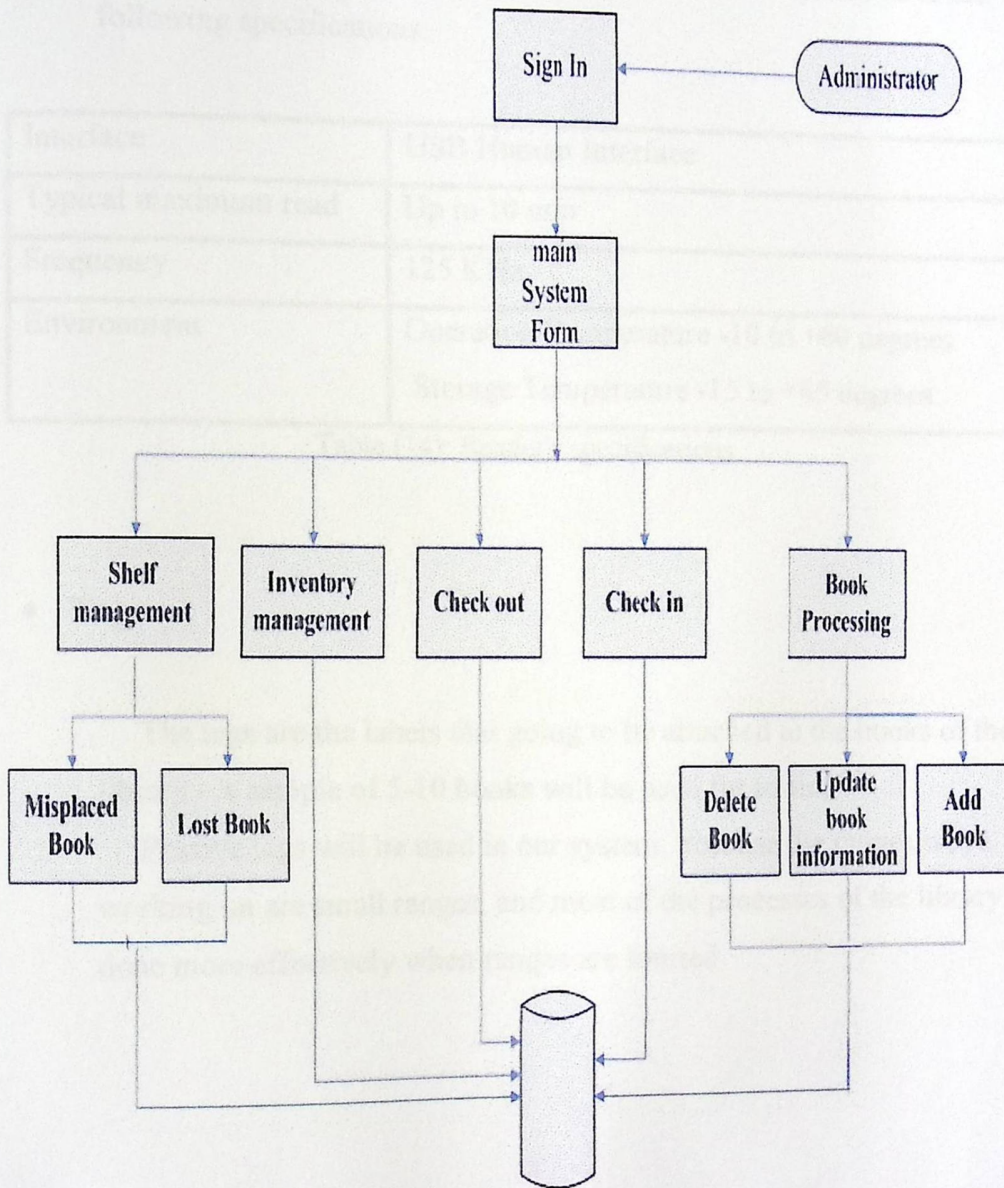


Diagram (5.4): System Main Processes

- Reader

The reader is the physical component that reads the tags and passes it over to the application software. It does nothing but reading all frequencies of the tags in its range. Every reader comes with specific specifications that are specified at the manufacturing stage.

The reader is going to be used for the testing of this system have the following specifications:

Interface	USB Human Interface
Typical maximum read	Up to 10 mm
Frequency	125 KHz
Environment	Operation Temperature -10 to +60 degrees Storage Temperature -15 to +65 degrees

Table (14): Reader's specifications

- **Tag**

The tags are the labels that going to be attached to the books of the library – a sample of 5-10 books will be used for testing.

Passive tags will be used in our system, because the ranges we're working on are small ranges, and most of the processes of the library are done more effectively when ranges are limited.

5.4 System Processes Flowcharts

Add new book

- ✓ Attach the tag to the desired book.
- ✓ Insert the new tag's ID into the database in the predefined order of the shelf.
- ✓ Add the book's information to the database.
- ✓ Place the book in the right order on the shelf

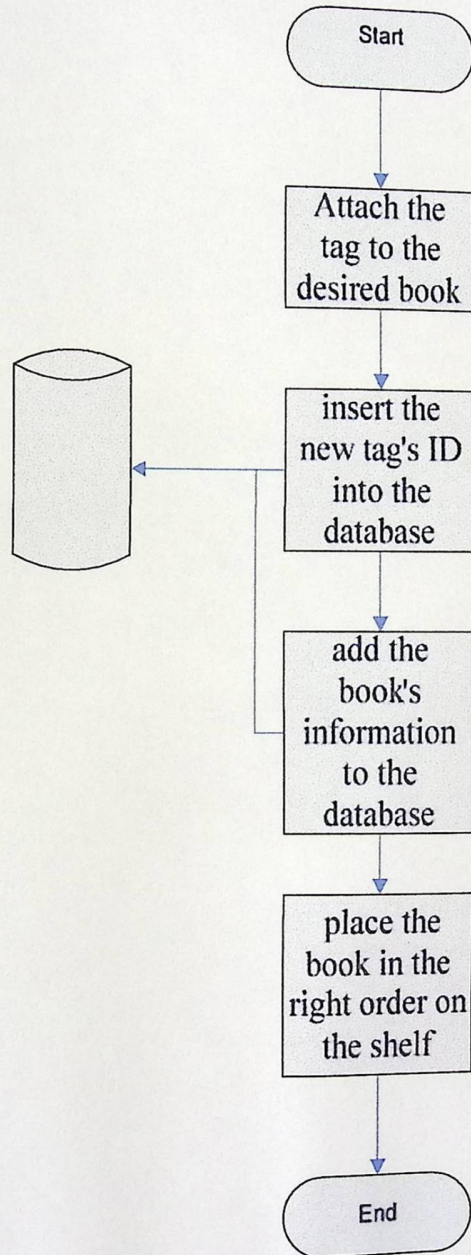


Figure (5.5): Add Book

Check In

The librarian uses the reader to read the ID of returned book, then change the status of the book from "Borrowed" to "Available", and remove the book from the person's borrow-list.

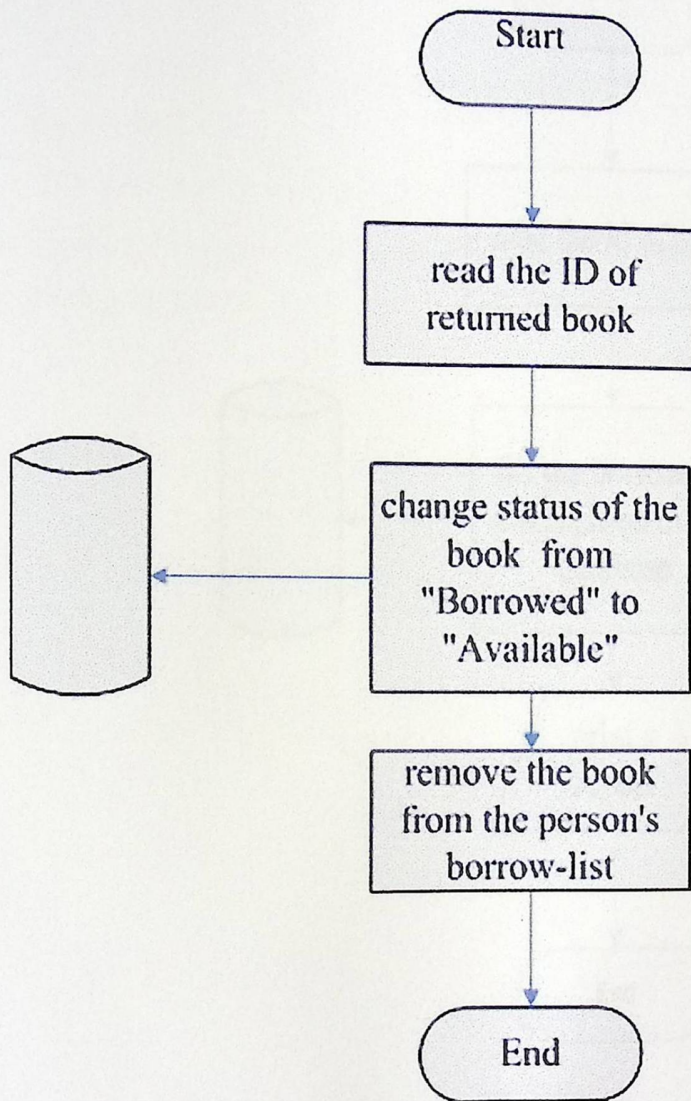


Figure (5.6): Check In

Check out

The librarian uses the reader to read the id of book that will be borrowed, then fill the borrower's information in the database such as student's number and name, finally print a report that includes the book's name and borrow / return date of the book

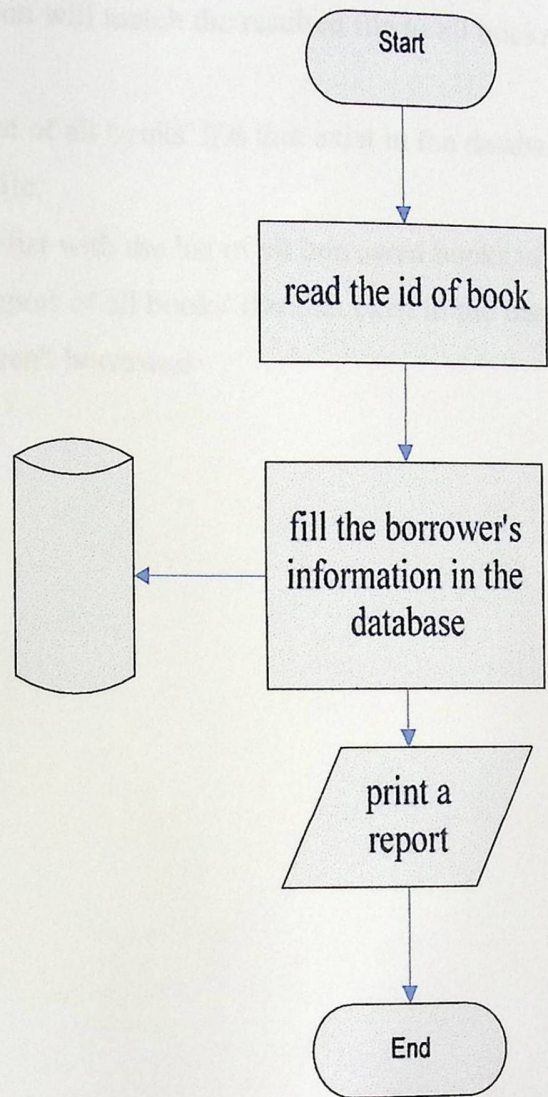


Figure (5.7): Check Out

Inventory management

- ✓ POWER on the reader

- ✓ Start reading the IDs of all books in the library.
- ✓ Send each read ID to the Application, right after reading it and before reading the next tag.
- ✓ The application will save all Ids in a temporary file.
- ✓ The application will match the resulted file to all books IDs resides in the database.
- ✓ Generate a list of all books' IDs that exist in the database and do not exist in the resulted file.
- ✓ Compare the list with the list of all borrowed books in the library.
- ✓ Generate a report of all books' IDs that exist in the database, not found in the library and aren't borrowed

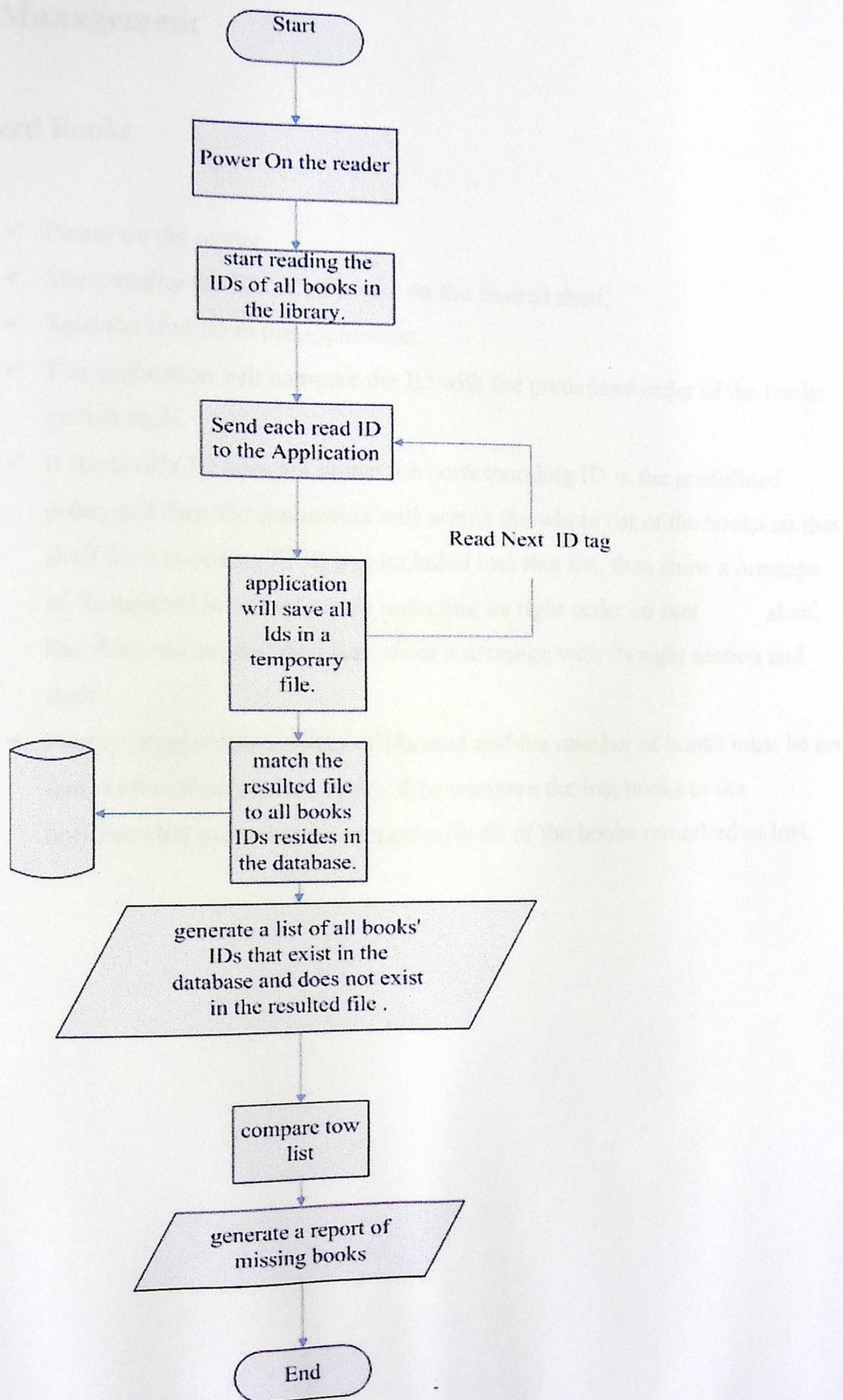


Figure (5.8): Inventory Management

Shelf Management

Misplaced Books

- ✓ Power on the reader
- ✓ Start reading the IDs of all books on the desired shelf.
- ✓ Send the read ID to the application.
- ✓ The application will compare the ID with the predefined order of the books on that shelf.
- ✓ If the book's ID does not match the corresponding ID in the predefined order, and then the application will search the whole list of the books on that shelf for a matching ID. If it is included into that list, then show a message of "misplaced book" on screen including its right order on that shelf. But if it's not on that shelf then show a message with its right section and shelf.
- ✓ Finally compare the number of Ids read and the number of books must be on that shelf to find any lost books, then compare the lost books to the borrowed list and generate a report with all of the books remarked as lost.

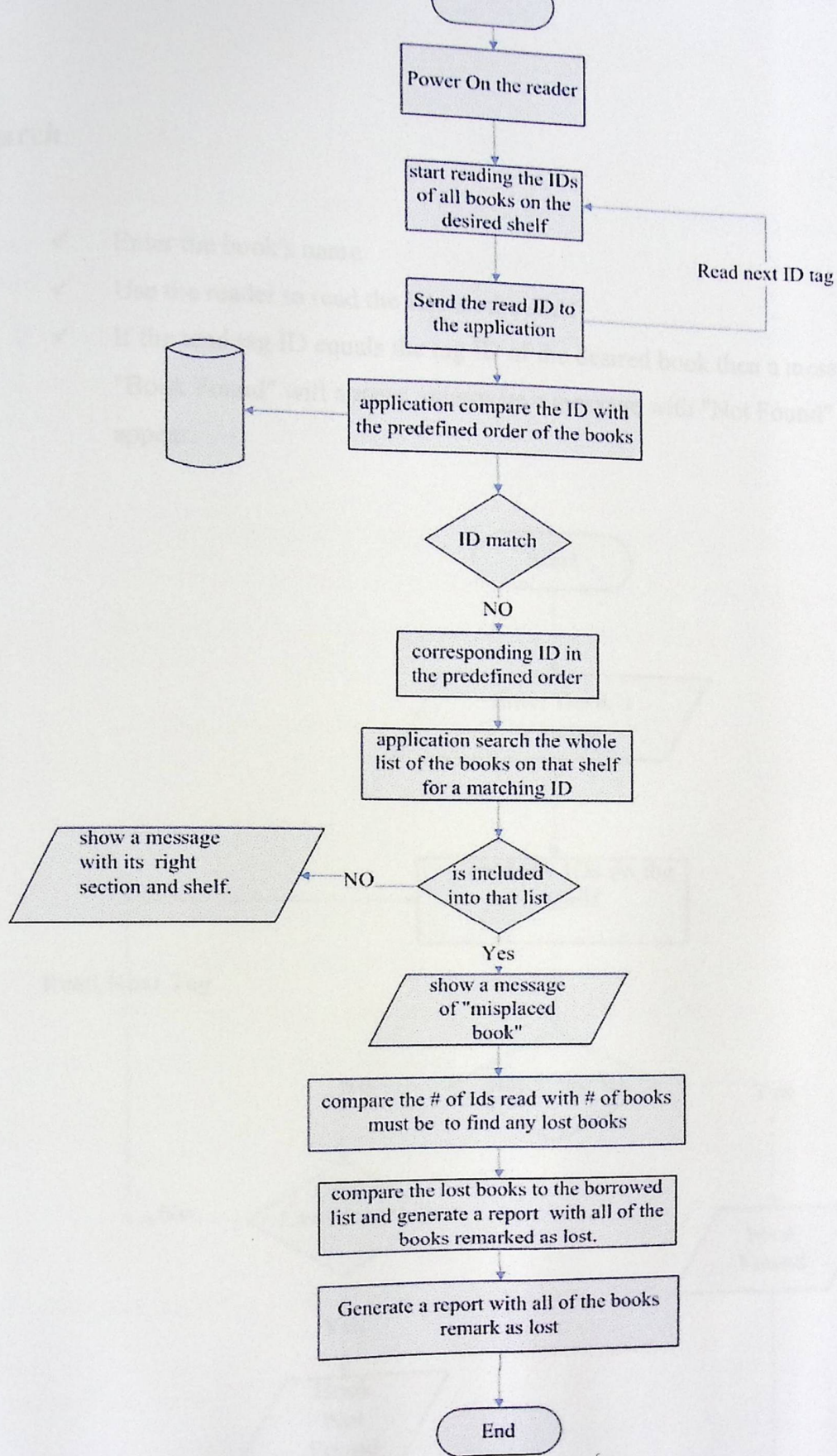


Figure (5.9): Shelf management (Misplaced Books)

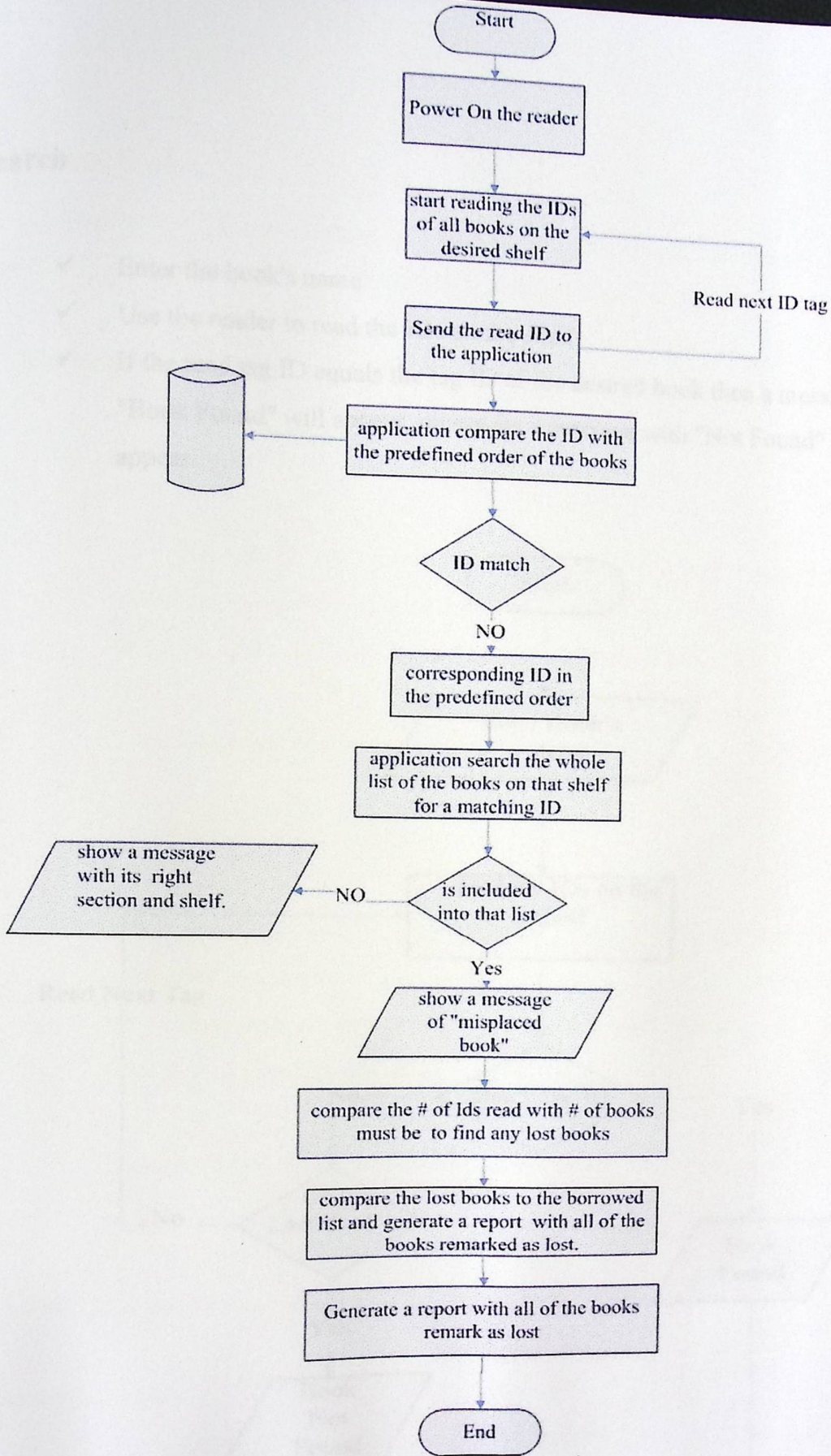


Figure (5.9): Shelf management (Misplaced Books)

Search

- ✓ Enter the book's name
- ✓ Use the reader to read the IDs on the shelf
- ✓ If the read tag ID equals the tag ID of the desired book then a message with "Book Found" will appear, otherwise a message with "Not Found" will appear.

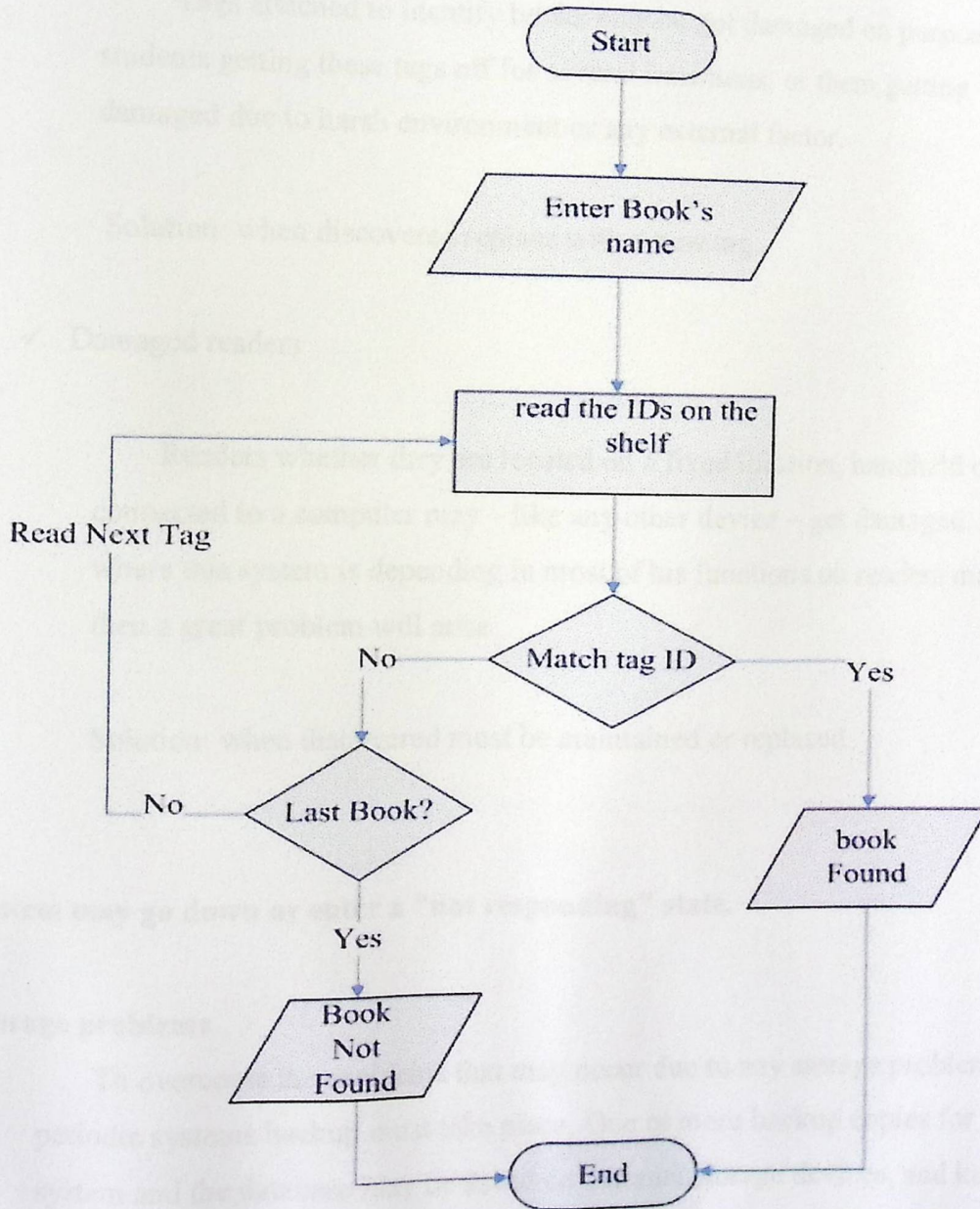


Figure (5.10): Search

5.5 Fault Tolerance

This section will demonstrate some problems the system may face during different phases, and how each one of these problems will be tolerated by the system.

Hardware malfunction

✓ Damaged tags

Tags attached to identify books may be got damaged on purpose by students getting these tags off for several intentions, or them getting damaged due to harsh environment or any external factor.

Solution: when discovered replace with a new tag.

✓ Damaged readers

Readers whether they are located on a fixed location, handheld or connected to a computer may – like any other device – get damaged. And where this system is depending in most of his functions on readers mainly then a great problem will arise.

Solution: when discovered must be maintained or replaced.

System may go down or enter a "not responding" state.

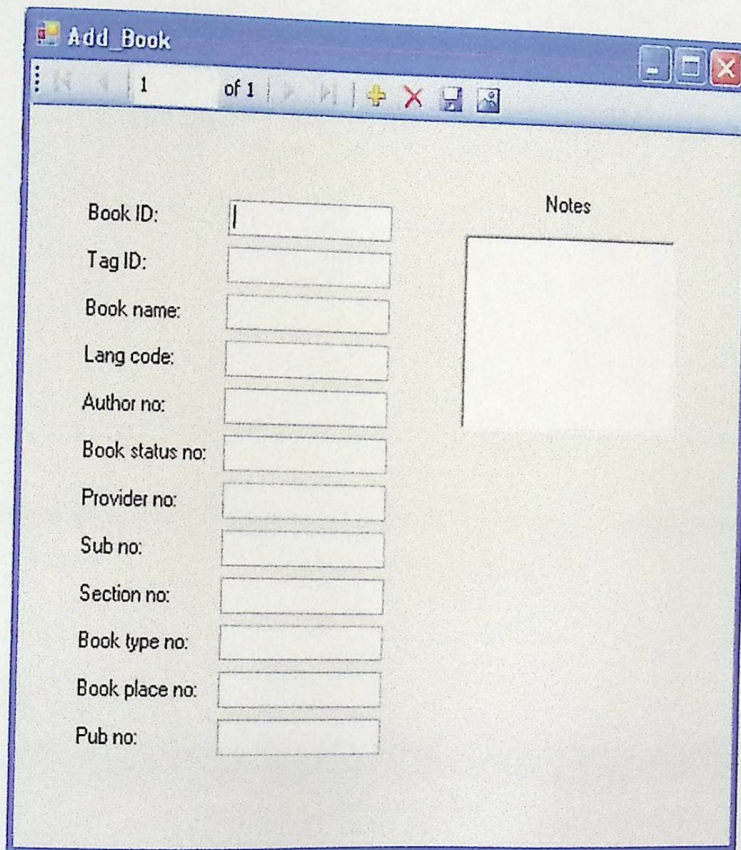
Storage problems

To overcome the problems that may occur due to any storage problems. A periodic systems backup must take place. One or more backup copies for the system and the database may be saved on external storage devices, and kept to solve some problems by restoring the system to a specific date.

5.6 Interface Design

✓ Add book

Through this form, the librarian can add a new book to the database system of the library after but a tag in each new book.

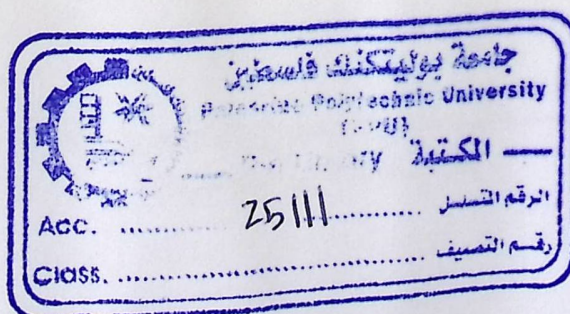


The screenshot shows a window titled "Add Book" with a standard Windows-style title bar. The window contains a form with the following fields:

- Book ID:
- Tag ID:
- Book name:
- Lang code:
- Author no:
- Book status no:
- Provider no:
- Sub no:
- Section no:
- Book type no:
- Book place no:
- Pub no:

To the right of these fields is a section labeled "Notes" with a large empty text area for entering additional information.

Figure (5.11): add book



✓ Check In

Through this form, the librarian uses the reader to read the ID of returned book, then change the status of the book from "Borrowed" to "Available", and remove the book from the person's borrow-list

The screenshot shows a window titled "checkin". At the top, there is a toolbar with a "1 of 1" indicator and navigation icons. The main area contains the following fields:

- Loan trans:
- Book ID:
- Loan date:
- Expected ret date:
- Mem no:

Figure (5.12): Check In

✓ Check Out

The screenshot shows a window titled "checkout". At the top, there is a toolbar with navigation icons. The main area contains the following fields:

- Loan trans:
- Book ID:
- Loan date:
- Expected ret date:
- Actual ret date:
- Fine:
- Mem no:

Figure (5.13): check Out

✓ Inventory Management

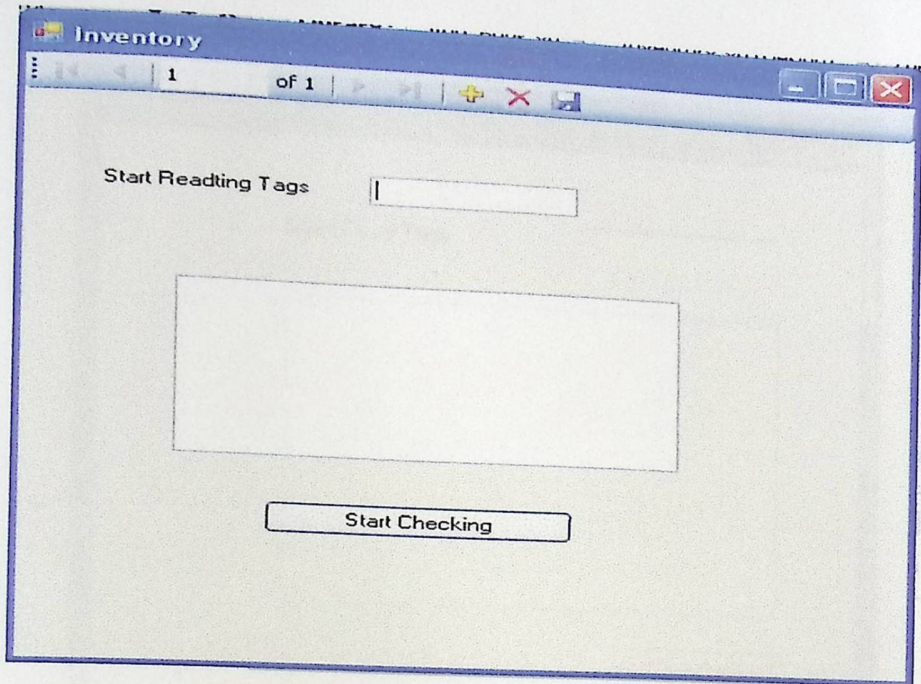


Figure (5.14): Inventory Management

✓ Search

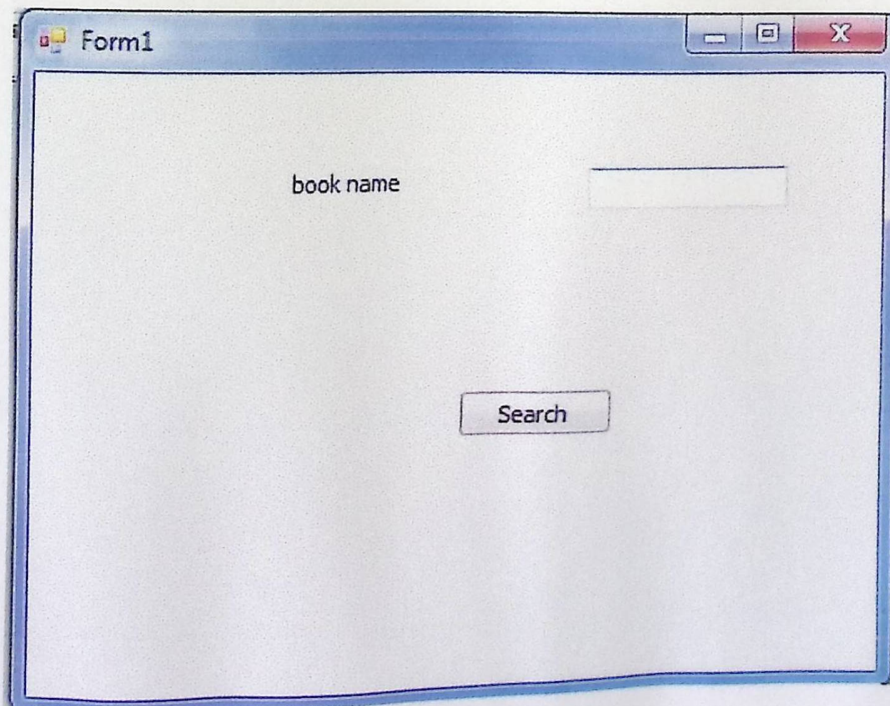


Figure (5.15): Search

✓ Shelf Management

Misplace Books

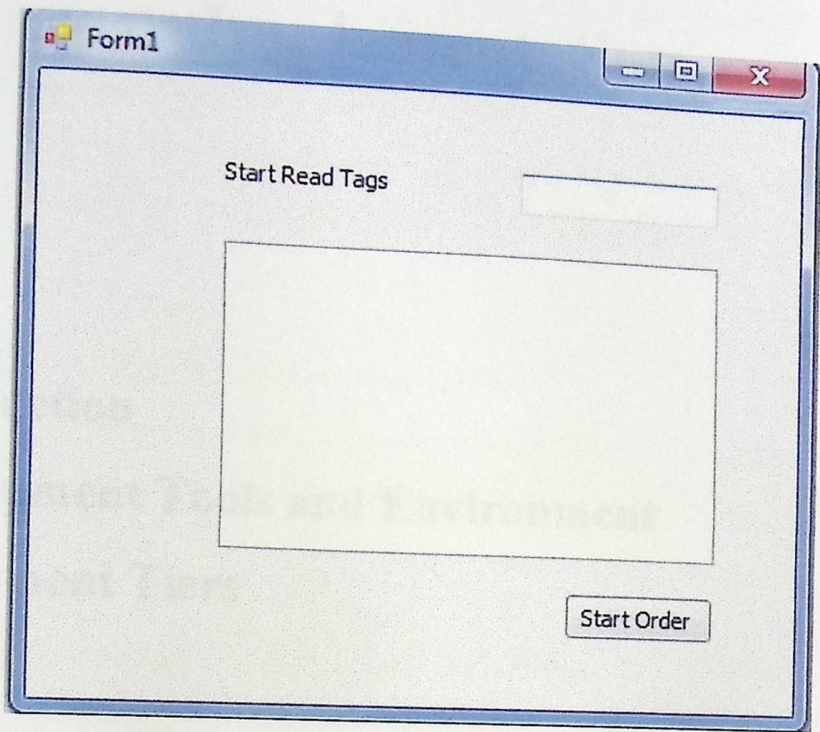


Figure (5.16) Misplaced Books

CHAPTER SIX

Implementation

6.1 Introduction

6.2 Development Tools and Environment

6.3 Deployment Tiers

6.2.1 Programming Language and Development Environment

6.2.1.1 Operating system Windows xp professional

6.2.1.1.1 Operating system Windows xp professional

Windows XP is one of the well known operating systems that support most of the programs and development tools used for developing the various applications. It provides a high security level when working with the internet and a good file management.

The next version "Vista" which is one of the most powerful products released by Microsoft. It is a significant platform for the development of various applications.

6.2.1.1.2 Operating system Linux

It is the open source and free operating system. It is application independent and it is a significant platform for the development of various applications.

6.1 Introduction:

The implementation phase in any project is the transition from theoretical to the practical phase, passing through the preparation of the source code, building the database, and the application of the system.

In this chapter we'll provide a detailed explanation about the development tool and environment and the deployment tiers.

6.2 Development Tools and Environment

It explains in some details the environment used for developing, programming and creating the library system application, which are the programming language and development environment, building the database and the RFID reader used.

6.2.1 Programming language and Development Environment

It includes the operating system, .Net framework and visual studio 2005.

6.2.1.1 Operating system windows xp professional

Windows XP is one of the well known operating systems that support most of the programs and development tools used for developing the various applications. It provides a high security level when dealing with the internet and a good file management.

The tool we used "Visual studio 2005" is one of the most powerful products of Microsoft Company, so the supportive platform for this environment is windows.

6.2.1.2 Microsoft .Net framework

Is the infrastructure used when developing and running .Net applications. It represents a fundamental change in building applications that are built

on an open architecture. Thus any developer can use his skills to develop any kind of applications. And feel free to run it on any platform with .Net framework downloaded on it.

The most important features of .Net framework are:

- ✓ Apply common skills across a variety of devices, application types, and programming tasks.
- ✓ Integrate with other tools and technologies to build the right solution with less work
- ✓ Build compelling applications faster.

6.2.1.3 Visual studio.net 2005

Is an integrated development environment (IDE) from Microsoft that is used to develop graphical user interface applications, windows forms applications and web based applications. It supports different programming languages like vb.net and C#.

We'll use this environment for developing the system application software. It will be desktop windows from application, using VB.net that uses visual basic as a programming language.

The main feature for this environment is that it integrates the code editor, designer and the debugger all in one place.

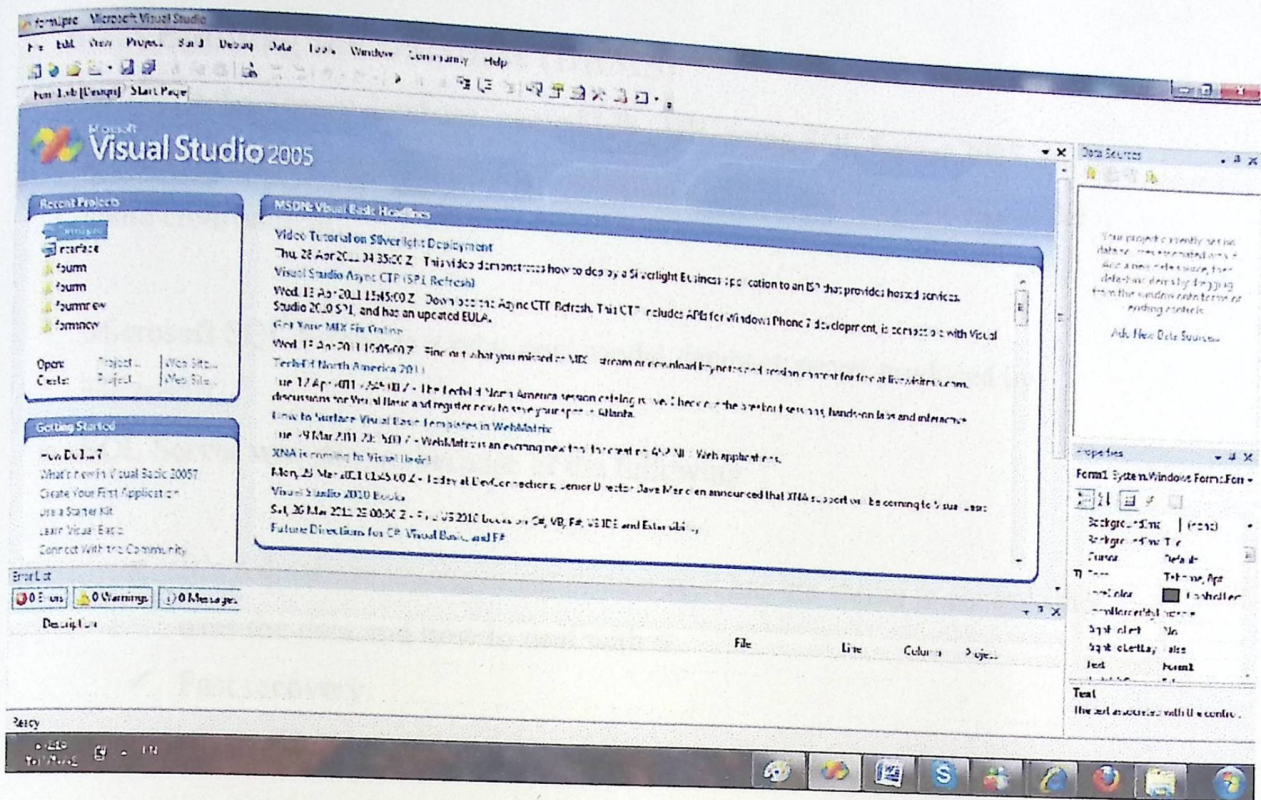


Figure (6.1): The establishment of a new project in the visual studio.net 2005

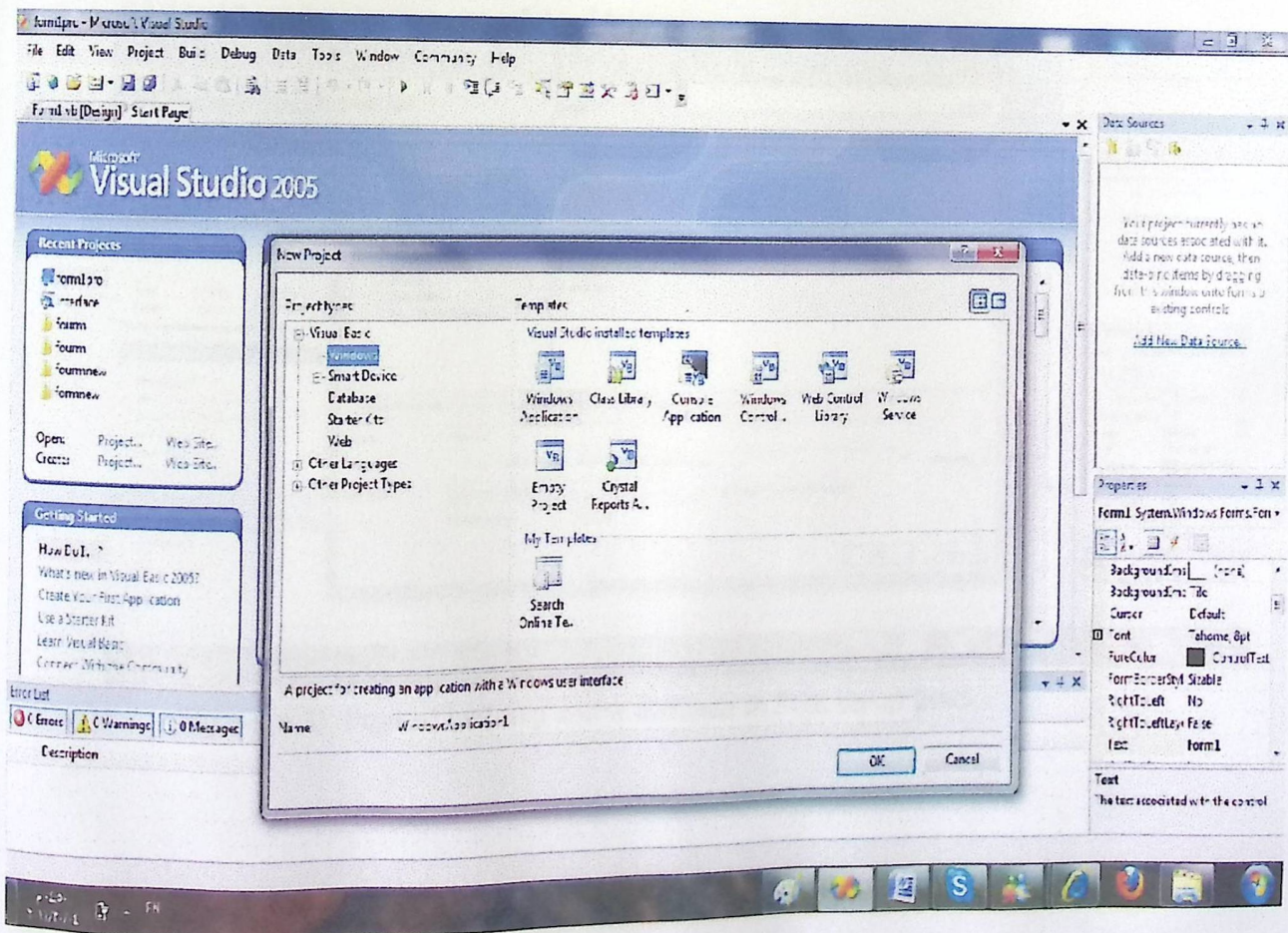


Figure (6.2): The establishment of vb.net desktop application

6.2.2 Building the Database (DBMS)

We built the library database, named Lib_DB, using SQL Server 2005. All the 14 tables that the system's database consists of were built successfully in the same environment.

Microsoft SQL Server is a relational model database server produced by Microsoft.

SQL Server was chosen because of the following:

- ✓ It's a database management system so it has the ability to control who uses the data and how to deal with it.
- ✓ Fast recovery.
- ✓ Compatibility with visual studio tools environment.

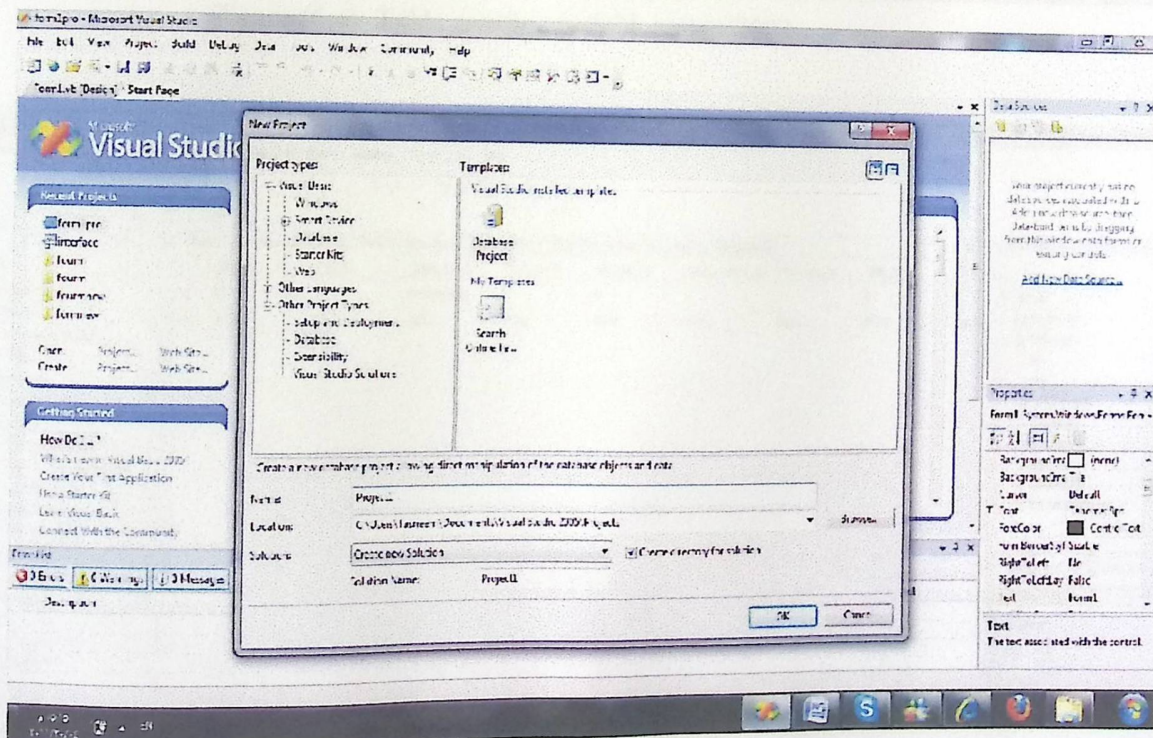


Figure (6.3): Page of building a new database in SQL server 2005

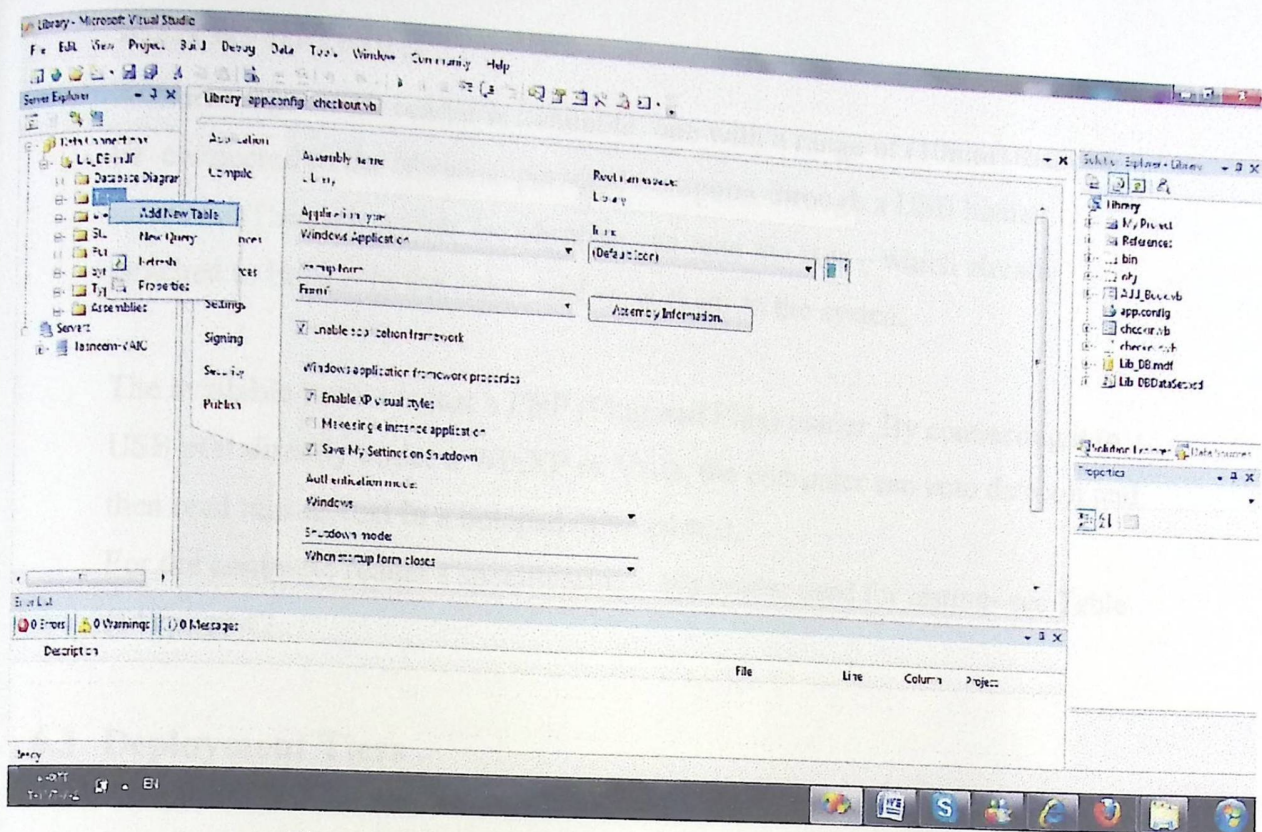


Figure (6.4): Table creation in SQL server 2003

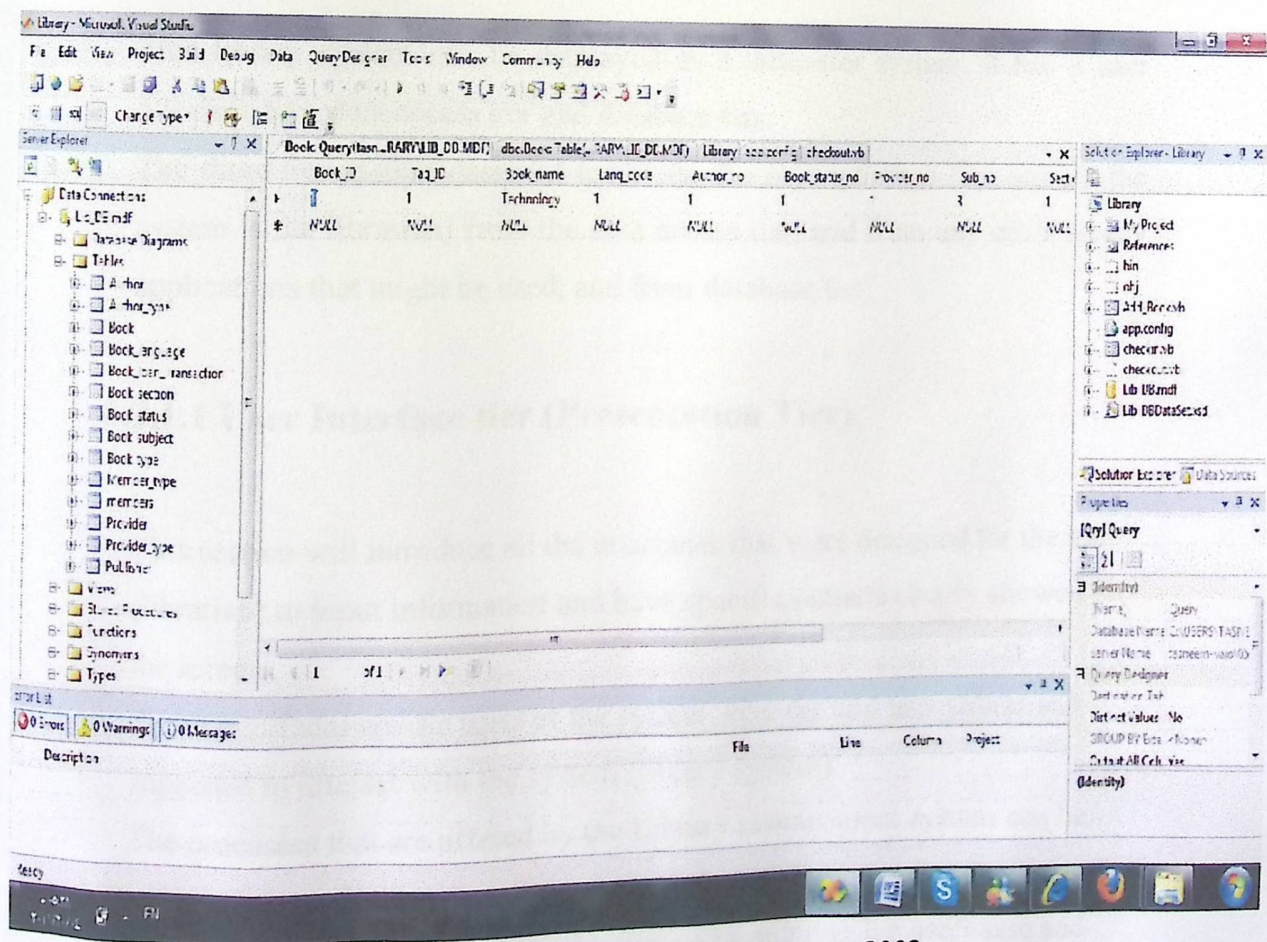


Figure (6.5): Data entry page in SQL server 2003

6.2.3 RFID reader

A short range RFID reader is available, one with a range of (10mm) that can be connected to the librarian personal computer through a USB human interface. Through which the librarian can read the tags – which already attached to books- in the range and enter them to the system.

The available reader is just a PNP (Plug and Play) reader. By connecting it to a USB port directly under a WinXP or Vista, the computer can auto detect it and then read tags as text in a notepad or word text.

For the complete reader's specification – the reader used for testing- see Table (14) page 42.

6.3 Deployment Tiers

6.3.1 Two -Tier system

This library system can be displayed as a three-tier system. It has a user interface tier, data access tier and database tier.

The three-tier system designed to divide the user interface (the user in the system is the librarian) from the data access tier, and from any other legacy applications that might be used, and from database tier.

6.3.1.1 User Interface tier (Presentation Tier):

This section will introduce all the interfaces that were designed for the user (librarian) to input information and have specific outputs clearly showed on the screen.

These interfaces are the parts of the system were the end user (librarian) supposed to interact with the system (library system).

The processes that are offered by the Library management system can be achieved through these interfaces:

First the librarian must log in to the system by entering his username and password in the login screen

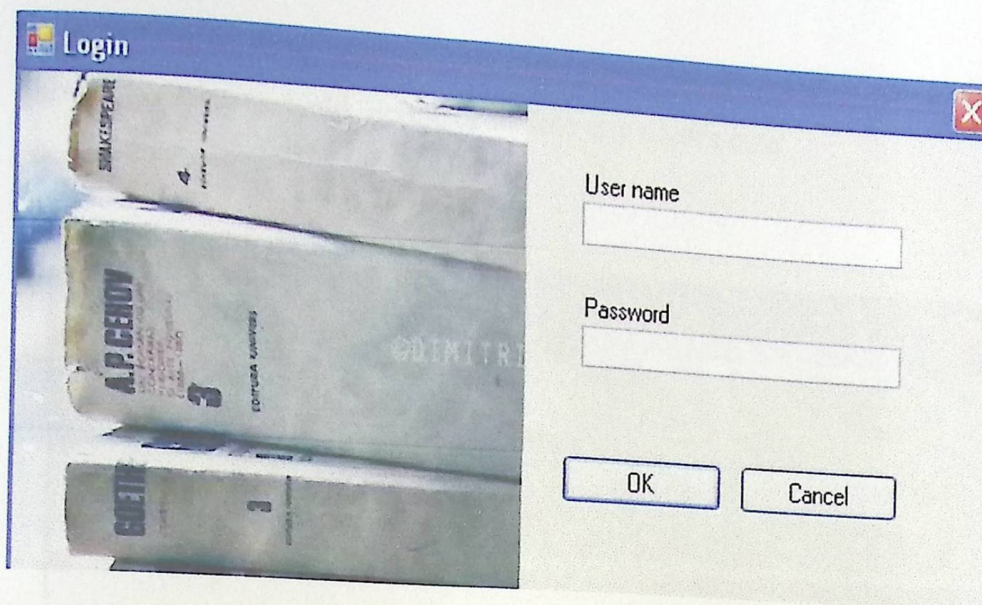


Figure (6.6): Login Screen

After logging in to the system the librarian can chose the process he's about to do. For example if he wants to show all the books in the library he will go The Books Control Screen

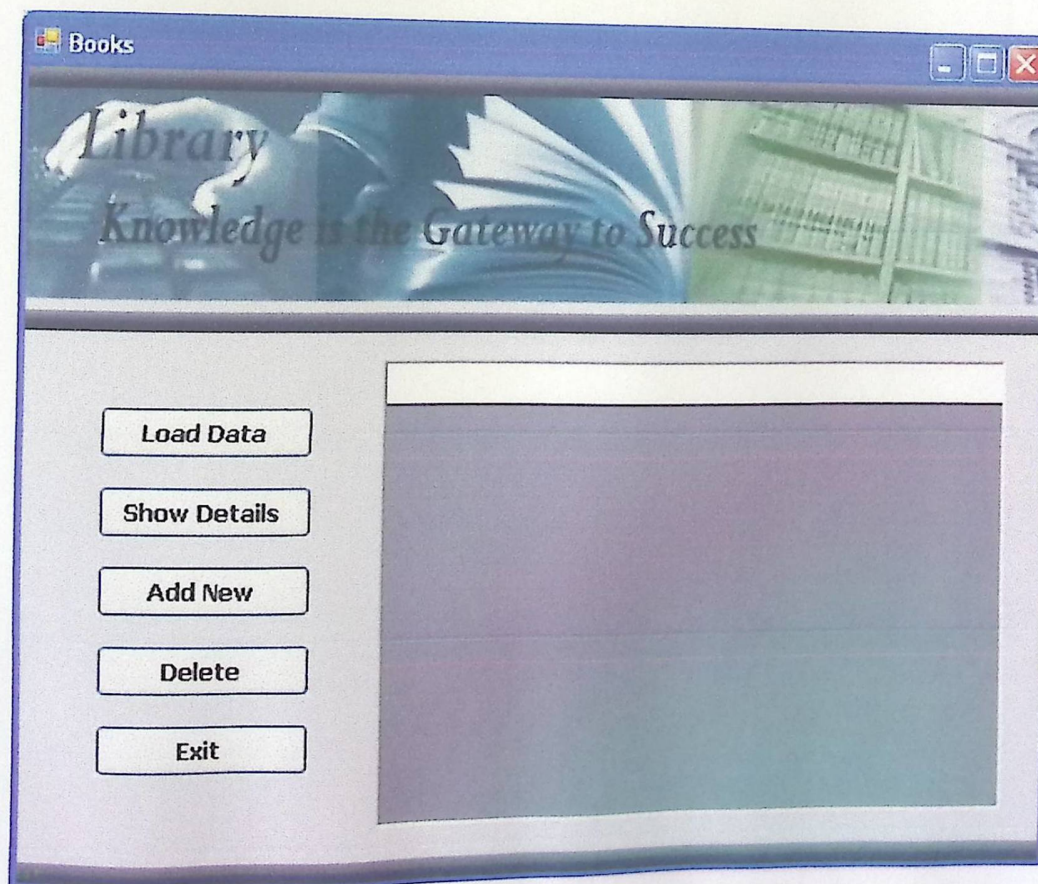


Figure (6.7): Books Control Screen

From the Book Control screen he can navigate to other screens where he can show all books, and add, delete or update any book's data.

The screenshot shows a software window titled "Add Book". The window has a blue header bar with the title and standard window control buttons (minimize, maximize, close). Below the header is a banner image with the text "Library Knowledge is the Gateway to Success". The main content area is a form with the following fields:

- Book's Name:
- Book's ID:
- RFID Tag No.:
- Publisher:
- Language:
- Section:
- Notes:

At the bottom of the form are two buttons: "Add" and "Close".

Figure (6.8): Add Book Screen

Book Details

Library Knowledge is the Gateway to Success

Book's Name

Book's ID

RFID Tag No.

Publisher

Language

Section

Availability Available Not Available

Notes

Figure (6.9): Update Book Screen

For the process of checking books in and out, these screens will be used.

checkin

Library Knowledge is the Gateway to Success

Tag ID: Fine:

Book ID:

Actual Return Date

Loan Date

Expectd Return Date

Loan Transaction

Member Name

Figure (6.10): Check In Screen

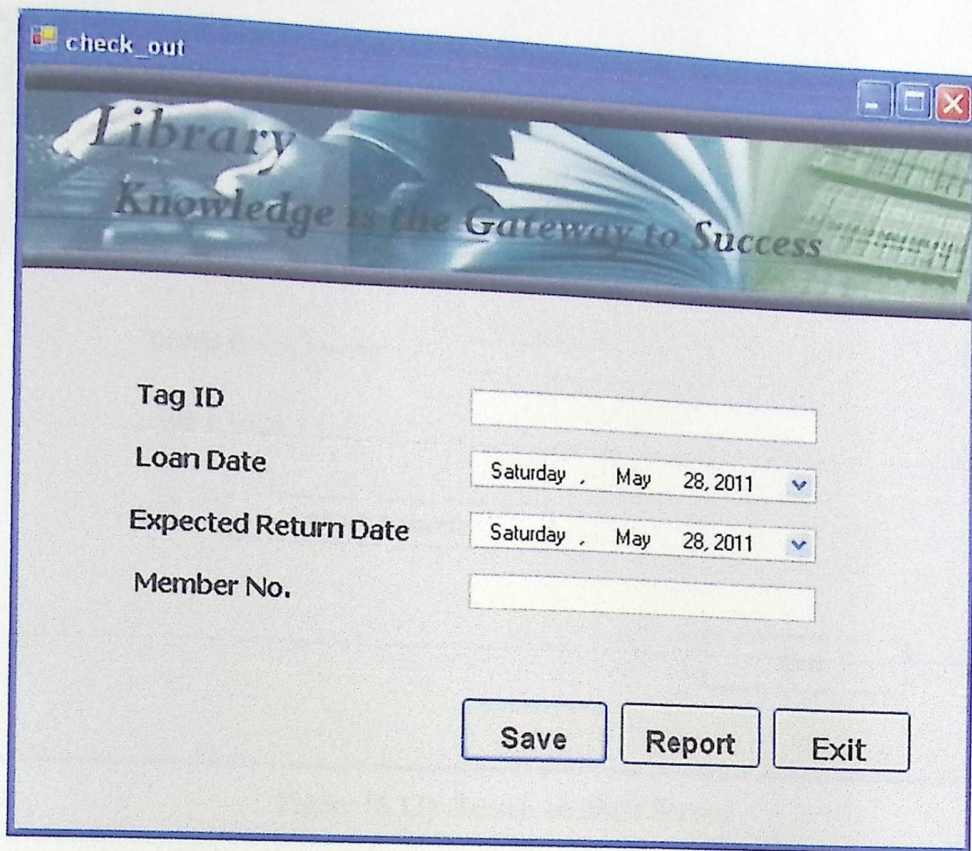


Figure (6.11): Check Out Screen

For the search issues, these screens will be used.

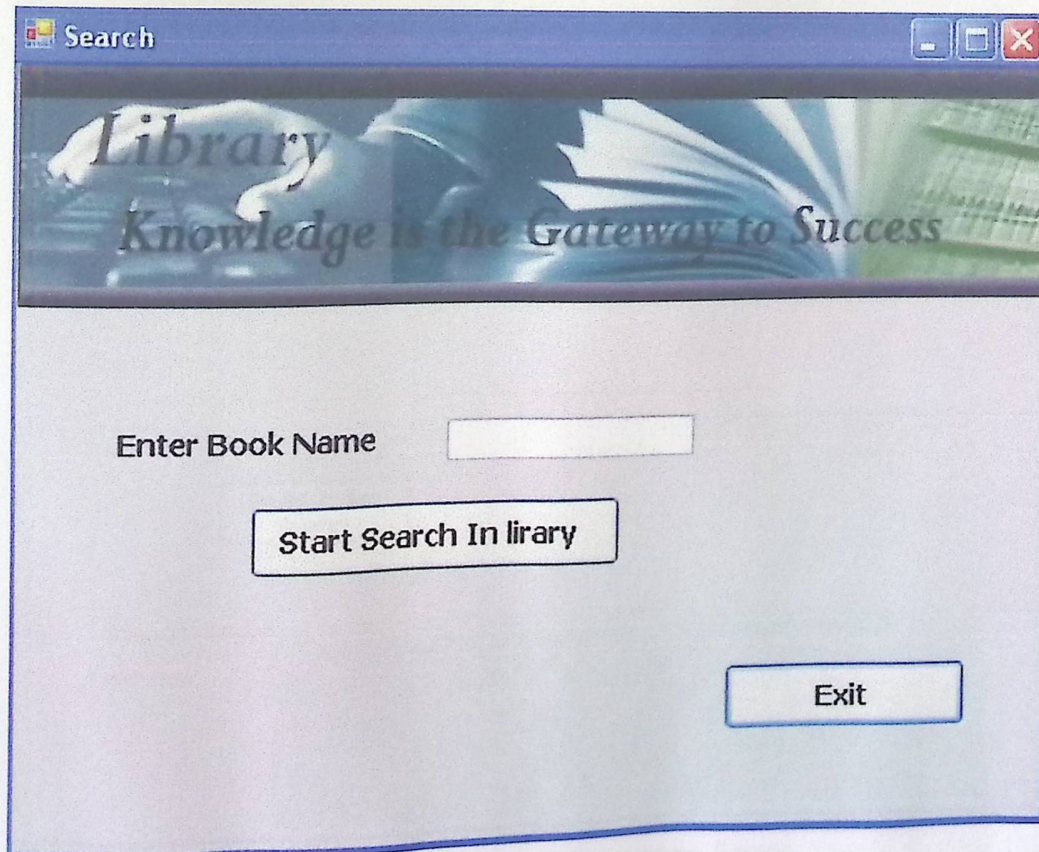


Figure (6.12): Search in Library Screen

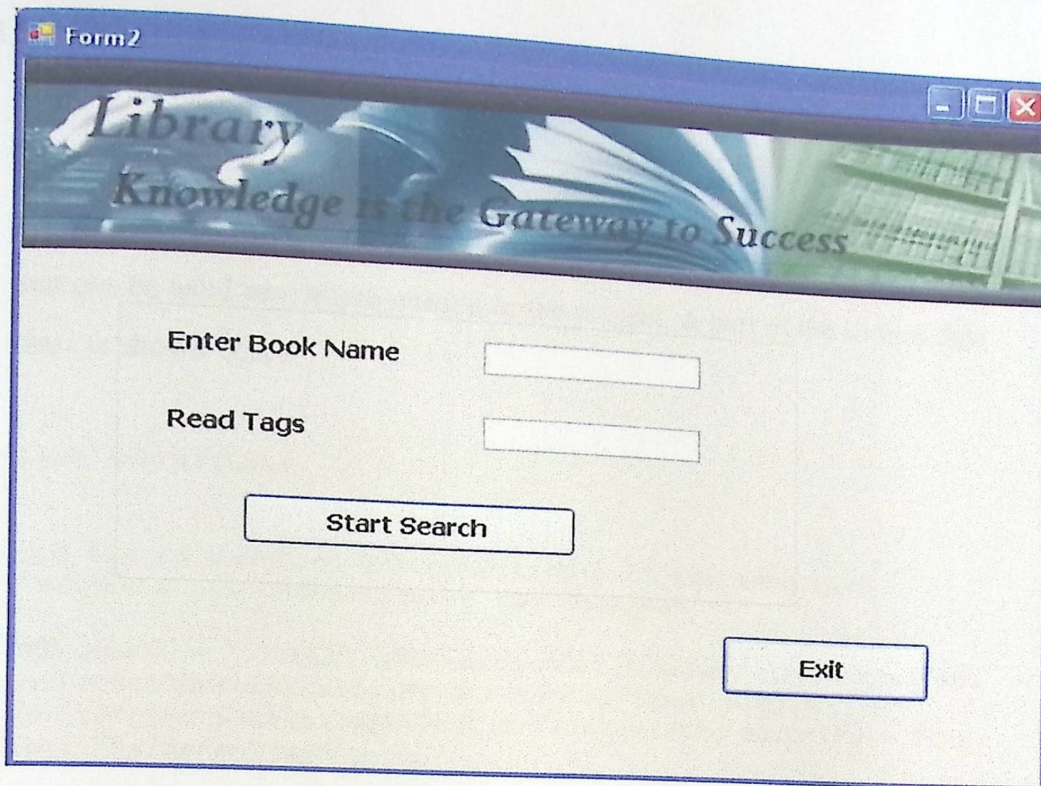


Figure (6.13): Search on Shelf Screen

Inventory management screen

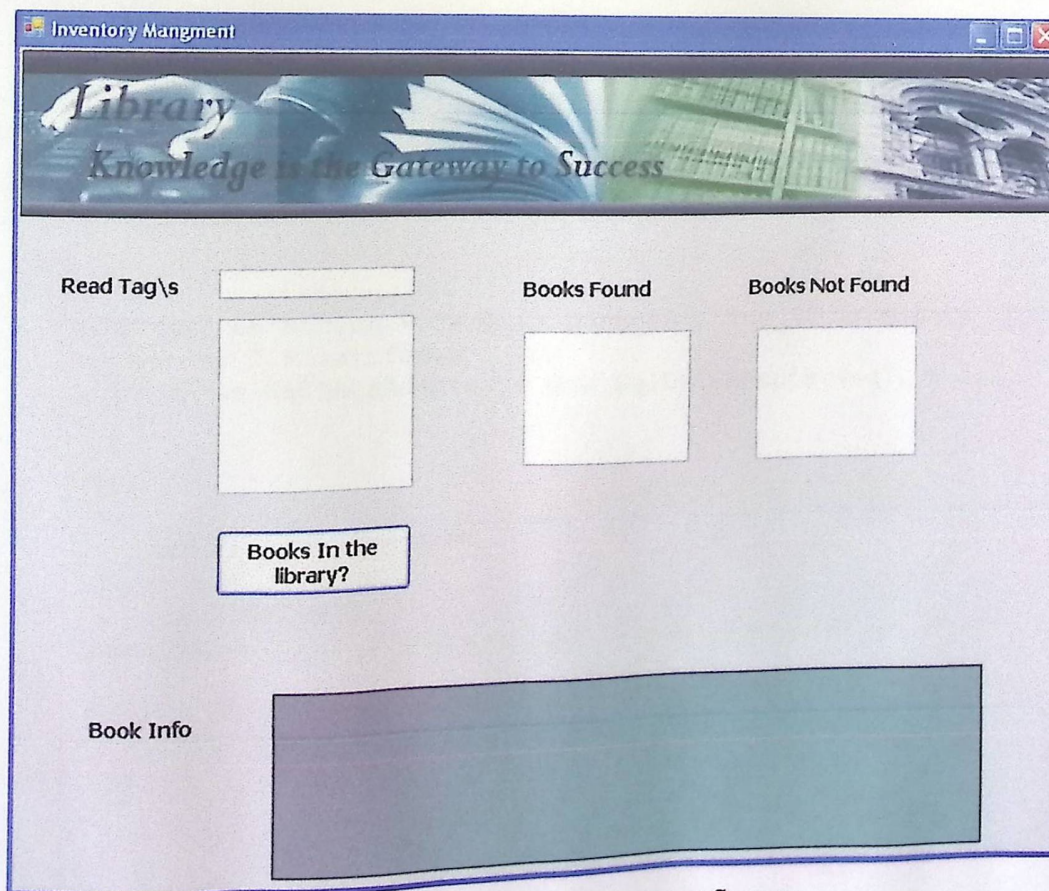


Figure (6.14): Inventory Management Screen

6.3.1.2 Data access Tier:

We used some classes to connect to the database and access the data like the LibraryData.vb class used in the system. It contains a number of methods that can be used any where needed in the project. A part of the library data class is shown below:

```
Public Class LibraryData

    Private Shared Function GetConnection() As SqlConnection
        'return a new connection to the database

        mdatapath = ".\SQLEXPRESS;AttachDbFilename=C:\Documents and
        Settings\Administrator\My Documents\Visual Studio
        2005\Projects\test\test\Test.mdf;Integrated security = True;
        User Instance=True"

        Return New SqlConnection("Data Source=" & mdatapath)
    End Function

    Public Overloads Shared Function GetBooks() As DataSet
        Return GetBooks("Book_ID")
    End Function

    Public Overloads Shared Function GetBooks(ByVal sortfield As
    String) As DataSet
        Dim conn As SqlConnection = GetConnection()
        Dim ds As New DataSet

        Try

            Dim sql As String = "select Book_ID , Tag_ID from Book
            order by " + sortfield
            Dim da As SqlDataAdapter = New SqlDataAdapter(sql, conn)

            Try
                da.Fill(ds, "Book")
            Finally
                da.Dispose()
            End Try

            Return ds

        End Try

    End Function

End Class
```

6.3.1.2 Data access Tier:

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        2005\Projects\test\test\Test.mdf;Integrated security = True;
        User Instance=True"

        Return New SqlConnection("Data Source=" & mdatapath)
    End Function

    Public Overloads Shared Function GetBooks() As DataSet
        Return GetBooks("Book_ID")
    End Function

    Public Overloads Shared Function GetBooks(ByVal sortfield As
    String) As DataSet
        Dim conn As SqlConnection = GetConnection()
        Dim ds As New DataSet

        Try

            Dim sql As String = "select Book_ID , Tag_ID from Book
            order by " + sortfield
            Dim da As SqlDataAdapter = New SqlDataAdapter(sql, conn)

            Try
                da.Fill(ds, "Book")
            Finally
                da.Dispose()
            End Try

            Return ds

        End Try

    End Function

End Class
```

```

Public Shared Function AddNewBook() As DataSet
    'Return a dataset representing a single Book
    Dim conn As SqlConnection = GetConnection()

    Try
        Dim sql As String = "Select * from Book where id = -1"
        Dim sa As SqlDataAdapter = New SqlDataAdapter(sql, conn)
        Dim ds As New DataSet

        Try
            sa.Fill(ds, "Book") ' returns an empty dataset but
            with the correct structure
            Dim dr As DataRow = ds.Tables(0).NewRow ' creates a
            new blank row
            ds.Tables(0).Rows.Add(dr) ' add the blank row to
            the dataset
        Finally
            sa.Dispose()
        End Try
        Return ds ' return the dataset containing one new,
        blank Book record

    Finally
        conn.Close()
        conn.Dispose()
    End Try

End Function

Public Shared Sub SaveBooks(ByVal ds As DataSet)

    Dim conn As SqlConnection = GetConnection()

    Try
        Dim sql As String = "select Book_ID , Tag_ID from Book"
        Dim da As SqlDataAdapter = New SqlDataAdapter(sql, conn)

        Try
            Dim cb As SqlCommandBuilder = New
            SqlCommandBuilder(da)
            If ds.HasChanges Then
                da.Update(ds, "Book")
                ds.AcceptChanges()
            End If
        Finally
            da.Dispose()
        End Try

    Finally
        conn.Close()
        conn.Dispose()
    End Try

End Sub

End class

```

Chapter Seven

Testing

7.1 Introduction

7.2 Component Test

7.3 Database Test

7.4 System Unit and Module Testing (Functional Testing)

7.5 Integration Testing

7.6 System Testing

7.7 Acceptance Testing

7.8 Interface Testing

7.1 Introduction

The testing phase is one of the most important phases during the project life cycle. The importance of testing a system comes from its general purpose which is verifying that the produced software package meets the expectations - that are pre-defined as requirements or specifications, functions properly and to uncover situations that may give negative impact to the end user.

In this chapter we'll apply seven types of testing starting from component testing and passing through module, database, system, integration, acceptance and interface testing. Taking into consideration that these tests will be applied to the system main functions which are adding a new book, Check in \ out, Inventory management, Shelf management and searching.

The tests that are going to be applied are:

1. Component Test.
2. Database Test.
3. System units and module testing.
4. Integration Testing
5. System testing.
6. Acceptance testing.
7. Interface Testing.

7.2 Component Testing

The team has tested the hardware that was used in the system implementation. The main hardware components in our system are the RFID reader and the tags. We have tried to read all the tags in a text editor to ensure that all tags have their pre-configured IDs and the reader works efficiently.

7.3 Database Testing

We've checked the database through doing the data entry process manually, and through the RFID and have got the same results.

7.4 System Unit and Module Testing

Unit and module testing has been performed using the Black Box testing method; which checks the functionality of the system by testing each function (Unit) of the system separately. Using Black Box testing you don't need any knowledge about the application's code, internal structure, programming language or any other internal details.

Function Requirement	Expected Behavior	Actual Behavior	Notes
Add Book	Add new book to database	Add new book to database	Match
Check In	Remove book from Borrowed table and student table.	Remove book from Borrowed table and student table.	Match
Check out	Read the book's ID, and add the information in student\Borrowed table.	Read the book's ID, and add the information in student\Borrowed table.	Match

Inventory Management	Compare the ID from reader with the one stored in database.	Compare the ID from reader with the one stored in database.	Match
Shelf Management	Finding if the book is not in the right place to put it in the right place according to the predefined order in the system	Finding if the book is not in the right place to put it in the right place according to the predefined order in the system	Match
	If the book were not on the shelf and it's not borrowed then its missing.	If the book were not on the shelf and it's not borrowed then its missing.	Match
Search	Searches for a book with the same ID entered before. If found, a message with "Book Found" will appear, else a	Searches for a book with the same ID entered before. If found, a message with "Book Found" will appear, else a	Match

	message with "Book not found" will show up.	message with "Book not found" will show up.	
--	---	---	--

Table (15): Module Testing

✓ Add new book

If the user forgets to enter any field, the process would not be accomplished and an error message will appear.

Otherwise the process will succeed, and a new record will be added to the database.

✓ Check In \ Out

If the user didn't enter the any required field, an error message will appear.

✓ Inventory Management

The inventory management process is based on reading the tags of all the books in the library, saving them in a temporary file and then comparing them with the books stored in the database.

If the comparison were done perfectly then a report based on the situation will be delivered, otherwise if any problems did occur due to the storing process or the temporary file, a message of that will appear.

✓ Shelf Management

If a book was placed wrongly on the shelf then a message with its right order will show up, otherwise a message of "It is perfectly ordered" will appear.

7.5 Integration Testing

All sub-units and sub-modules must be integrated with each other. And this integration is tested to show if there were any defects that appear upon their integration. After testing the integration of all sub-units of the system, the results indicated that all sub-units and sub-modules work together properly.

7.6 System Testing

We have tested the system under several conditions and there were some errors and problems. Upon these results, all identified problems have been resolved.

7.7 Acceptance Testing

After testing the system against its requirements, we could determine that it achieves its functional requirements, and it is ready to be deployed in the real world. The system currently allows the librarian to deal with the library process in a rapid and easy way and provides him/her with logical results.

7.8 Interface Testing

This section simulates (tests) how all system screens will be used by the librarian, showing that all main system screens are working as expected.

Login Screen

An appropriate validation was applied on the login screen to insure that the librarian has entered both his user name and password before entering the system.

Without entering both of the password and the username like the situation in figure 7.1, the error message in figure 7.2 will appear

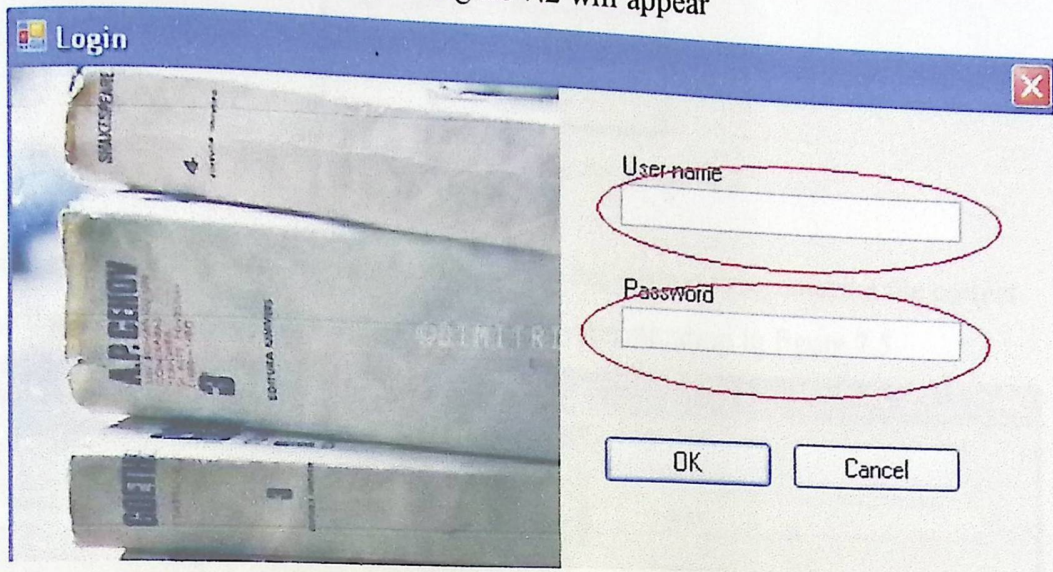


Figure (7.1): Situation1.

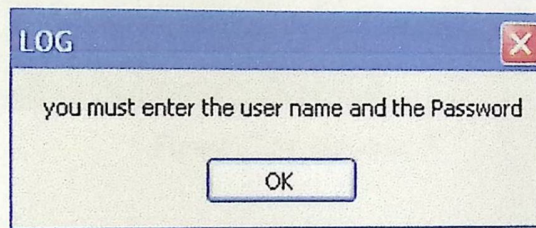


Figure (7.2): Error message for Situation 1

Entering the user name (Default: Admin) without the correct password like the situation in figure 7.3 will result in the error message shown in figure 7.4

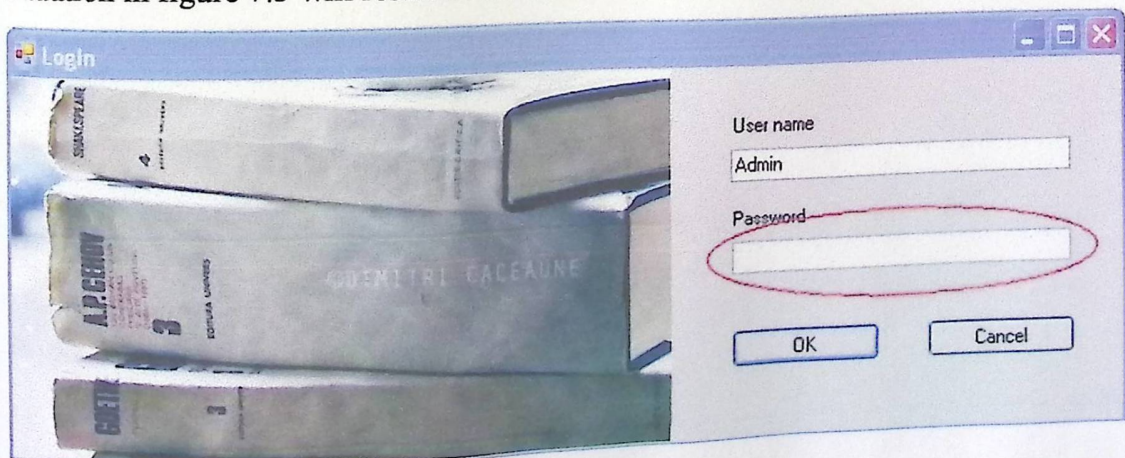


Figure (7.3): Situation 2

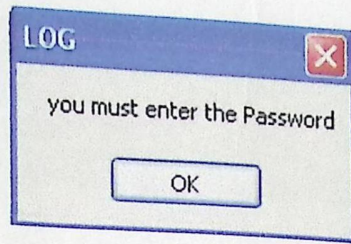


Figure (7.4): Error message for situation 2

The only situation that will log the librarian into the system is by entering the correct password and username (Admin, Admin), like in the situation in figure 7.5

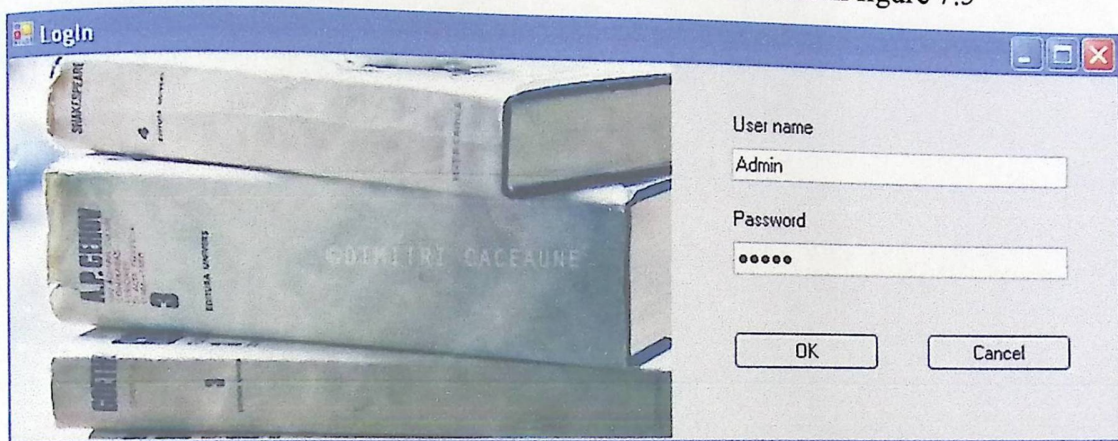


Figure (7.5): situation 3

Inventory Management

When the librarian starts the inventory management process, he must read the books tags through the RFID Reader. The system then will sort them into found and lost books like shown in figure 7.6

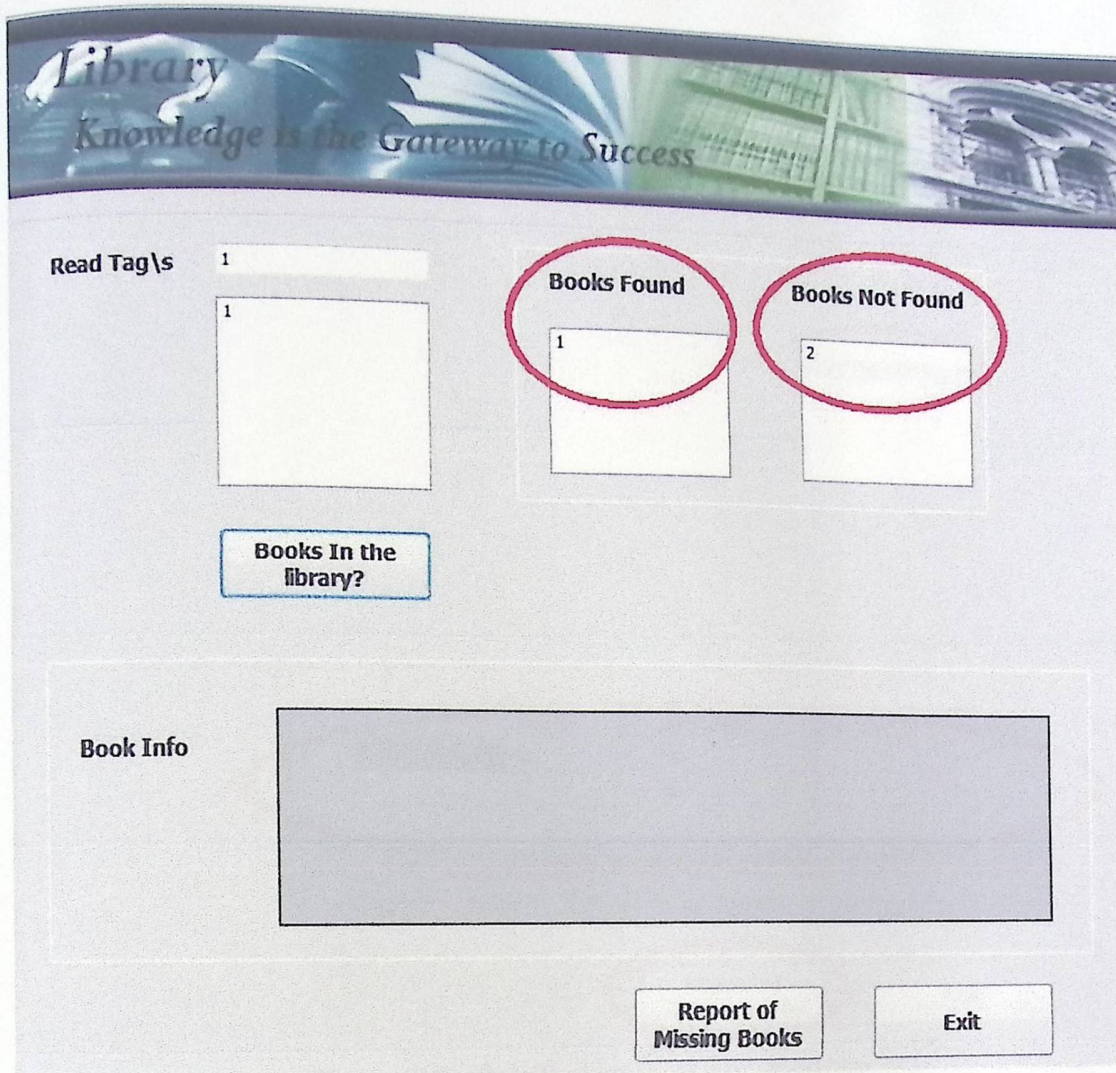


Figure (7.6): Inventory Management Test

If the librarian needed any more details about the lost or confirmed books, he needs only to double click on its ID in the second part of the screen all of the Book's information will be shown. Look figure 7.7

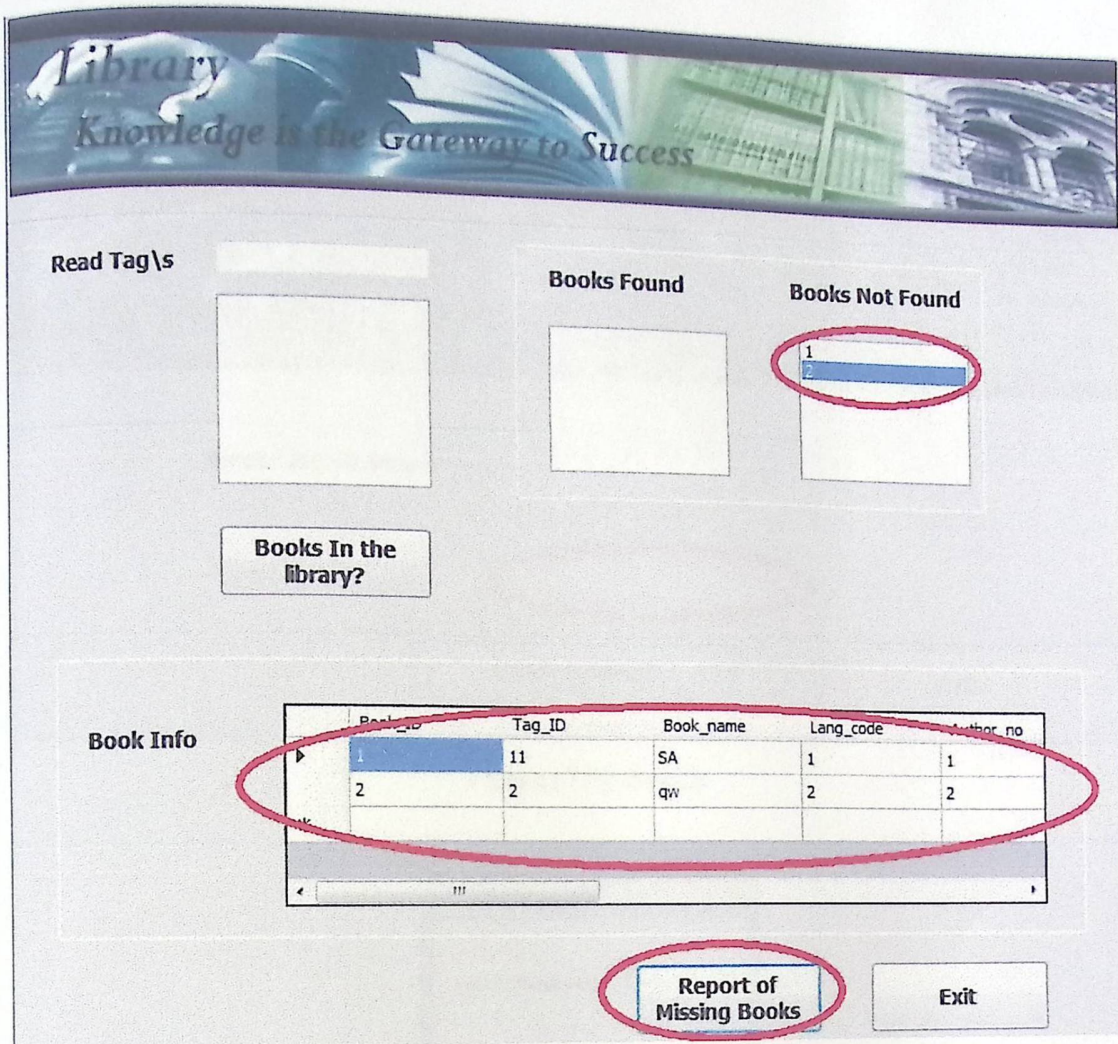


Figure (7.7): Details about a selected Book ID

Search Screens

If the librarian searched for a specific book to know if the library has a book with that name or not, he will get a message of "Book Found" like in figure 7.8, or "Book not Found".

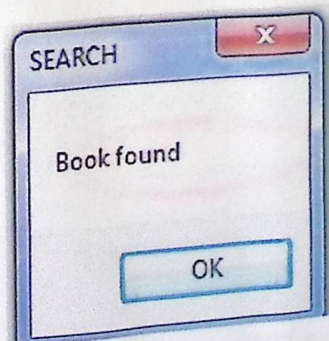


Figure (7.8): Book found

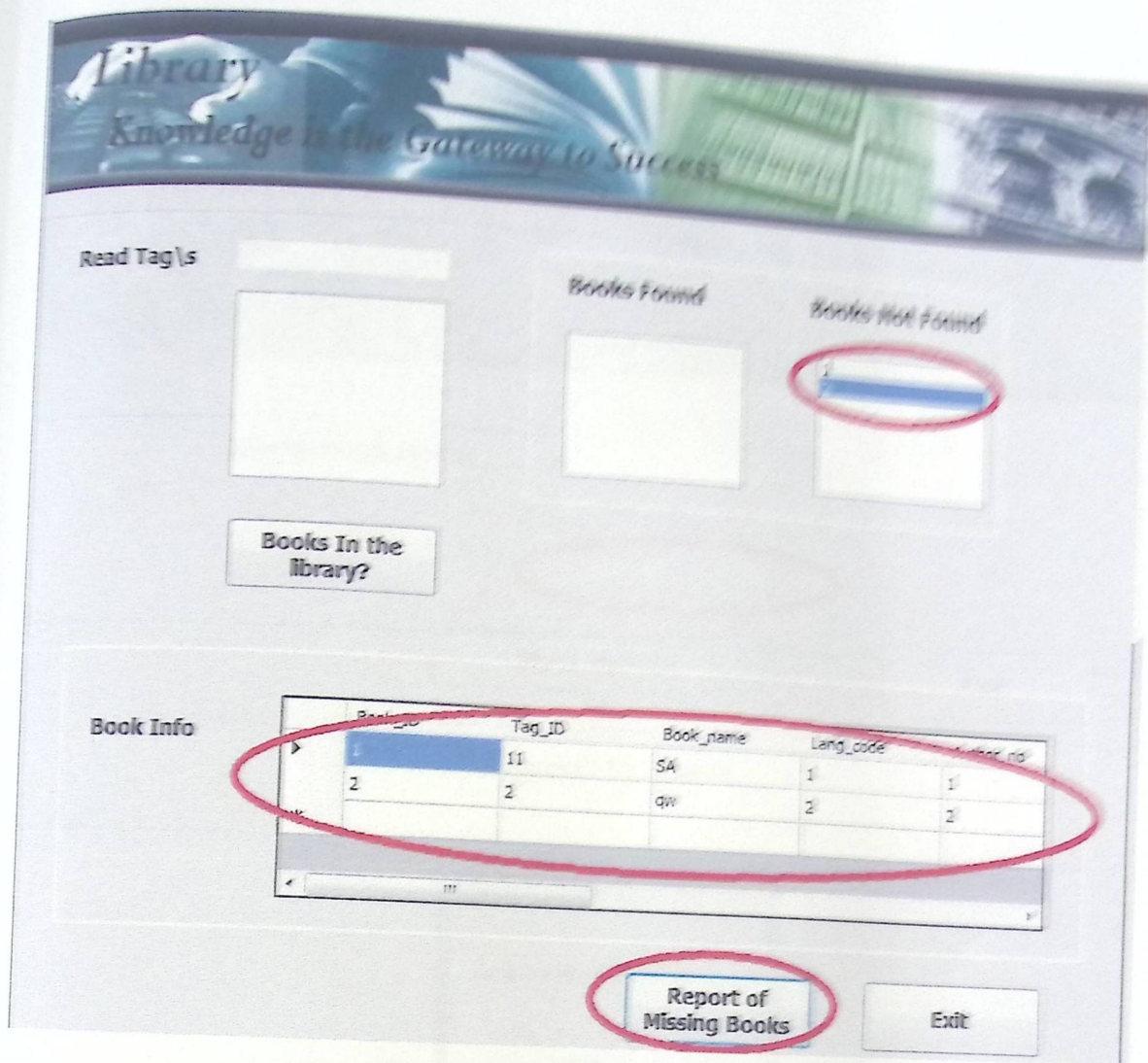


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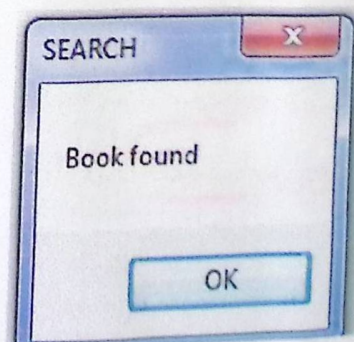


Figure (7.8): Book found

In the second part depends on reading tags of books on the shelf I want to search on. So if the librarian didn't enter the tags like in the situation in figure 7.9 a message box with a note that he must read tags like in figure 7.10.

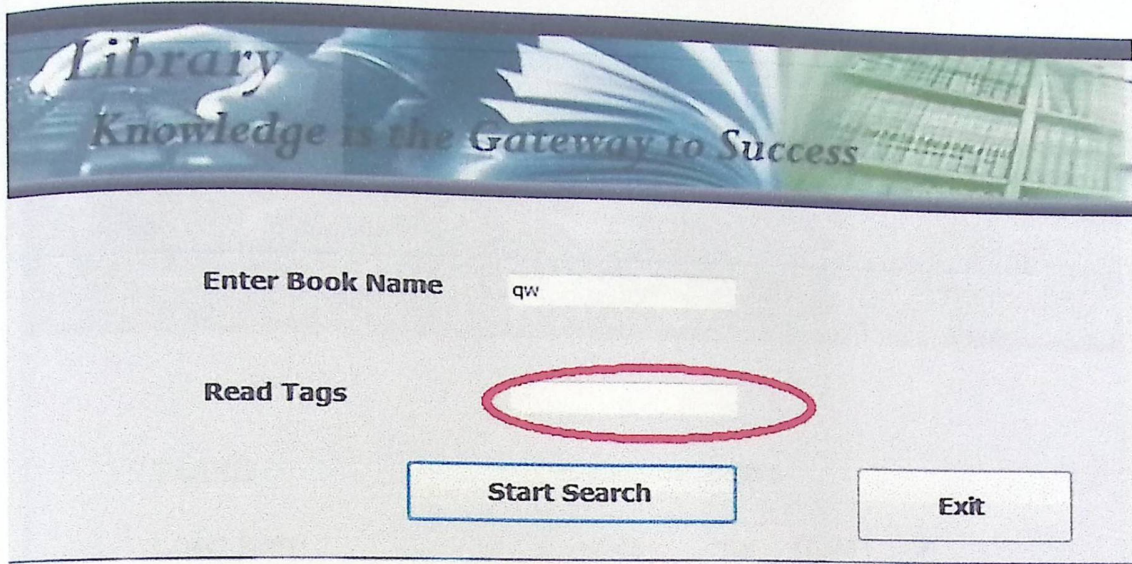


Figure (7.9): Search

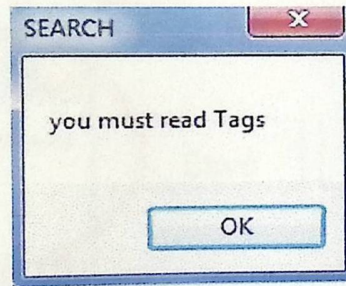


Figure (7.10): Read Tags error message

If the process was done successfully, the message in figure 7.11 will appear.

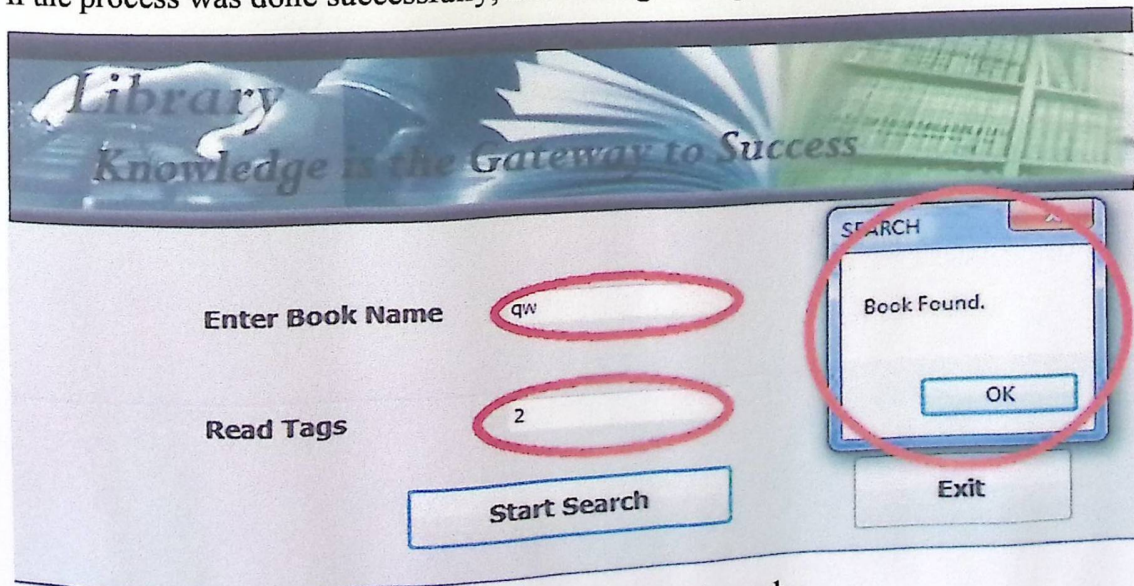


Figure (7.11): A successful search

Check In/Out

If the librarian didn't enter all the required field like in the situation in figure 7.12, an error message with "Please enter all the required fields" will be shown.

check_out

Library
Knowledge is the Gateway to Success

Tag ID: 6578567476476589899

Loan Date: Tuesday, May 17, 2011

Expected Return Date: Sunday, May 29, 2011

Member No. (Empty field circled in red)

Buttons: Save, Report, Exit

Error Message (circled in red):
Library
Please Enter all the required fields
OK

Figure (7.12): Check Out – Empty fields

If the librarian didn't enter valid dates – didn't change the defaults set by the system, like the situation in Figure 7.13, a message with "Date not Valid" will be shown.

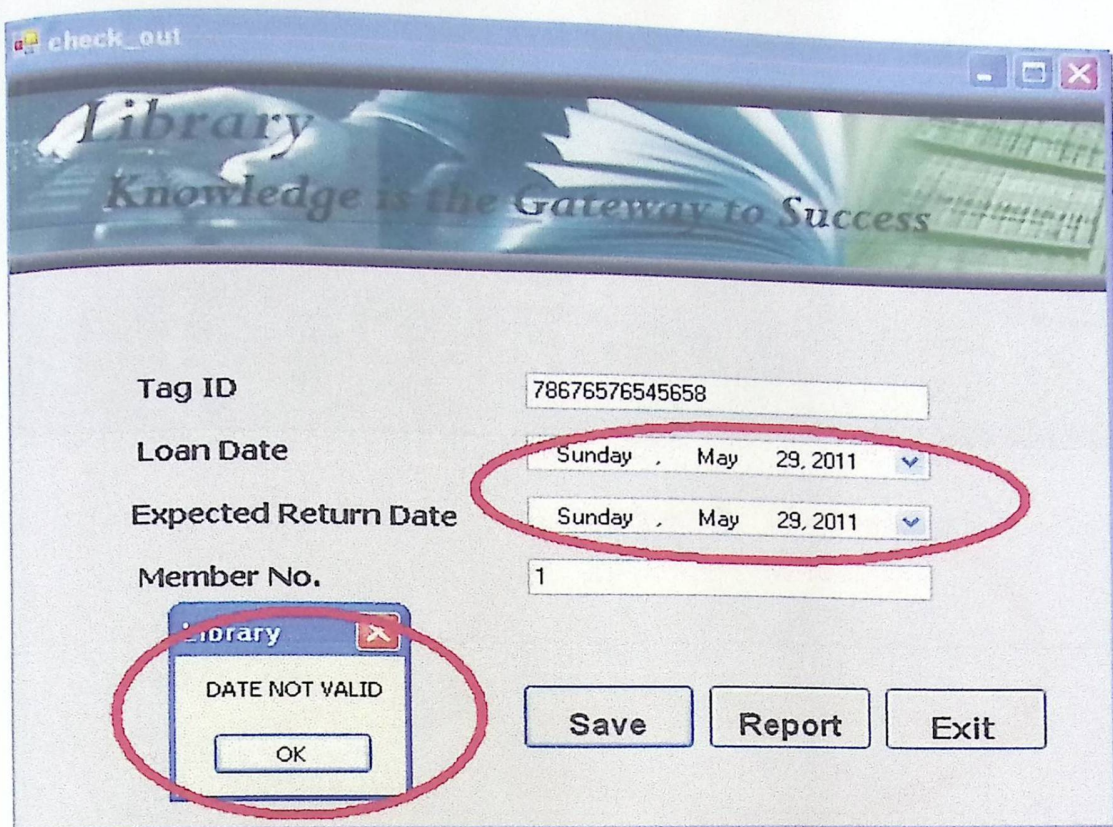


Figure (7.13): Date not valid

After all the fields are entered correctly, the system will check if the book is already loaned to another one. If it was loaned then a message with "Book is not available!" will be shown. Check figure 7.14.

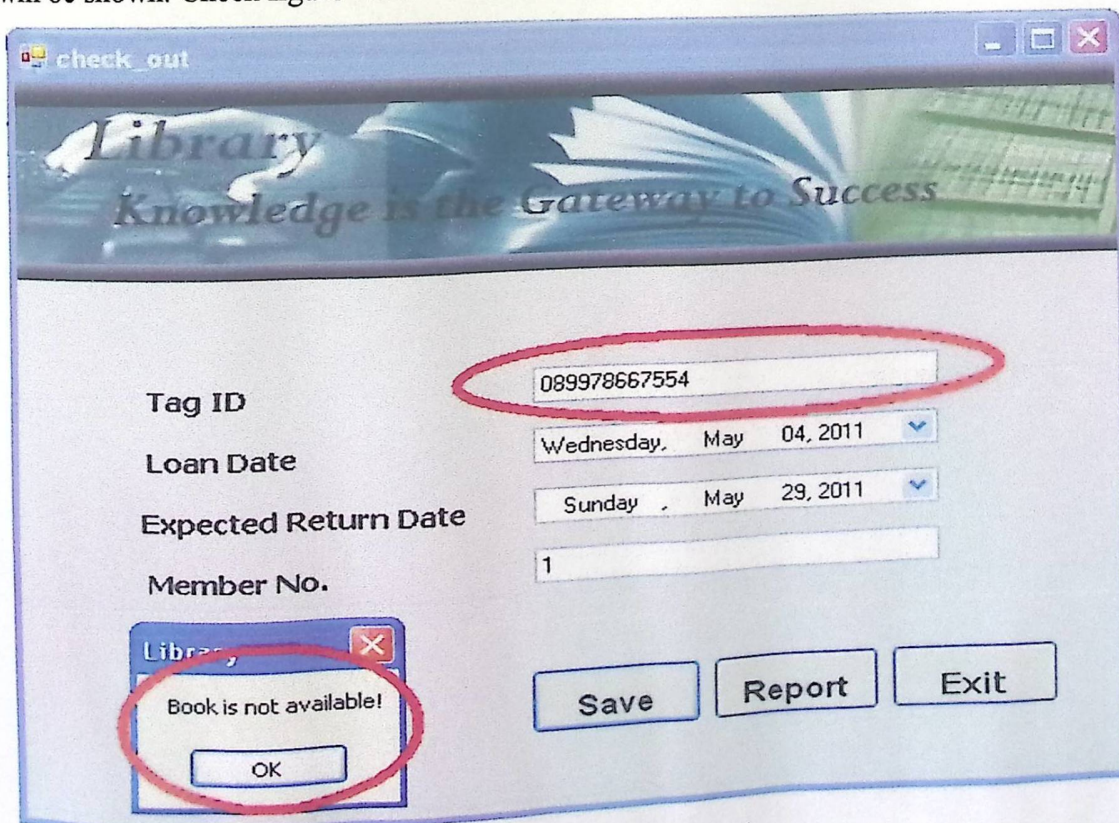


Figure (7.14): A loaned book

Finally if everything went okay, then the librarian will be notified that the book was added successfully. Check Figure 7.15.

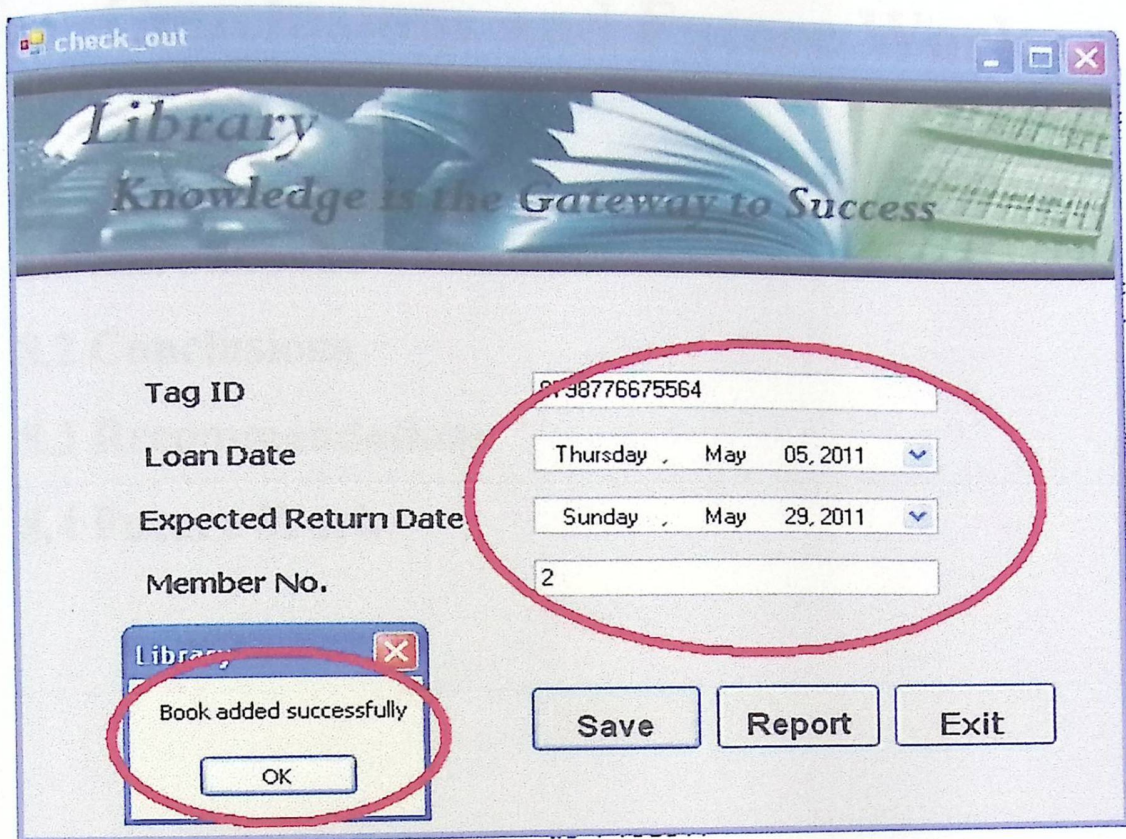


Figure (7.15): Book added successfully

CHAPTER EIGHT

Conclusions and Future Work

8.1 Introduction

8.2 Conclusions

8.3 Recommendations

8.4 Future Work

8.1 Introductions

After we have finished the implementation of the RFID based library management system, we have reached to a set of conclusions and recommendations that may improve it in the future.

This chapter will list a number of conclusions we have reached, and a set of recommendations and future work.

8.2 Conclusions

- RFID as a technology has enhanced some of the processes that are done in a traditional way in the targeted library.
- The system enhances the existing system that is applied in the library.
- The system worked on a number of processes which are adding a book, searching for a book, shelf management and inventory management.
- The system helps the librarian to manage the librarian an efficient and time saving way.
- Getting the IDs of the books through the RFID reader ensures the right entry of the ID, unlike the traditional way where typos may result in data loss in many ways.

8.3 Recommendation

- The idea of this system will be a great match for the current Palestine Polytechnic University Library where the traditional system is still used.
- Provide a training that ensures that the librarians are aware of the system main components and the software capabilities, so they can make the best use of it.

8.4 Future work

As this project delivers mainly the technology not the management system itself, so there are some areas inside the university campus that can be served efficiently through using this technology like:

- Parking access control
- Inventory management for the university's store
- Attendance system

For the current developed system –library management system, a number of processes can also be managed more efficiently when converted to RFID based ones like:

- **Anti-theft**

An anti theft system can be integrated to ensure that no books are got out of the library without being registered

- **Self Check In /Out**

Library members can perform a self check in or out for books without having to go through the known cycle of borrowing a book from the library. This can be performed by designing a box that supports the RFID technology where the members can put the desired book on the top of it. The box will get the member a report and updates the data in database by performing a loan transaction.

- **Book Drop**

This is meant to allow the members who borrowed books from the library to be able to return these books at more than one location and also without having to go through the traditional cycle of returning a book. This process can be done in other locations – not necessarily in the library, like bus station, subways or any public place.

This process can be considered as a partial automation of the library management system so that there will be no need for traditional processes' cycles.

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