A MANAGEMENT AND ANALYSIS TOOL FOR LIBRARY OPERATIONS

IEE 505 PROJECT FALL 2017

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1. Introduction

Learning is no more a privilege but a right that every individual needs to have access to. Libraries have always been pillars of learning that propagate learning in a community. They have become nodes that make global information and knowledge accessible in a local setting (Häggström, 2004). Running a library can be challenging owing to the sheer volume of transactional data that accompanies its operations. These day to day transactions come with the rigors to inventory management in addition to other operational issues that every organization faces like workforce scheduling, revenue analysis and delivery/supplier analysis.

The project deals with the day to day operational demands of the library to make this cumbersome experience more seamless and rewarding just like the books or resources present in the library.
Accurate documentation of all transactions and real-time inventory management are crucial. A good library system should not only handle the rigors of day to day operations but should also aid the library management in their decision-making process.

The various avenues of possibilities are endless. The few avenues that we have tried to focus on in this project are workforce scheduling, revenue analysis, order fulfillment analysis and transactional data analysis. The project strives to produce functionality without compromising on the GUI aspects that are equally important to enhance the user experience.

2. Problem Statement/User Requirements

The problem statement for this project was straightforward. It included a design of a database that helped with all transactions and the decision-making process without compromising on the GUI. Excel VBA in conjunction with MYSQL was required to be used to satisfy the requirements of the problem statement. The problem statement or user requirements could be broken down into two functional categories.

2.1 Information Management System Requirements

The need of the hour was to make an IMS system that was clean, efficient, user friendly and accurate in dealing with all the data that was sent its way. The key stakeholders for these database needs were identified as the members, employees, supply chain professionals and database admins. The functionality required by each are given as follows:

Members: The key requirements here were Search and Reserve books, updating member information and database account creation.

Employee: The key requirements here were updating employee information and updating leave information.

Database Administrators: The database administrators are the ones that demand absolute IMS functionality to maintain all transactional records related to books, data related to members and employees. They would require functionality that allows them to add, delete, update data at their discretion.

Supply Chain Personnel: The requirement would be to update all the information regarding the buying transactions in the data so that it can be used to future analysis.

2.2 Decision Support Requirements

The requirement here is to come up with a tool that would aid the library management in their decision-making activities. The key users of this function with their functionality requirements are mentioned below:

HR Admins: The prime requirement here would be to manage the leave schedule of the employees so that regular library operation is not affected due to a shortage of employees.

Management: The areas where they would need some assistance would be in revenue analysis and transactional analysis. The key here would be to provide them information in a form that is easy to decipher so that they could take their decisions swiftly.

Supply Chain Personnel: They would need assistance to analyze the order completion time and the cost of orders to make decisions on future publishers based on their order completion time.

During this project, the above-mentioned requirements were addressed.

3. Database Design

The first stage in the Database design process was to come up with the ER Diagram. The ER Diagram is given below.

3.1 ER Diagram

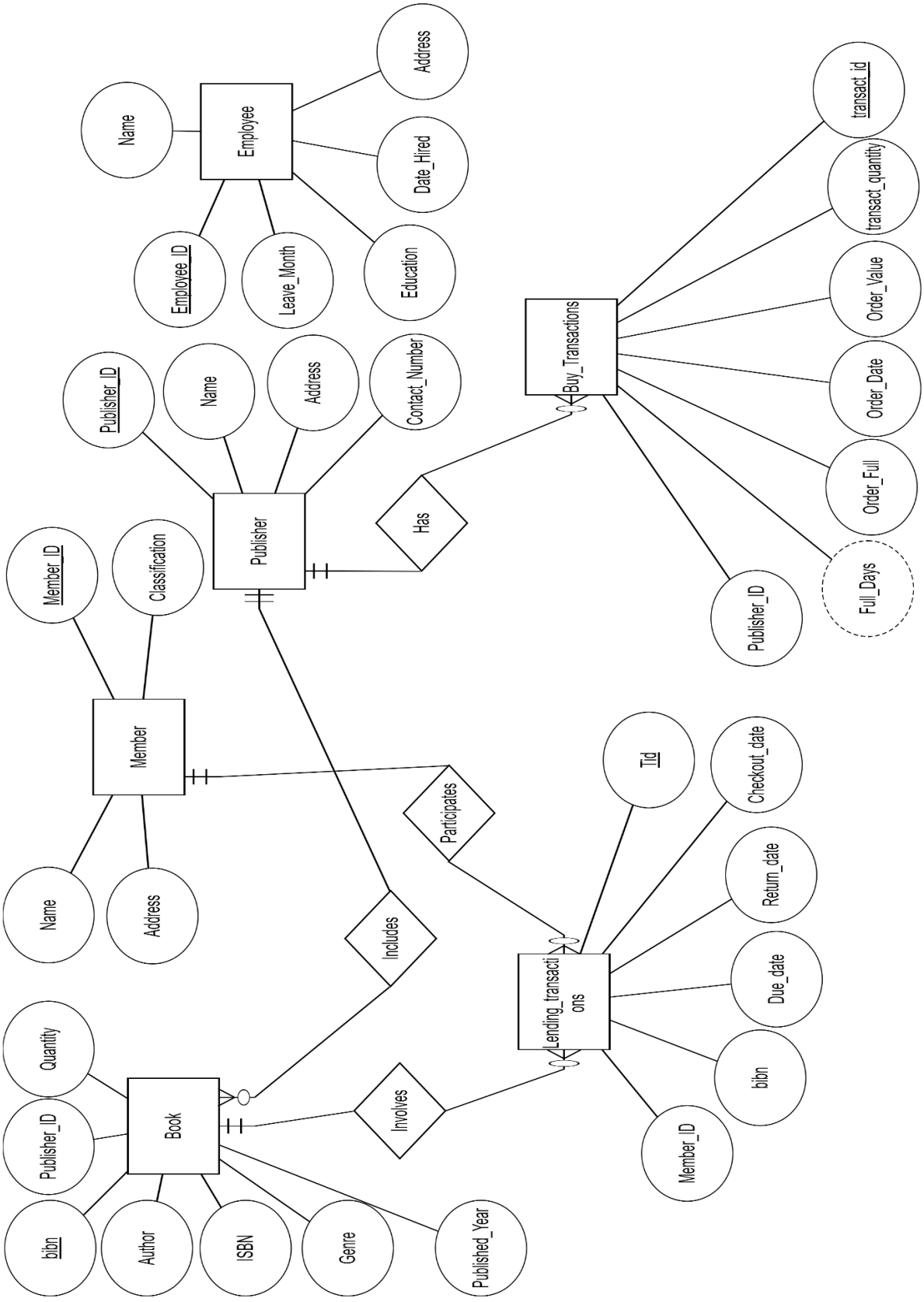


Figure 1

3.2 Assumptions

1. Every Lending Transaction can contain one and only one book. For the relationship between the book and the lending transactions entity a one to many cardinality is assumed. Similarly, since every lending transaction only involves one book there would only be one publisher that is linked to one transaction. Hence the assumption that the relationship between the publisher entity and the lending transactions entity is one to many becomes valid. One lending transaction can have only one publisher but one publisher can be linked to many lending transactions. Multiple items can be checked out one after the other with the help of the GUI, but each such checkout would have a unique transaction id. This will be explained in detail under that section.
2. The cardinality between the member and the lending transactions entity is assumed to be one to many. A member can have multiple lending transactions, but a lending transaction can have only one member.
3. The cardinality between the book and publisher entity is assumed to be many to one. Every publisher can have multiple books, but one book has only one publisher.
4. The cardinality between the publisher and the buy transactions entity is assumed to be one to many. Every publisher can be part of multiple buy transactions, but each buy transaction has only one publisher.
5. The data used to populate the table and run the analysis does not comprise of real data. Dummy data has been generated and used for this project. The title used for the books and names of authors are all fictitious. The data analysis segment of the project has been used to showcase the functionality that the database is capable of.
6. The employee entity is a standalone entity that is there in the database just to add an extra dimension to the library operations database in terms of workforce scheduling.
7. We have treated all member classifications as the same and not given any special privileges to any one type of member based on their classification.
8. All employees if they want to be members need to apply for membership using the database just like a regular member would. An Employee ID does not warrant membership in this case.
9. The data that is used to showcase the inner workings of this tool is from the current year alone, historical data has not been considered. In addition to this, the revenue and expenditure due to two major library operational activities is alone considered. Additional revenue streams or expenditure due to facility operation and employee cost are not considered in the scope of this project.

3.3 Entity and Attribute Description

3.3.1 Entities

The Entities present in the ER Diagram are given as follows:

1. Book (Contains the details of all the books in the database)
2. Member (Contains the details of all the members in the database)
3. Publisher (Contains the details of all the Publishers)
4. Lending Transactions (Details of all the Book Lending Transactions)
5. Buy Transactions (Details of all the Buying Transaction made by the Library from the Publisher)
6. Employee (Contains details of all the Employees working in the Library)

3.3.2 Attributes of the Entities

Book

1. Bibn (Bibliography Number, primary key)
2. Author (Name of the Author)
3. ISBN (ISBN Number)
4. Genre (Genre of the Book)
5. Publisher_ID (ID of the Book Publisher, foreign key)
6. Published_Year (Year of Publication)
7. Quantity (Inventory on Hand)

Member

1. Member_ID (ID of the library member, primary key)
2. Name (Name of the member)
3. Address (Address of the member)
4. Classification (Classification of the member)

Publisher

1. Publisher_ID (ID of Book Publisher, primary key)
2. Name (Name of the Publisher)
3. Address (Address of the publisher)
4. Contact_number (Contact Number of the Publisher)

Lending Transactions

1. Tid (Transaction ID of a lending activity, primary key)
2. Checkout_date (Date when a book is checked out of the library)
3. Due_date (Date when the book is expected back)
4. Return_date (Date when the book is returned)
5. Bibn (Bibliography number of the book that is checked out, foreign key)
6. Member_ID (Member ID of the member who initiates the lending transaction, foreign key)

Buy Transactions

1. Transact_id (Transaction ID of a buying activity, primary key)
2. Transact_quantity (Quantity of items in the transaction)
3. Order_value (Total value of the transaction)
4. Order_date (Date the order was placed)
5. Order_full (Date the order was fulfilled)
6. Full_days (Number of days taken to fulfill the order, Derived Attribute)
7. Publisher_ID (ID of the book Publisher, foreign key)

Employee

1. Employee_ID (ID of the employee, primary key)
2. Name (Name of the Employee)
3. Address (Address of the Employee)
4. Date_hired (Hiring Date of employee)
5. Education (University the employee studied at)
6. Leave_month (Month the employee is going on vacation or proposing to go on vacation)

3.4 Relational Modelling and Table Design

The following relational model was implemented.

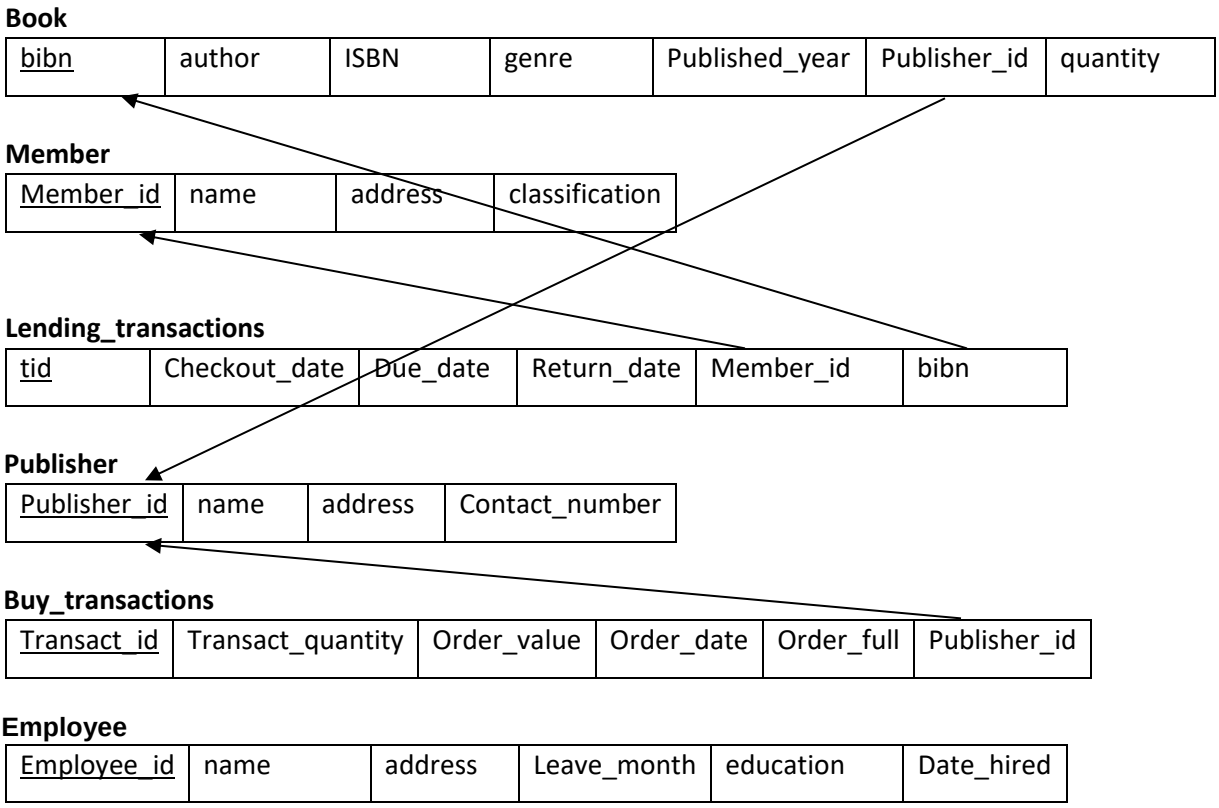


Figure 2

4. Database Setup and Application Design

4.1 Database Design

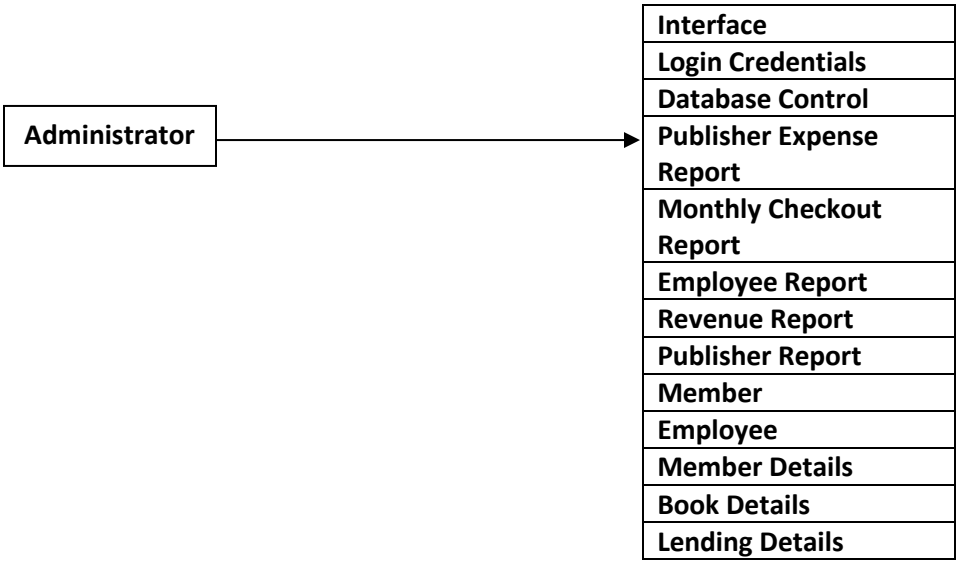
Once the conceptual modelling of the database was done using the ER Diagrams and Relational modelling, the next step was the practical implementation of the concepts. Once the tables were created using MYSQL the next stage of the implementation process involved the process of searching for data and populating the tables. Real relevant data was difficult to obtain so data was generated using dummy data generators available online and was coupled with data obtained from other online resources as well. Once the data was obtained, before the data could be imported into the tables, there was a need for cleaning of the data. After the cleaning process, the data was imported into the tables using MYSQL. This marked the end of the database design process and we moved onwards to the next phase which was application design.

4.2 Application Design

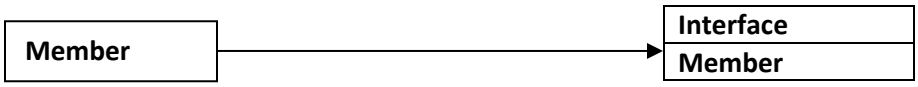
As mentioned before the key was to come up with a tool that provides the necessary functionality to benefit all the stake holders without compromising on the user interface. Our goal was to present a user interface that was clean, easy to use and self-explanatory. The application was designed using Excel VBA and the data was extracted from the tables in the database by establishing the connections to MYSQL using the VBA code. The GUI of the tool developed will be explained in detail in the next section, so in this section we will look at the functionality that the application designed provides.

Initial Sign-In form

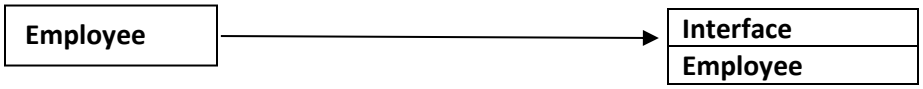
As the database is opened the user is presented with a sign-in form to enter his user name and password. The two basic types of user accounts here would be the admin account which grants privileges to access the entire functionality of the database and the other user accounts that grant limited functionality. Only the worksheets that the user has been granted privileges for, will be visible, the remaining sheets will be hidden. The diagram below seeks to illustrate this difference in privileges for the different users.



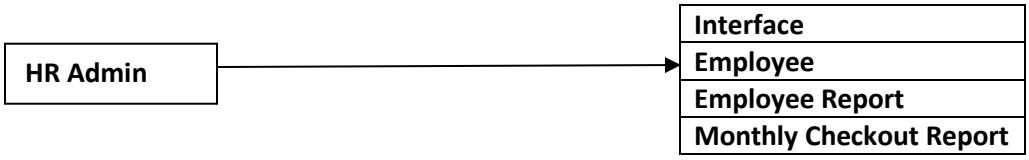
These are the worksheets that the administrator is granted privilege to access. The Login Credential worksheet is used to manage the users that can access the database and set the worksheets or applications that they can have access to. The Database Control is like the central nervous system of the database since it allows you to perform any function that the admin deems necessary through one centralized control interface.



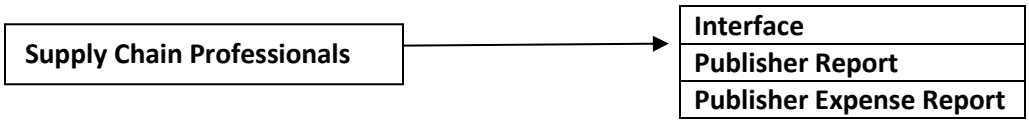
Since a member should have access to only member related functions we have given him access to the interface which contains the book catalog and the member worksheet which allows him to search and reserve a book and allows him to update his details if he chooses to do so.



An employee similarly has access to the employee page which allows him to update his details and add his leave details to the system.



HR Administrators would have access to these four worksheets since they need to make workforce scheduling calculations based on the volume of transactions in a month and the number of employees on leave every month. They also have access to the Employee sheet to update Employee details.



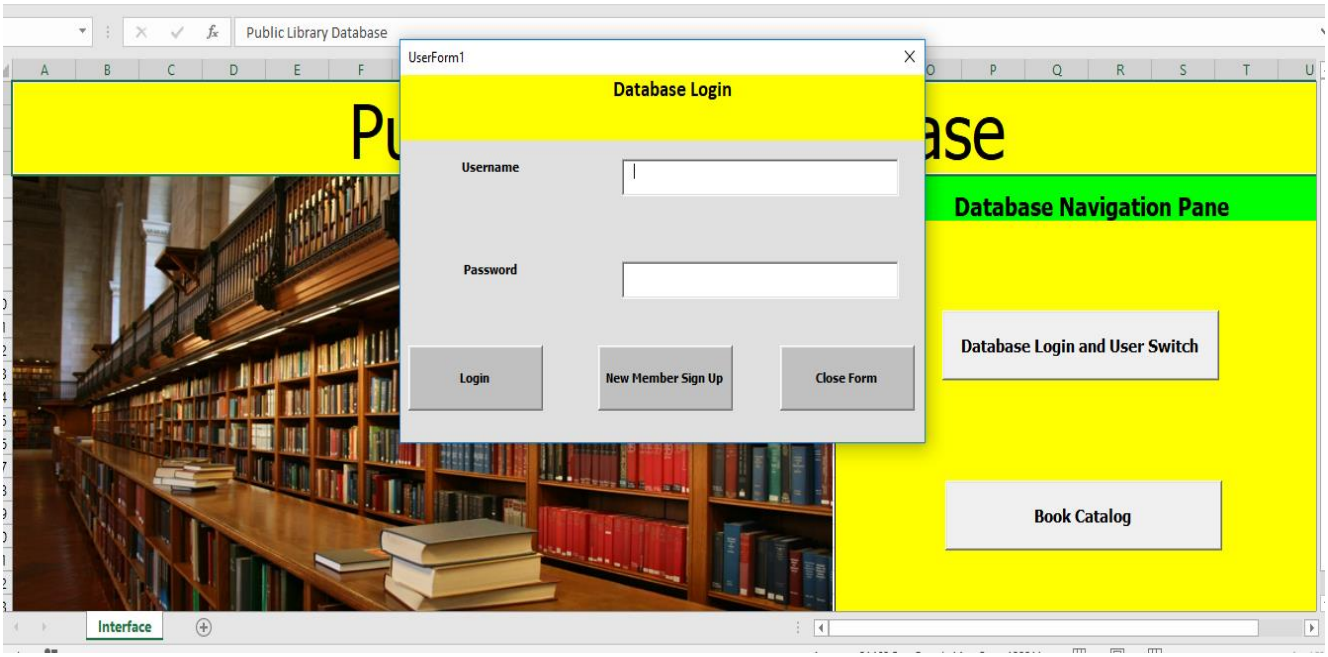
The supply chain professionals would need to access the following worksheets to make decisions on the publishers who are our suppliers in this project based on the time it takes for order fulfillment and how expensive the buy transactions are.

As you can see the interface worksheet is common to all users since it provides two basic functions which includes access to the book catalog and the ability to switch user to access different privileges.

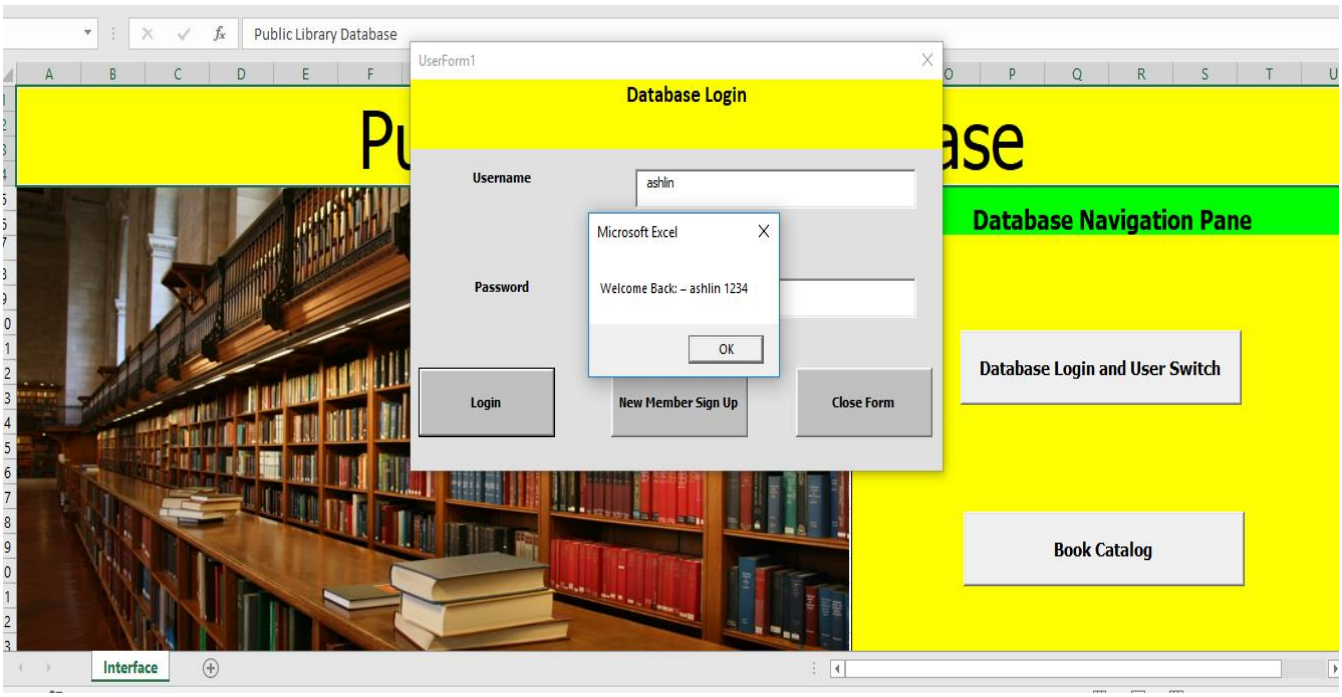
5. Graphical User Interface

5.1 Initial Sign-In Form and New Member Sign-Up

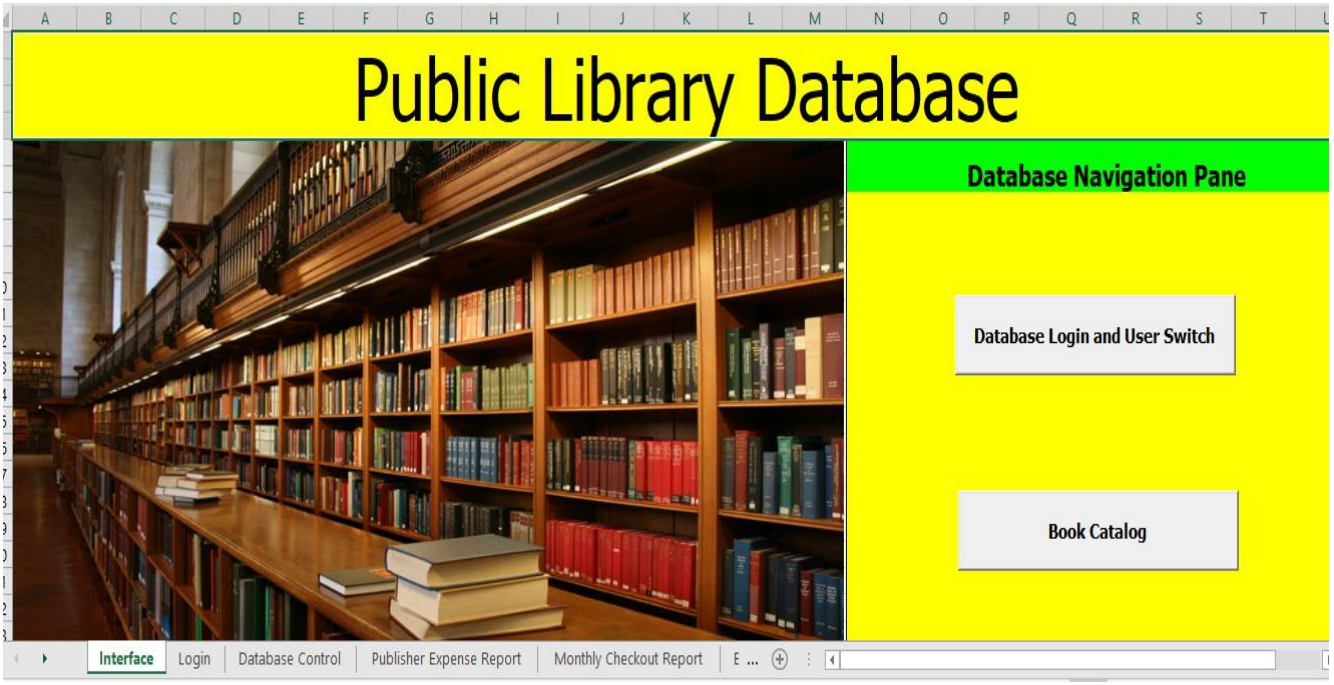
The sign-in form opens by default as soon as the tool is launched. The screenshot is displayed below.



As you can see in the screenshot, the sign-in form opens on startup and asks the user to enter the username and password. You have two options here you can either login using your username and password, or you sign up to be a new member. If you opt to sign-in using an admin login, all the worksheets of the database are automatically made visible on a successful login.

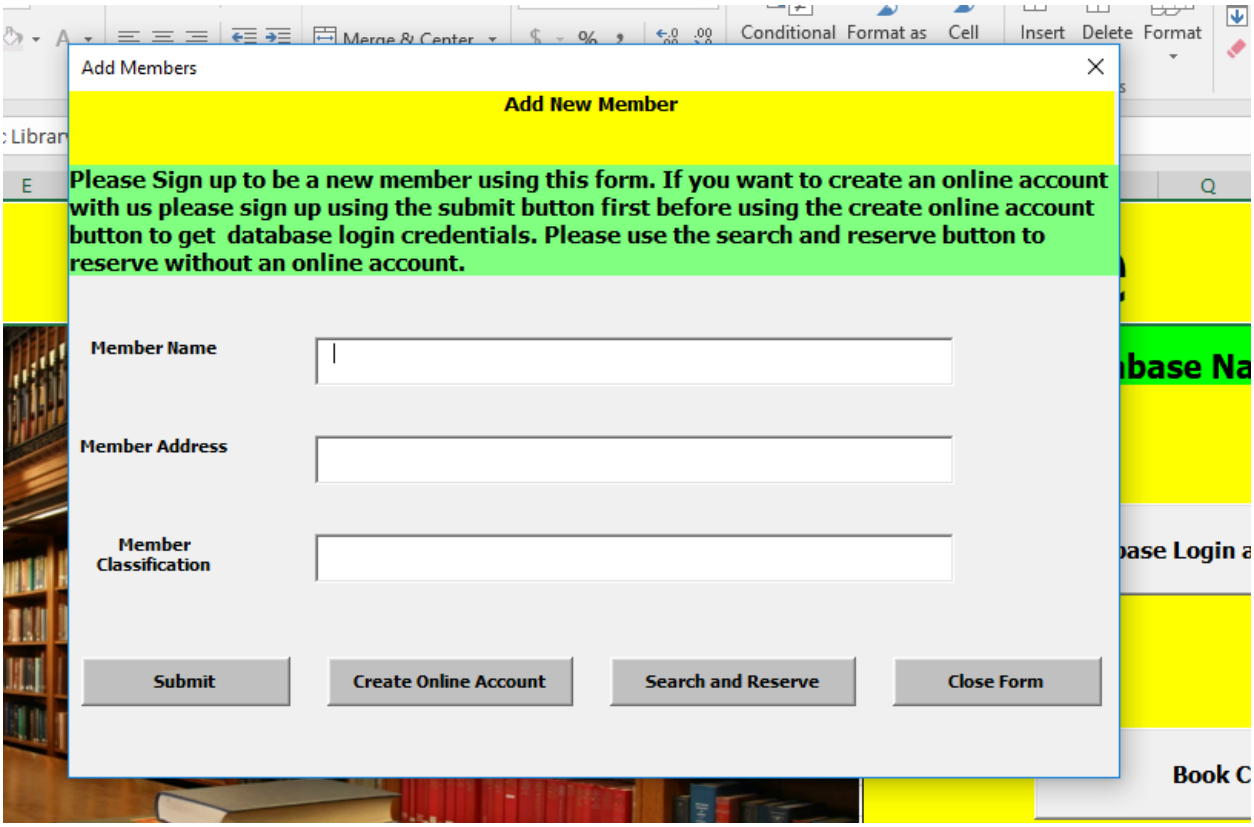


After a successful login attempt the following message is displayed via a text box and then all the worksheets in the tool are automatically made visible.

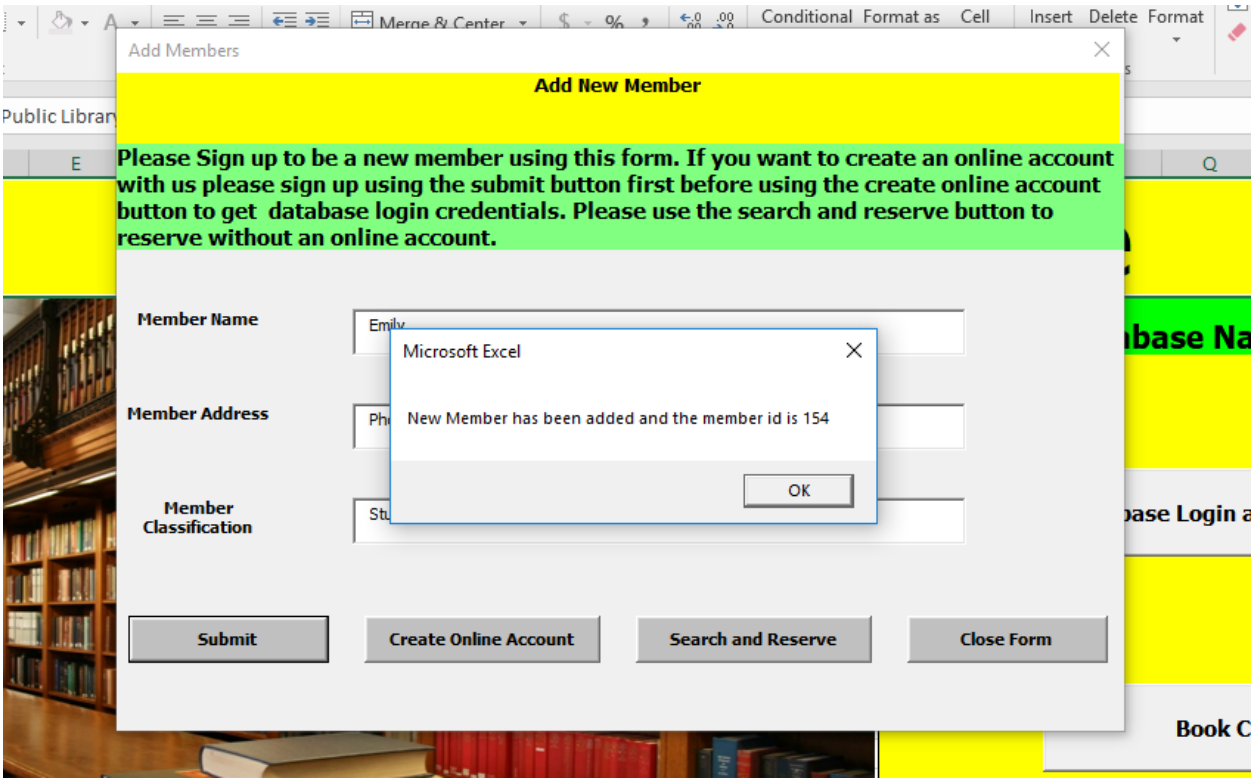


The worksheets are now made visible.

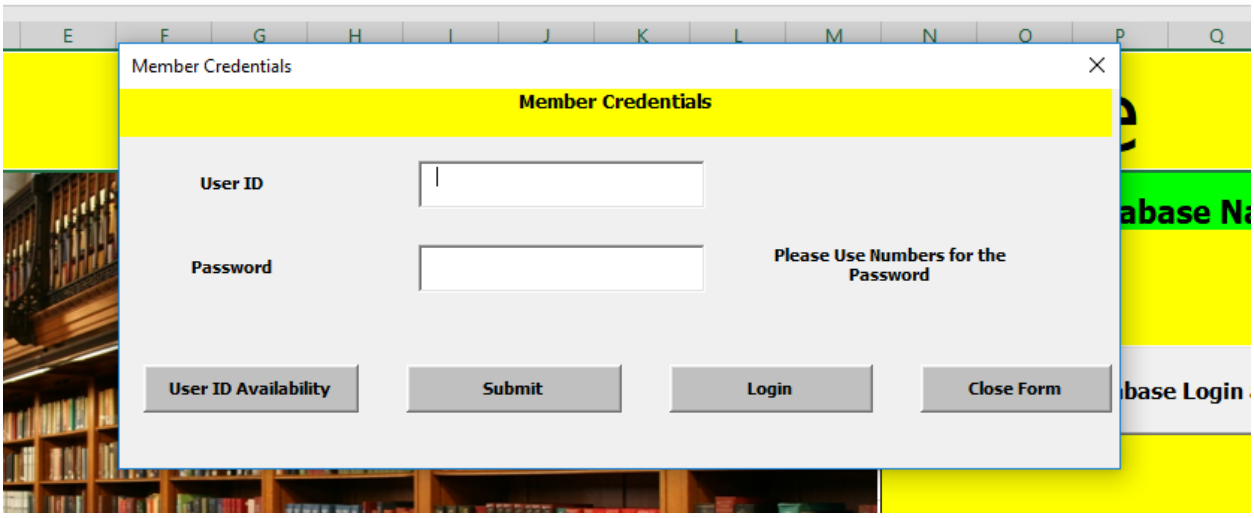
Now if you select the New Member Sign Up button the following form will be displayed.



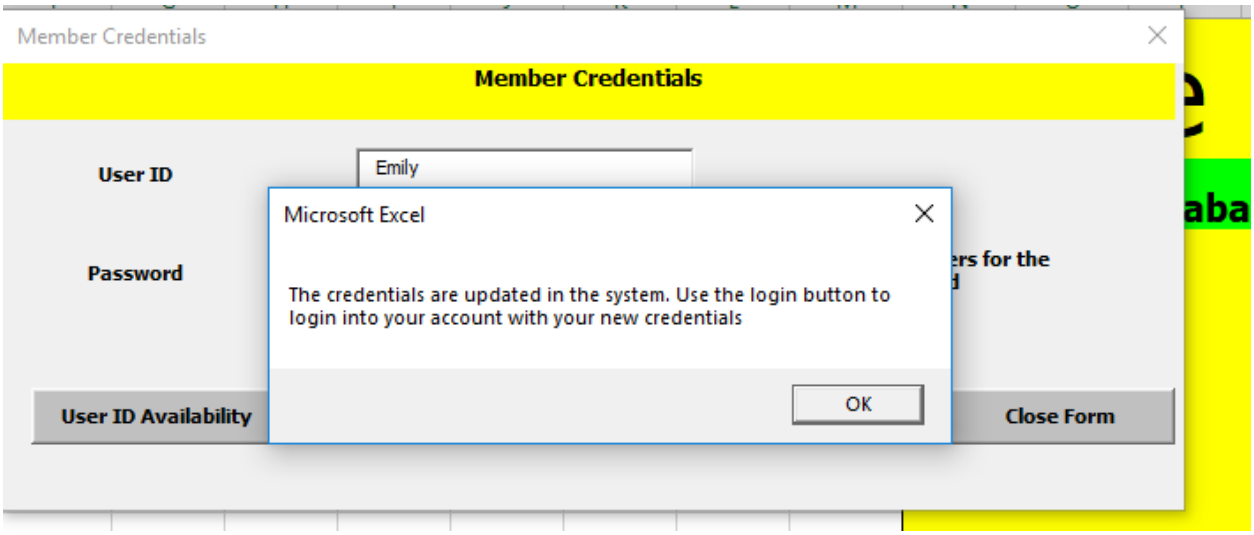
Here you have two options you can either become a member and reserve a book directly using the search and reserve function without creating an account or you can become a member and then use the search and reserve function on the member page after your login. The next few screenshots are going to demonstrate that process in detail.



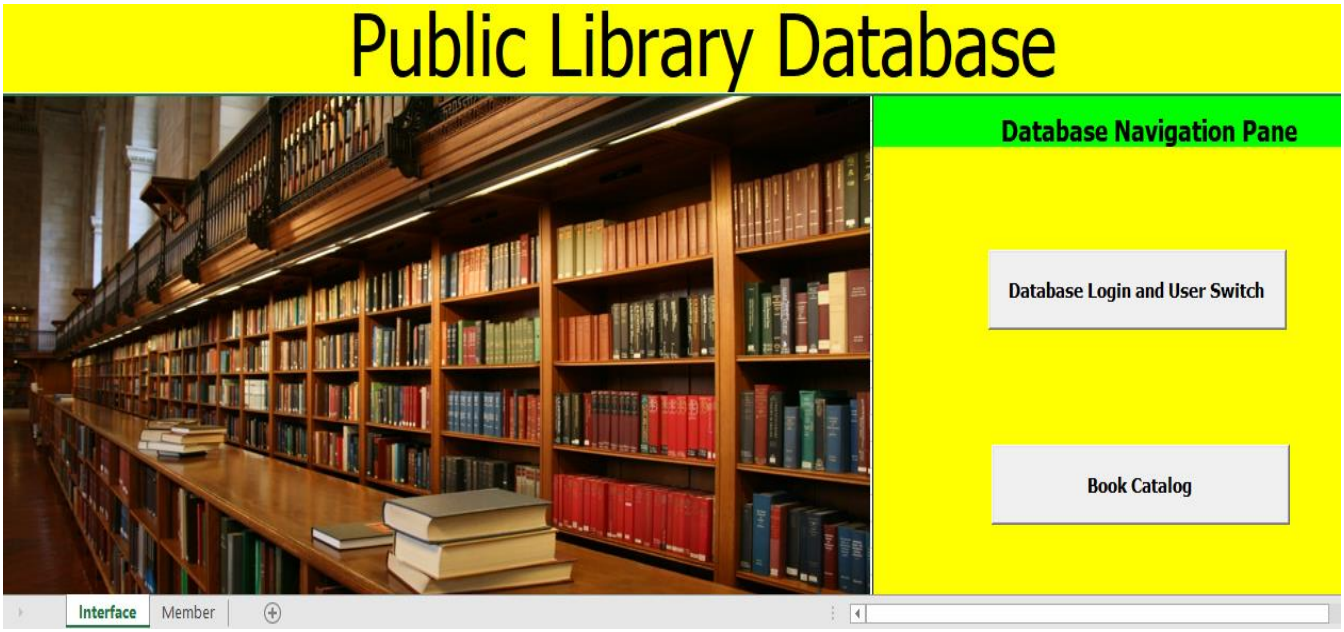
Once you have signed up to be a member and click the submit button the following message is displayed. You can now proceed to create an online member account by clicking on the create online account button. The following form will be displayed.



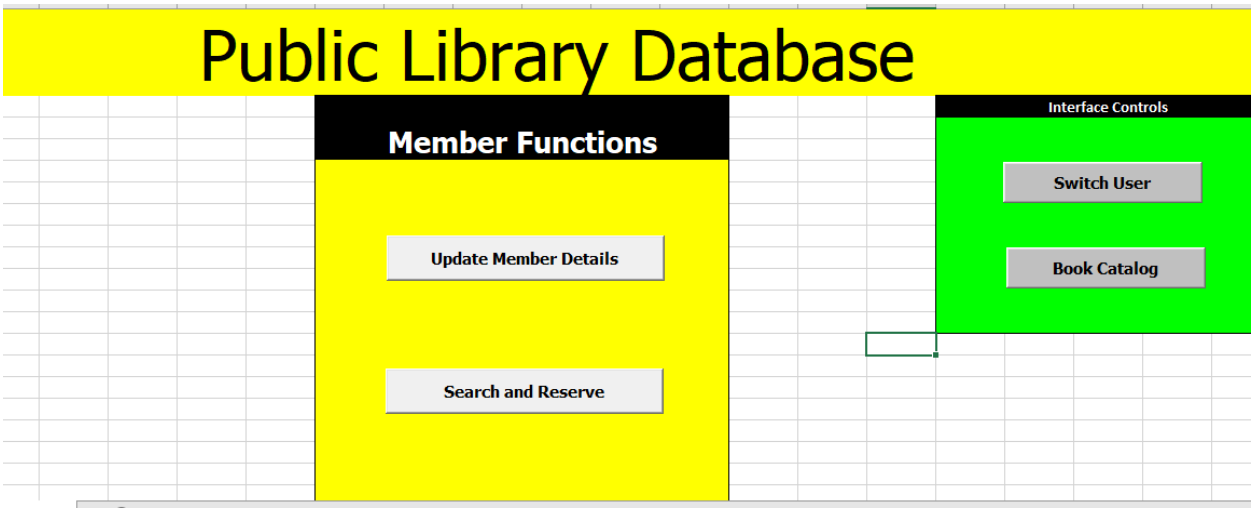
Here you can check to see if the user id that you are selecting is in use before you submit. The system automatically checks for it either way after you click the submit button just to make sure no duplicate credentials exist.



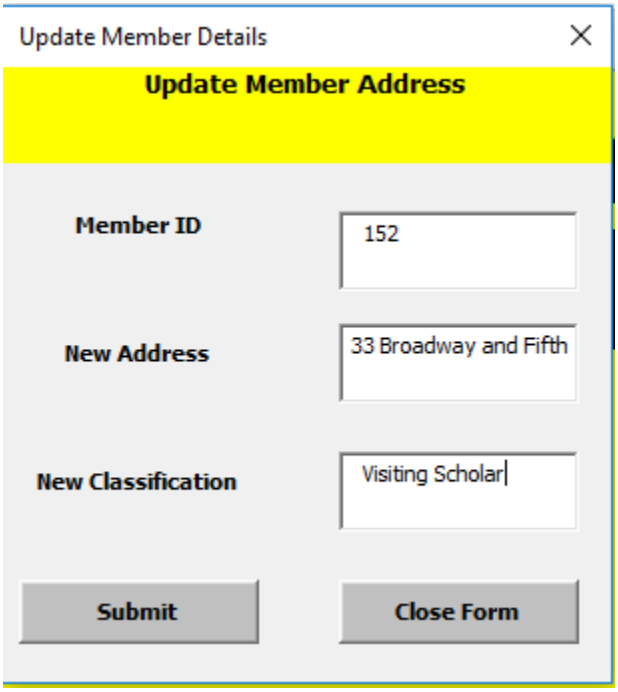
Once you enter your user id and password it gets stored in the Login credentials worksheet and you can login right away.

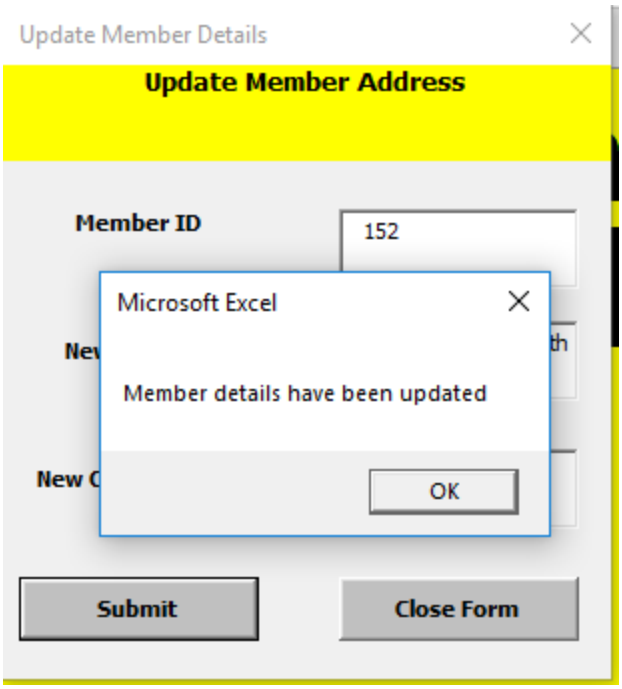


Since you are logged in as a member you have access to only two worksheets mainly Interface and Member. Once you are logged in as a member you have following functionalities as a member. You can access the database and update your details or to search and reserve a book which automatically updates the inventory once the book has been checked out.



Now we next look at the Update Member Details function that is available on the Member page. The Search and Reserve function will be discussed in detail in the next section under operational functions. The following screenshots document that process.



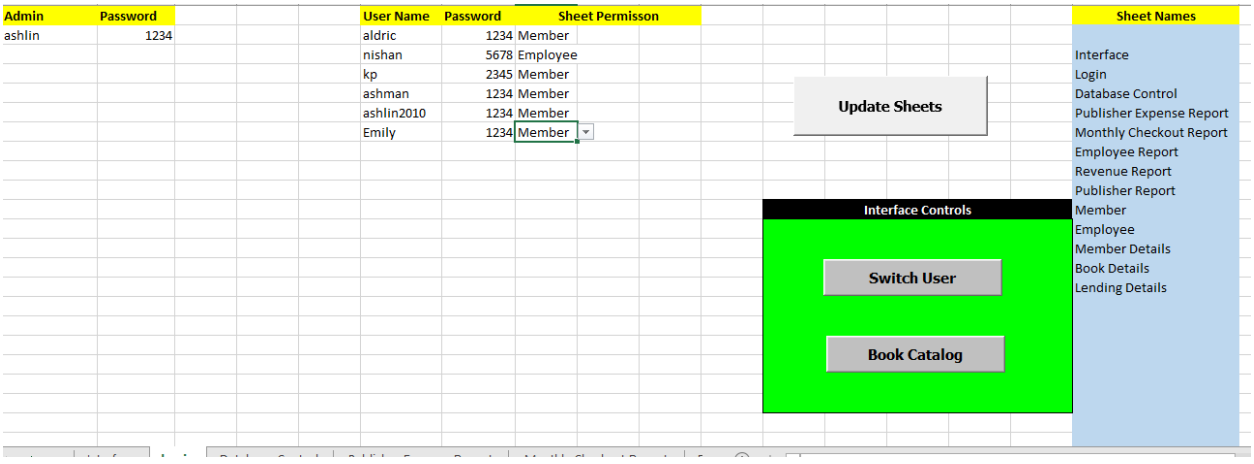


Now that we have discussed what is possible from the initial sign-in form it's time to delve into the administrative functionalities of the database, which can be done easily just by clicking on the switch user button and entering the admin login credentials.

5.2 Admin Login Options

5.2.1 Login Worksheet or Login Control

Next, we check out the login page of the database. Here we have all the login credentials of the database users. Any new member login credentials will be automatically input here once the online registration process is complete.



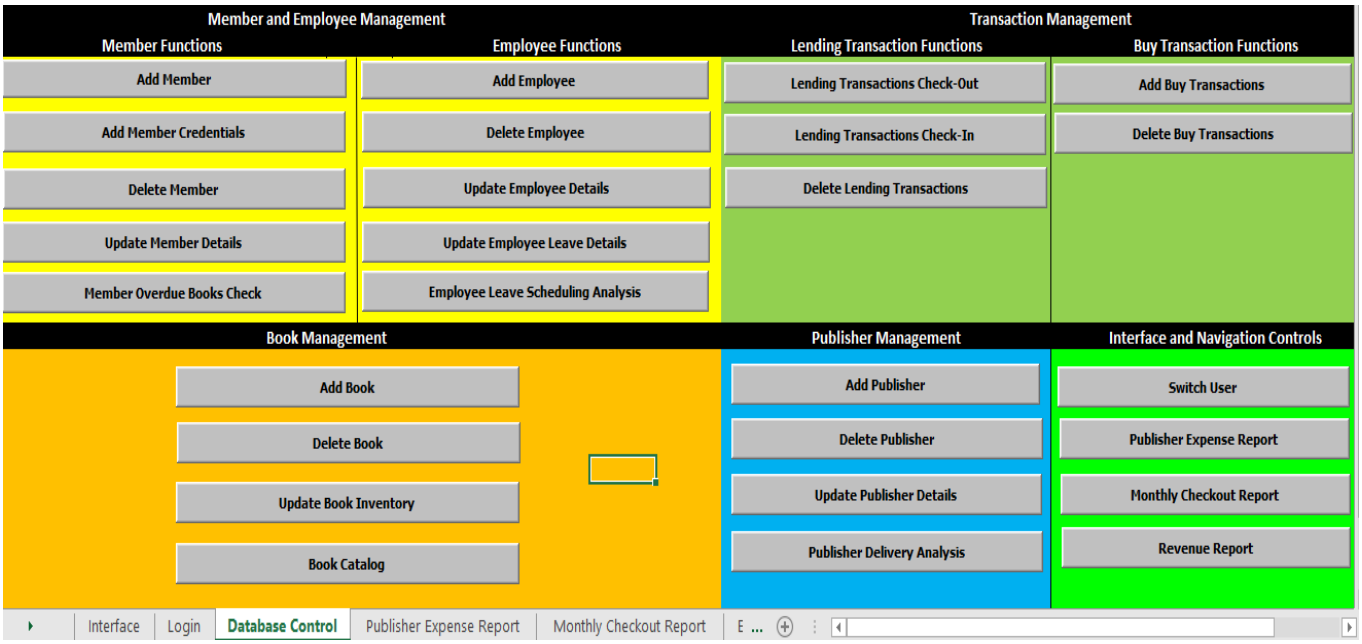
The login credentials are divided into two, we have the admin credentials and then the other users of the database. The access privileges to the other users of the database can be given using the drop-down menu located right next to their credentials. The drop-down list is populated using a dynamic list containing all

the sheet names which is shown highlighted in blue. The sheet names in the column is updated using the update sheets button which adds new sheets to the dynamic list range. A simple For loop is used to check the names of the sheets next to user credential and then make visible only those sheets the user has access to. Here the different users of the database like HR admins, supply chain professionals can be granted access to the sheets that relevant to them to excel in their roles.

5.2.2 Database Control

We look at the Database Control Worksheet next. Like mentioned before this is the central nervous system of our database. Using the control buttons here you can perform simple tasks like adding, updating and deleting of the records in any of the entities such as members, employees, books, publishers, lending transactions or buying transactions. You can also perform day to day operational functions like searching and reserving a book (Lending) or a checking a book back into the library.

In addition to this you also have access to several advanced decision support functions like Employee Leave Scheduling Analysis, Publisher Expense Reports, Monthly Checkout Reports and Publisher Delivery Analysis. Clicking on any of these decision support control buttons would take you the worksheet where you can view the analysis.

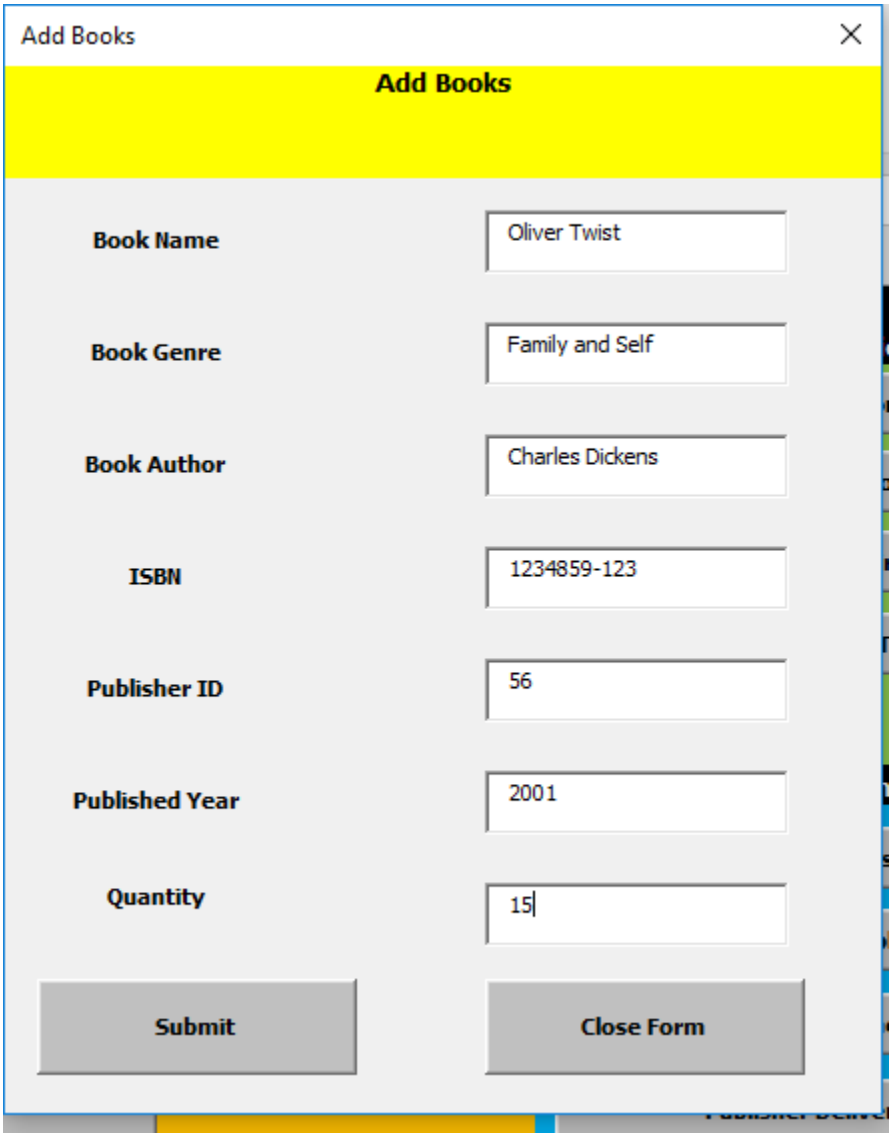


5.2.3 Basic Database Functionality

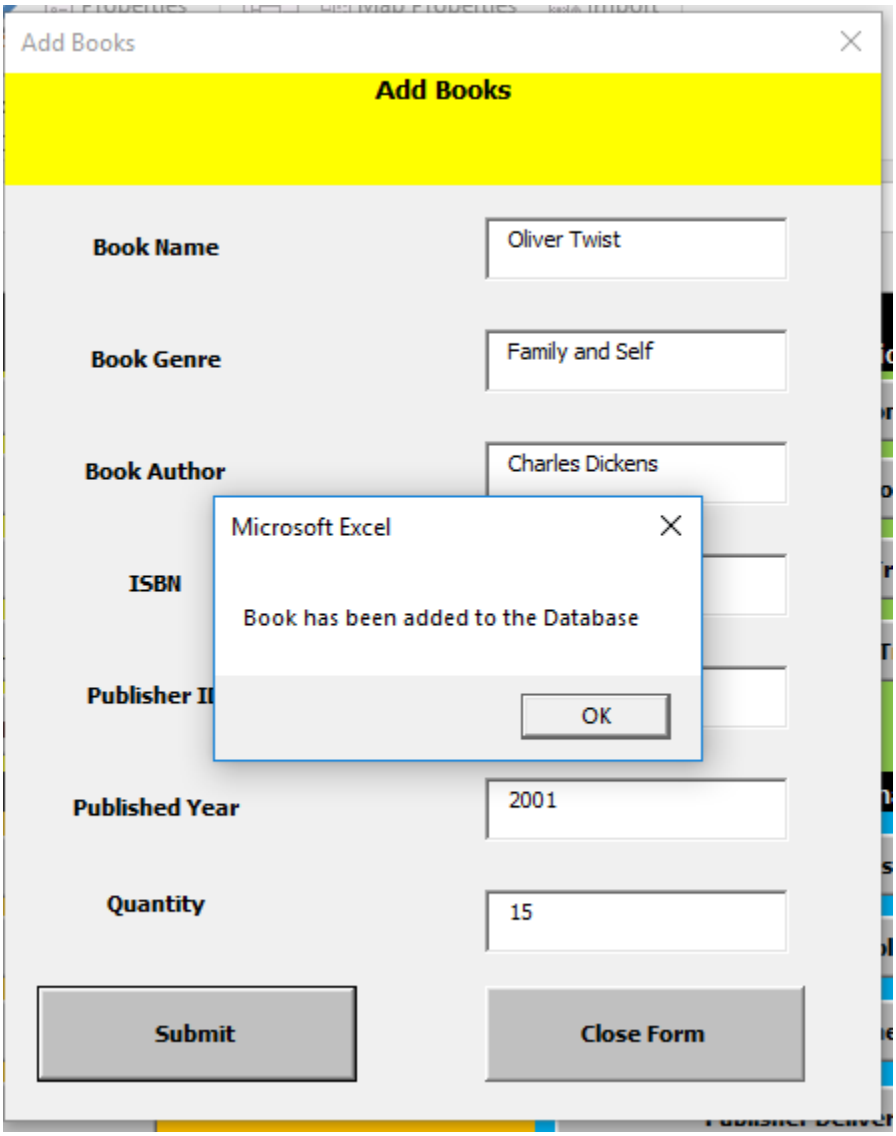
It would be redundant to show screenshots of the all the user forms that appear on the screen for the basic functions like adding, deleting or updating records of an entity. So, showing the user forms of a single entity should suffice since the basic principle should be the same across all the entities. Once the basic functionality is displayed we will move on to some of the advanced functionality that the database has to offer. For this report we pick the control buttons under Book Management to showcase the user forms.

Add Books

Once we click on the Add Book button a simple user form like the one displayed below appears on the screen. Once we input the necessary data and click the submit button the book is added to the inventory.

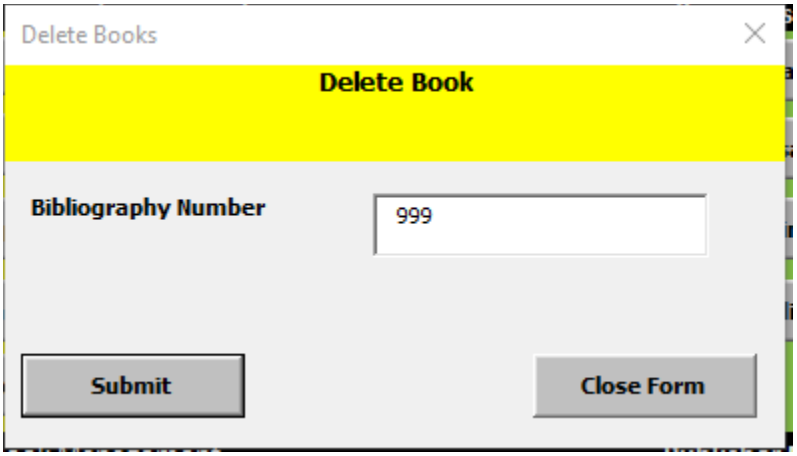


We get the following screenshot below once the book has been successfully added to the system.

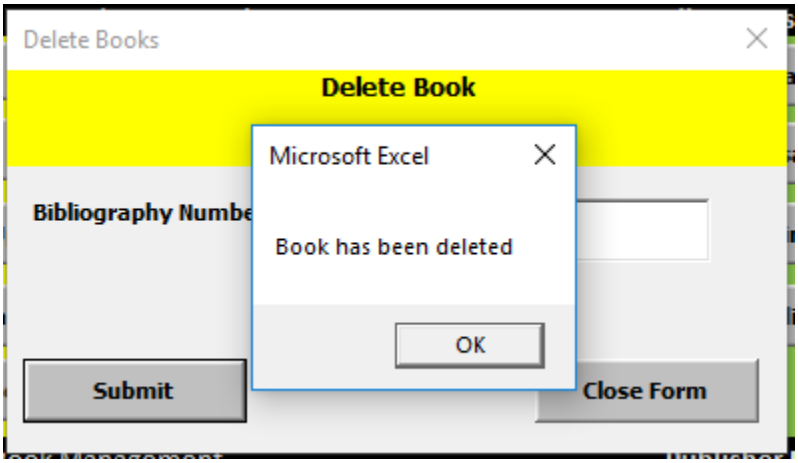


Delete Books

If we need to delete a book from a database all we need to do is click on the delete book button. We only need the bibliography number to complete this operation. If the user doesn't remember the Bibliography number, he can always look it up using the Book Catalog button which will be explained later.

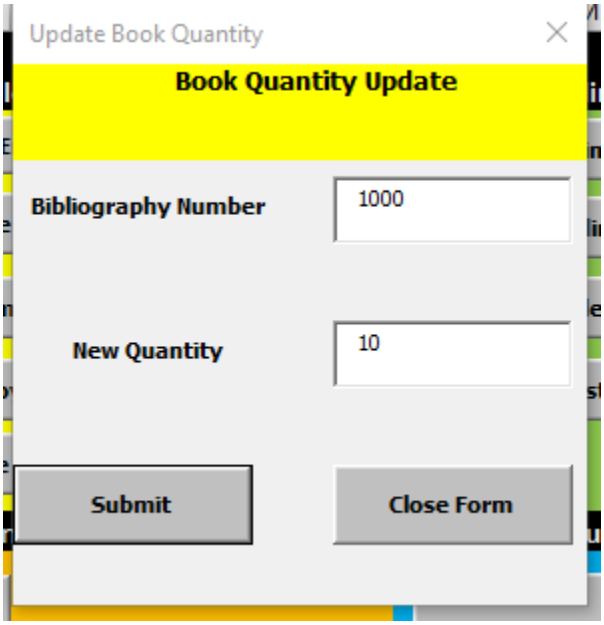


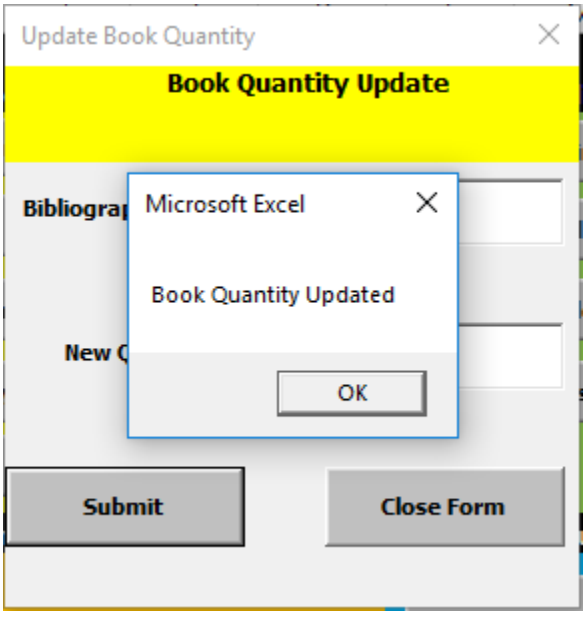
Once you click Submit the following screenshot will be seen.



Book Inventory Update

If you want to update the inventory due to a new influx of book shipments, it can be done using this button. It is important to note here that any transaction whether it is check-out or check-in of books is updated in the inventory automatically. The screenshots are below.

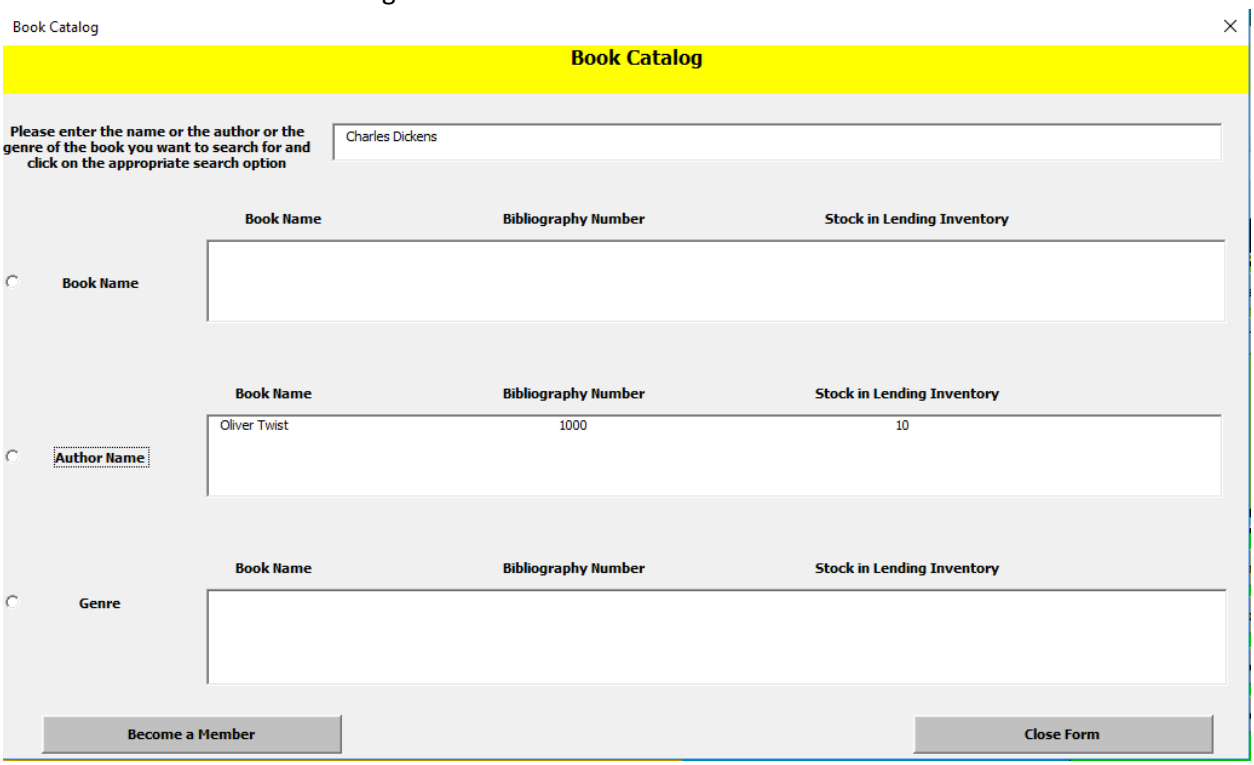




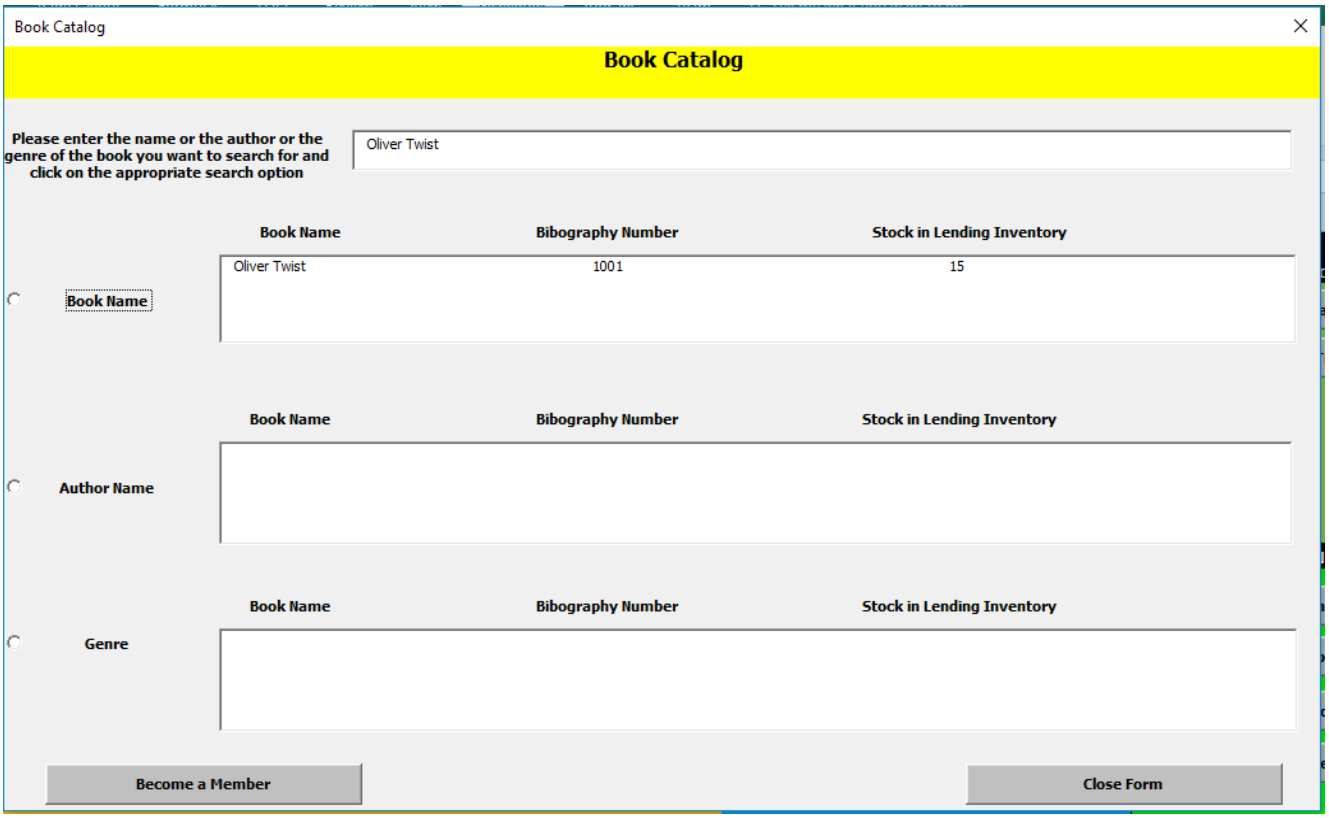
Book Catalog

Another function that is important and needs to be discussed here is the book catalog function. It searches for the book either by name, author or genre and displays all the details along with real time inventories so that the user knows if the book is in stock or is off the shelf. Once you enter the data in the text box provided all you need to do is click on the option button to search using the criteria you want, be it name, author or genre. Below is displayed a Book by Charles Dickens that was searched for using the different criteria. After the search is over the option button is refreshed by default to make any subsequent searches possible without closing the form. The catalog function displays a message that the book is not available if the book has never been part of the inventory library.

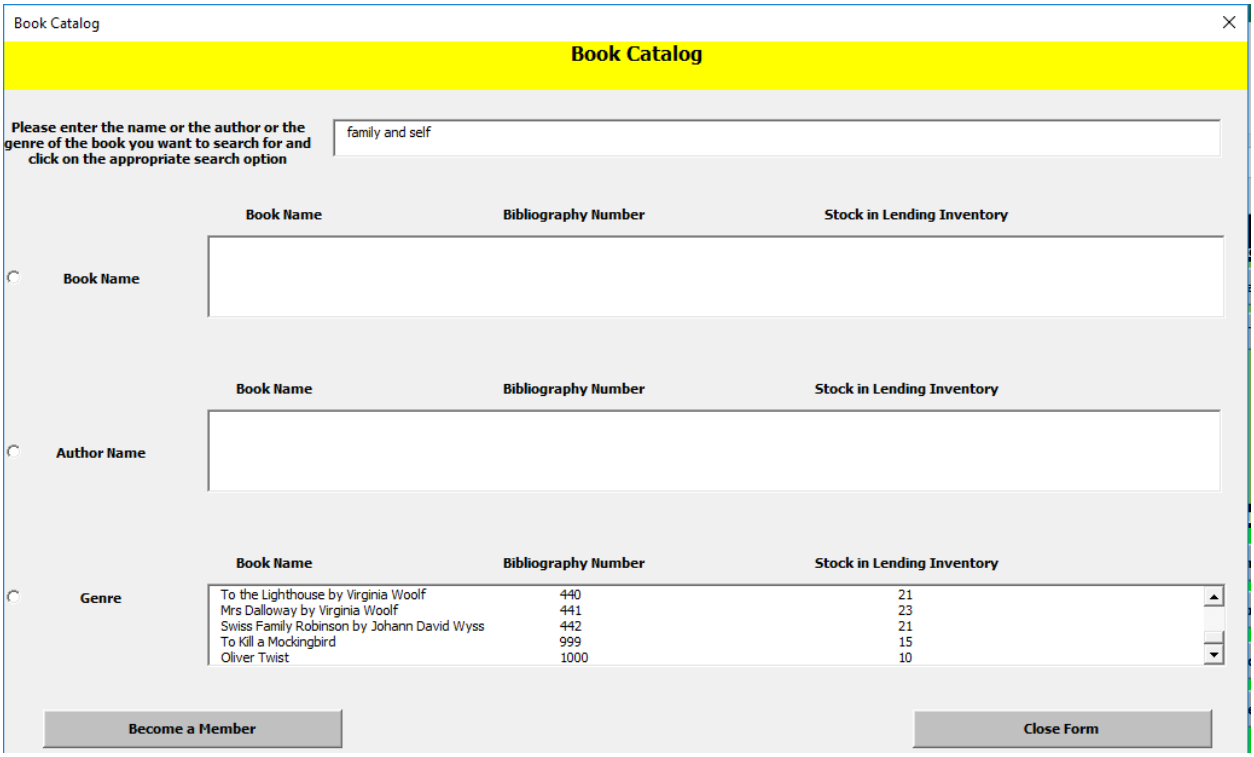
When the search was done using **Author Name**



When the search was done using **Book Name**



When the search was done using **Genre**



Similarly, the basic functionalities **(Add, Delete, Update)** for other entities can be carried out.

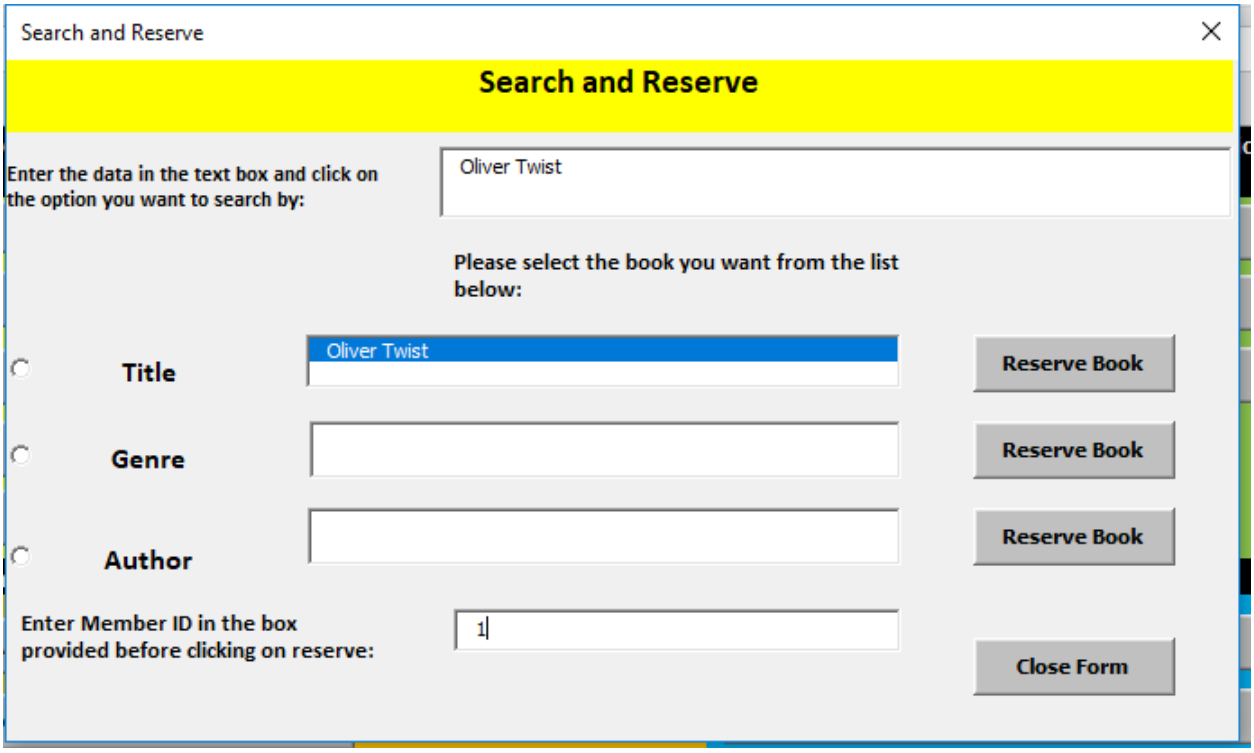
5.2.4 Operational Database Functions

The next phase of functionalities that are to be discussed are the functions that aid day to day operations of the library.

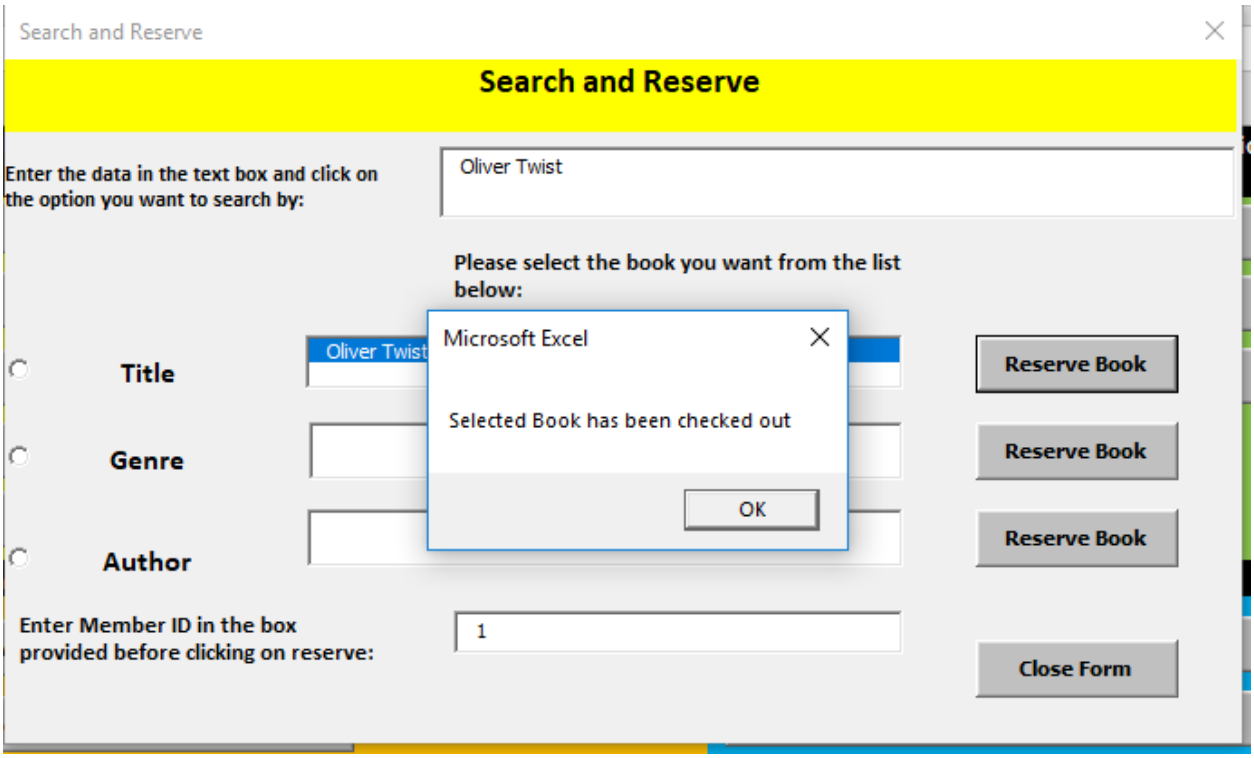
5.2.4.1 Search and Reserve Function (Book Check-Out)

This is used to search for the book present in the database. Once the book has been listed, it can be selected in the list box and then the reserve book button can be clicked. If the **book is not in stock** or if the number of books borrowed by a **member exceeds 10**, the submit button shows the respective error messages pertaining to what the problem was. The inventory is updated in real time which implies that if a book is checked out of the system using the search and reserve function then the inventory is automatically deducted. Here the checkout date is automatically added to the transaction record using the system current date**. To accounts for errors in the data entry in the user form, there are checks to see if a member id is entered, the member id is valid and if a book has been selected from the list.**

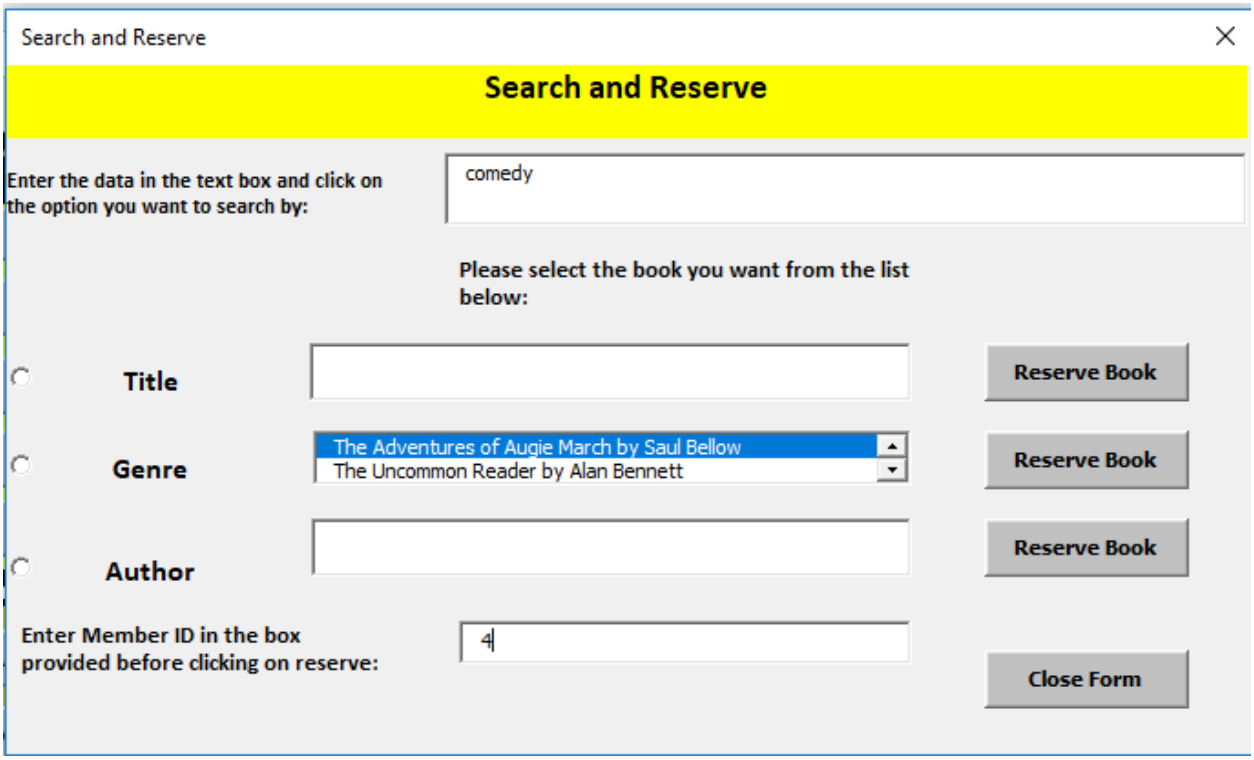
Here the search for a book is done using the **Book Name.**



Once the book is selected and the member id is entered you can click on reserve book to perform the book checkout.

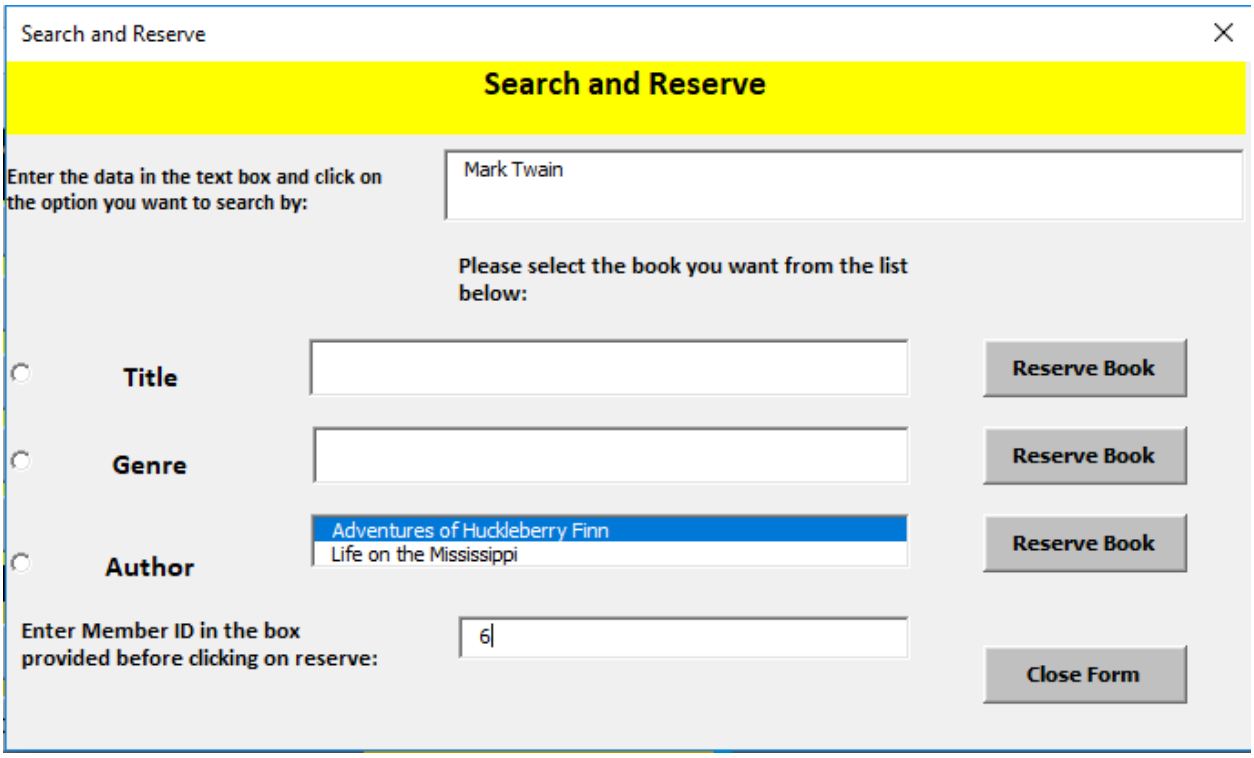


When you search by **Genre** if multiple titles exist under them all will be displayed, and you can select the book you want to check out.



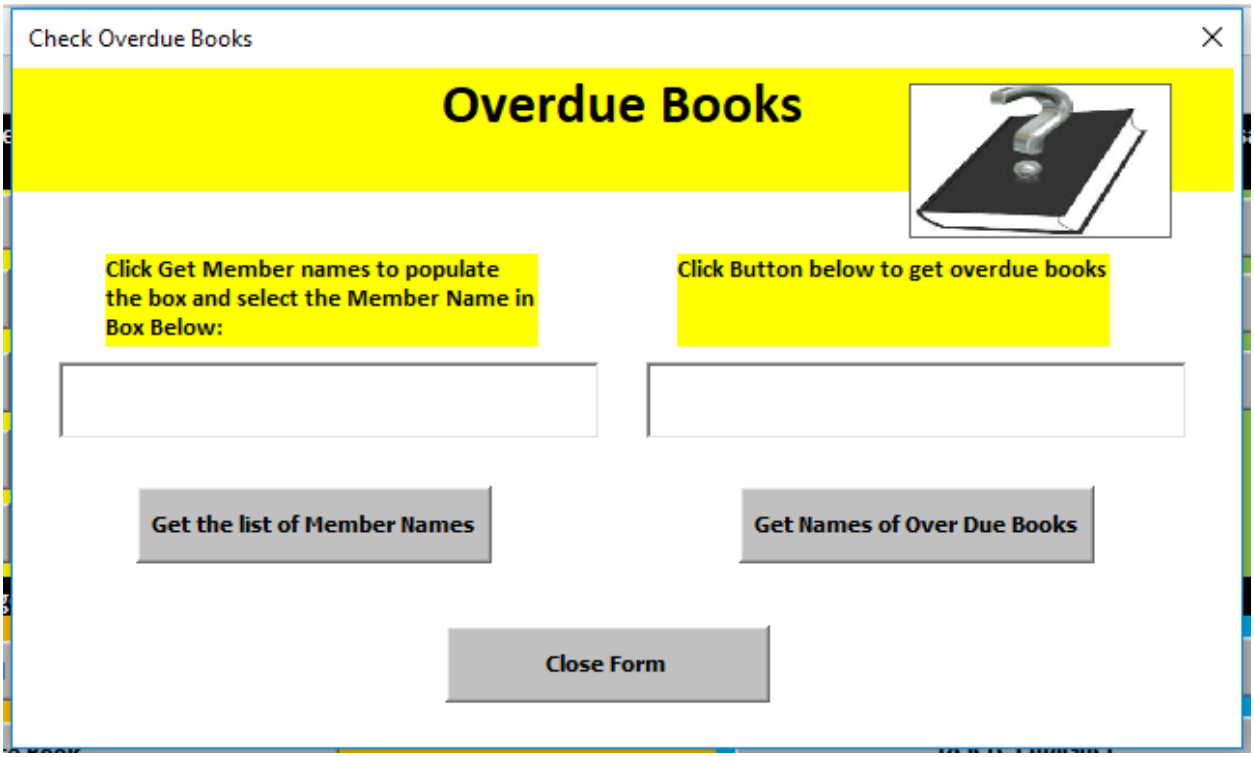
Once selected you can use the reserve book button to complete the transaction.

You can reserve the book you want using the **Author Name** as well. Once the book is selected and the member id has been entered, you can click on reserve book to complete the book checkout.

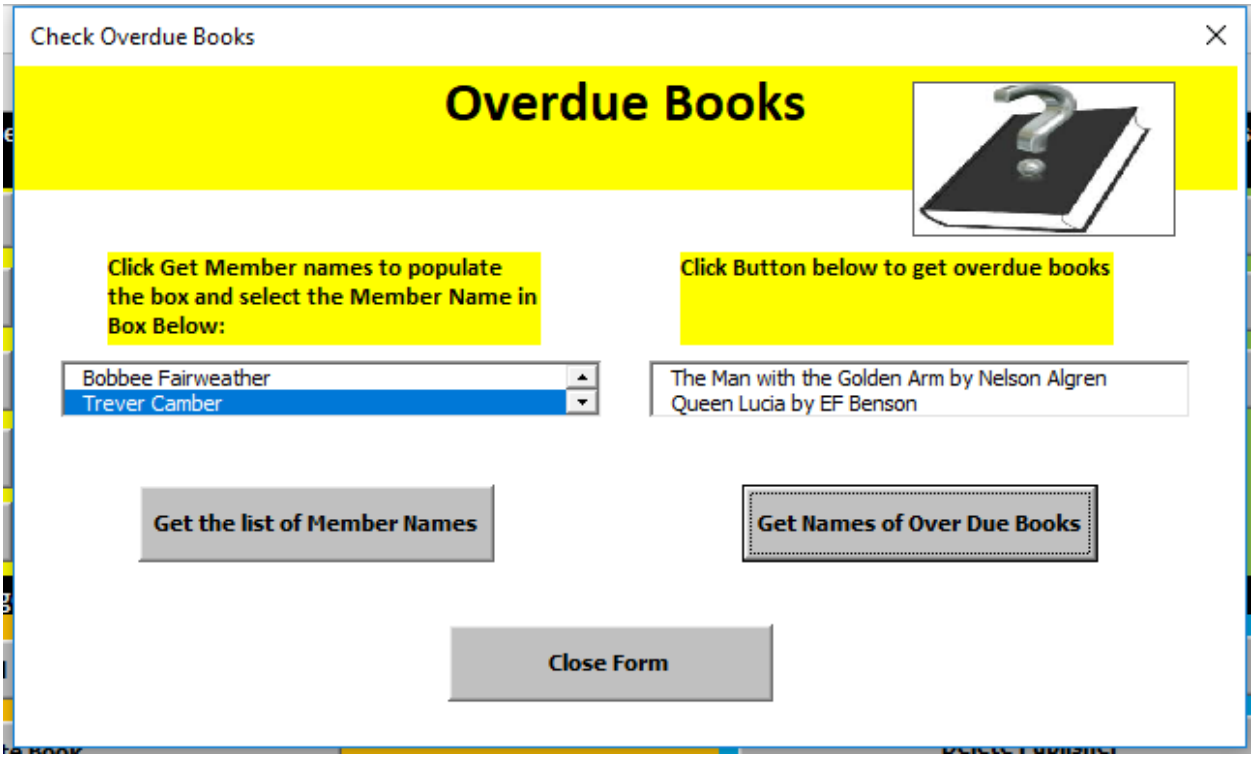


5.2.4.2 Member Overdue Function

The purpose of this function is to display all the overdue books that have been checked out by members. It provides the user the ease of seeing all the books checked out by a member on one interface using a simple user form.

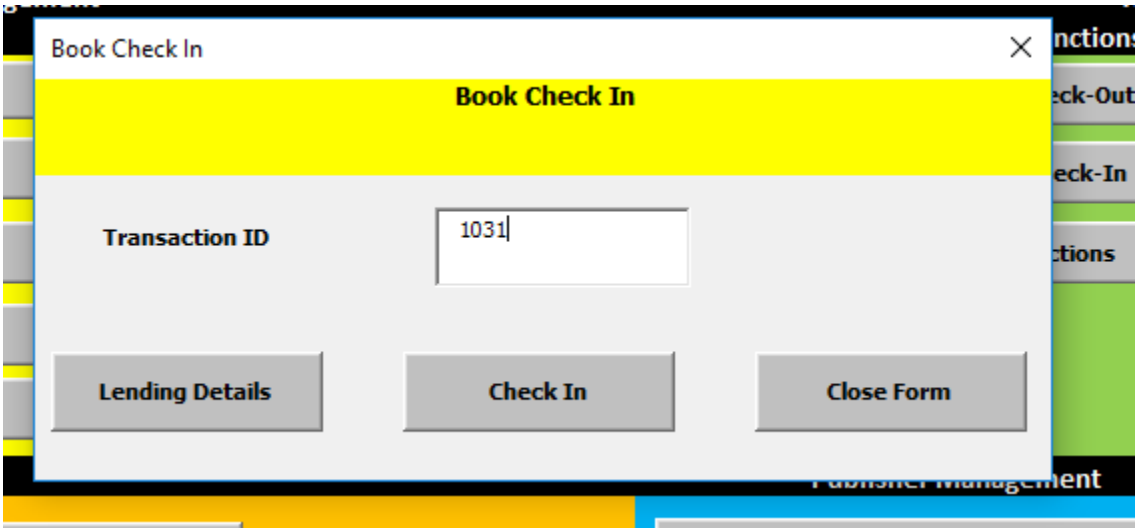


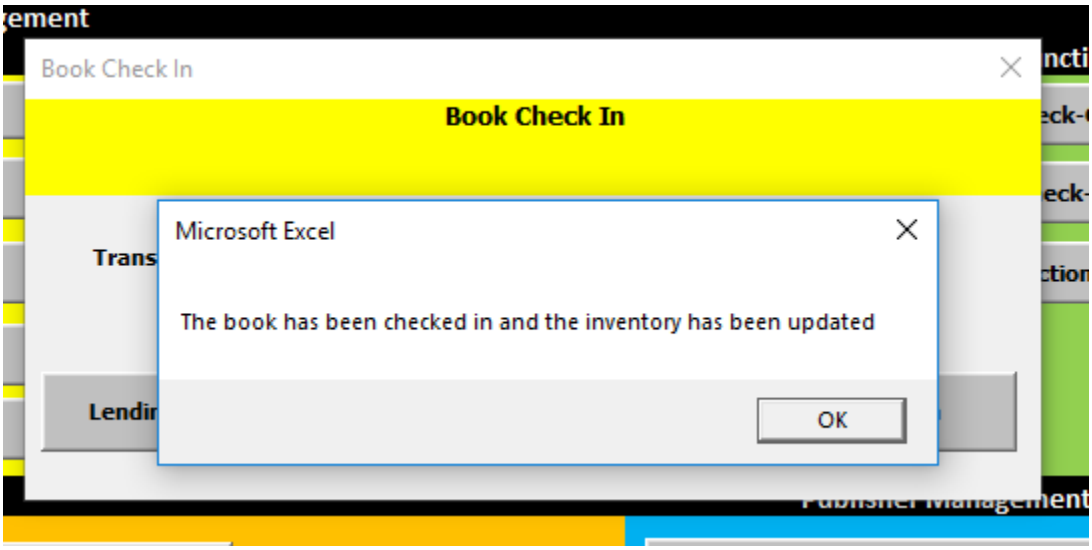
Once we click on the **Get list of Members** button the list of all members will be displayed and after you select the member from the list box you click on the **Get Names of Over Due Books** to get the list of books that the member has checked out but not returned and are past the due date.



5.2.4.3 Lending Transactions Check-In (Book Check-In)

This operational function allows us to check books that were lent to the members back into the system the return date of the book is automatically entered using the system date and need not be entered by the user. In case the member forgets the transaction id number. It can be easily found out using the Lending Details button on the form. Once on the lending details worksheet the user(admin) can complete the member book check-in by relaunching the Lending Check-In form. The screenshots of the check-in process are shown below.



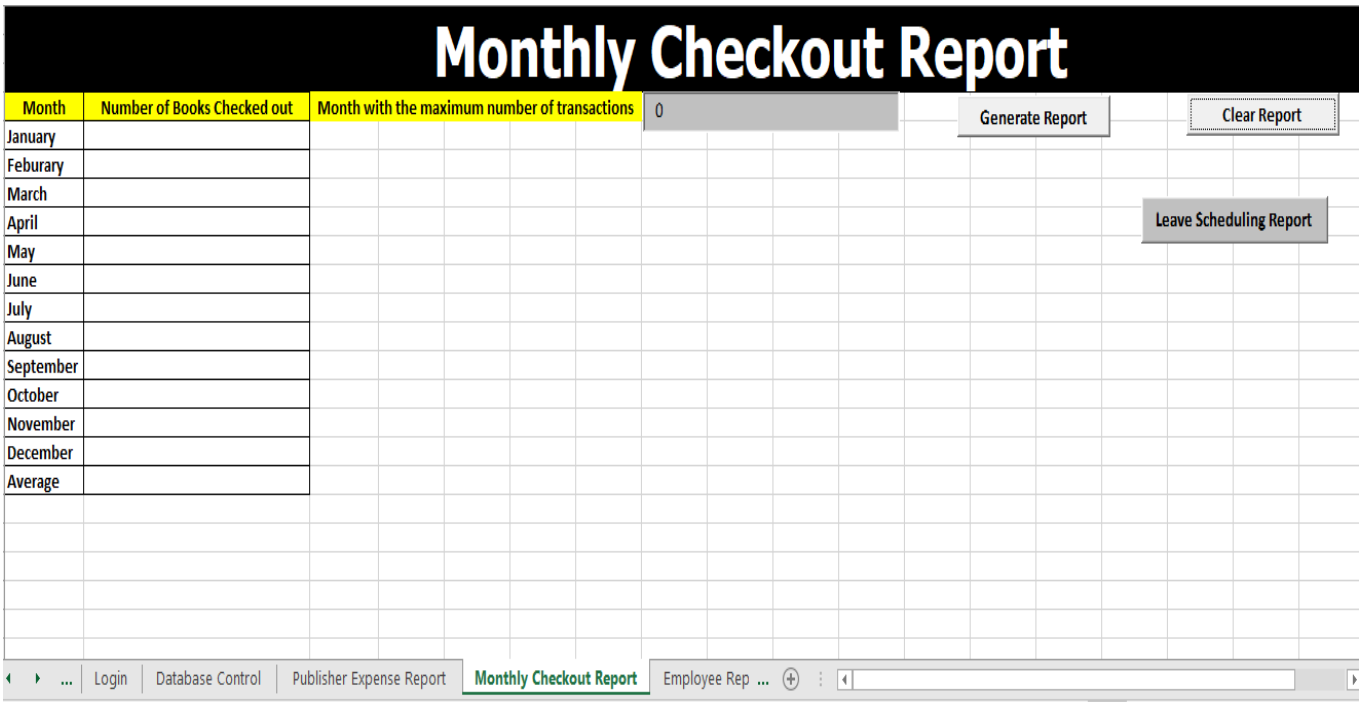


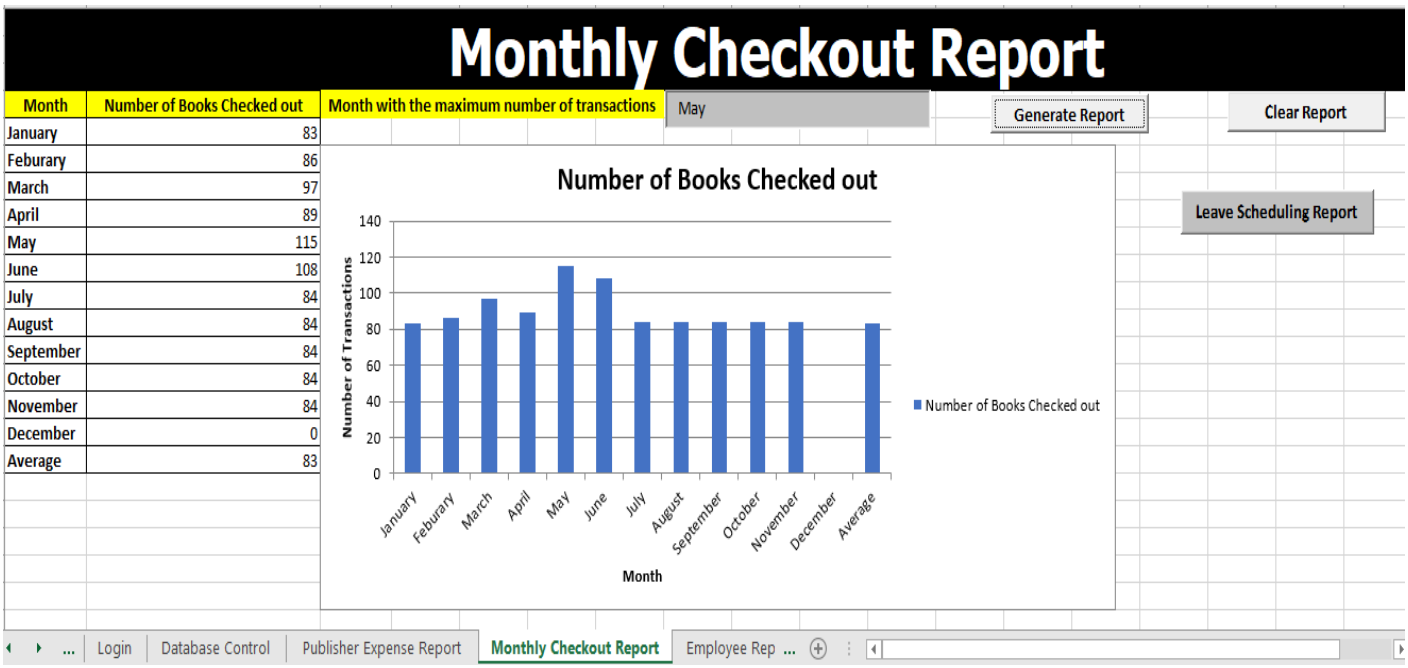
Now that all the basic functions and the operational functions have been covered we move to the decision support functions that the tool does provide

5.2.5 Decision Support Functions

5.2.5.1 Monthly Checkout Report

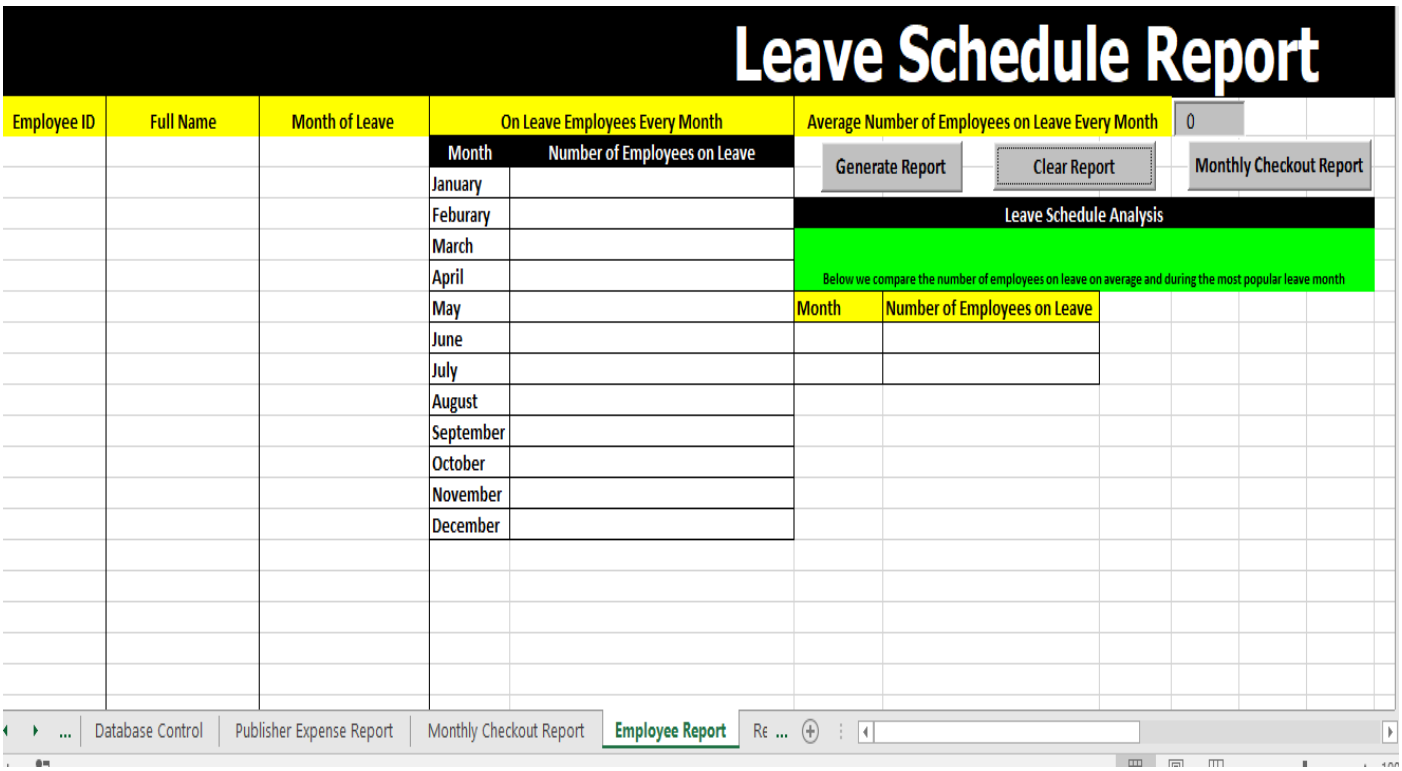
This report displays the number of transactions that take place in each month, thus giving a clear picture of the monthly transaction volume. The average and the month of maximum transaction volume is also displayed, and the results are portrayed in a concise pictorial representation using a chart right next to the report details, so the user doesn't need to leave the report screen to have access to the data analysis results. A control button is also provided to the access the Leave Scheduling Analysis Report which is another decision support function of this tool and will be discussed in detail in the next section. The results generated by this report used in conjunction with the report details of the Leave Scheduling Report would help HR Admins and the Library Management to make decisions regarding hiring additional help during high volume months or reorganizing the leave schedule to make low volume months coincide with months where the number of employees available is relatively low.

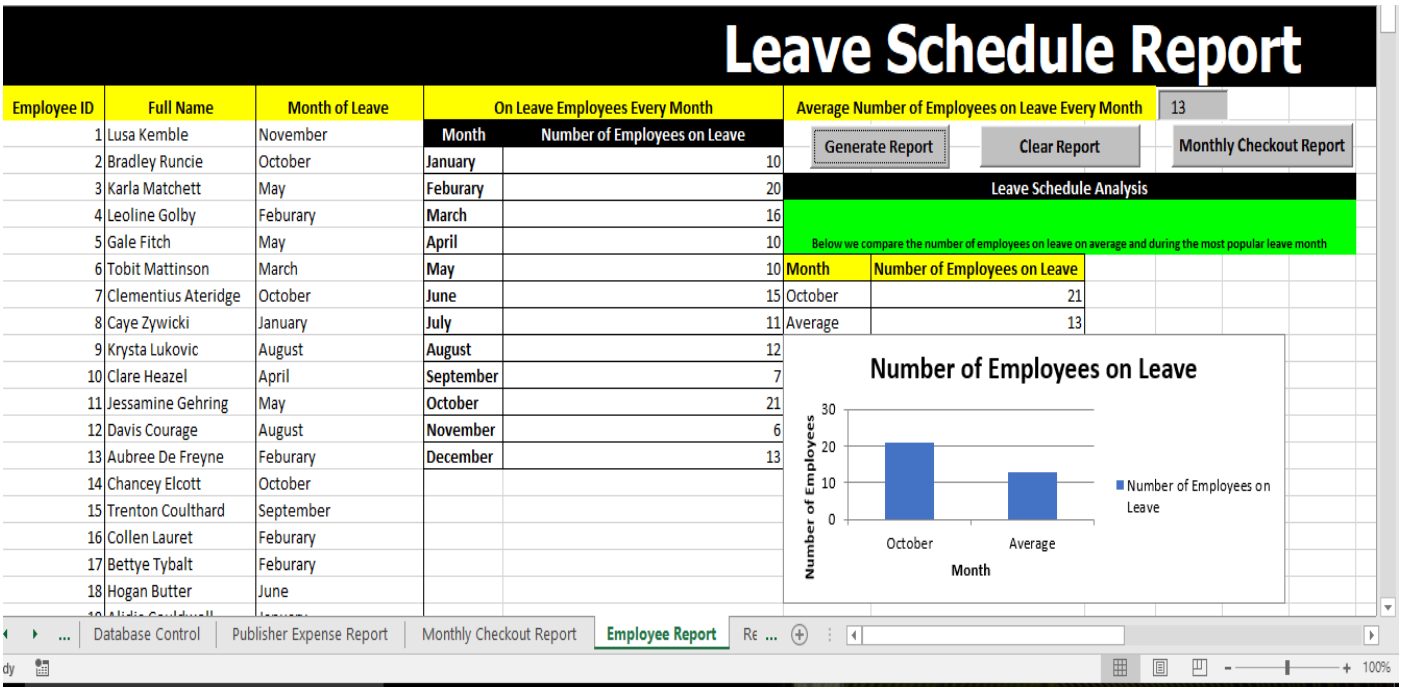




5.2.5.2 Leave Scheduling Analysis Report

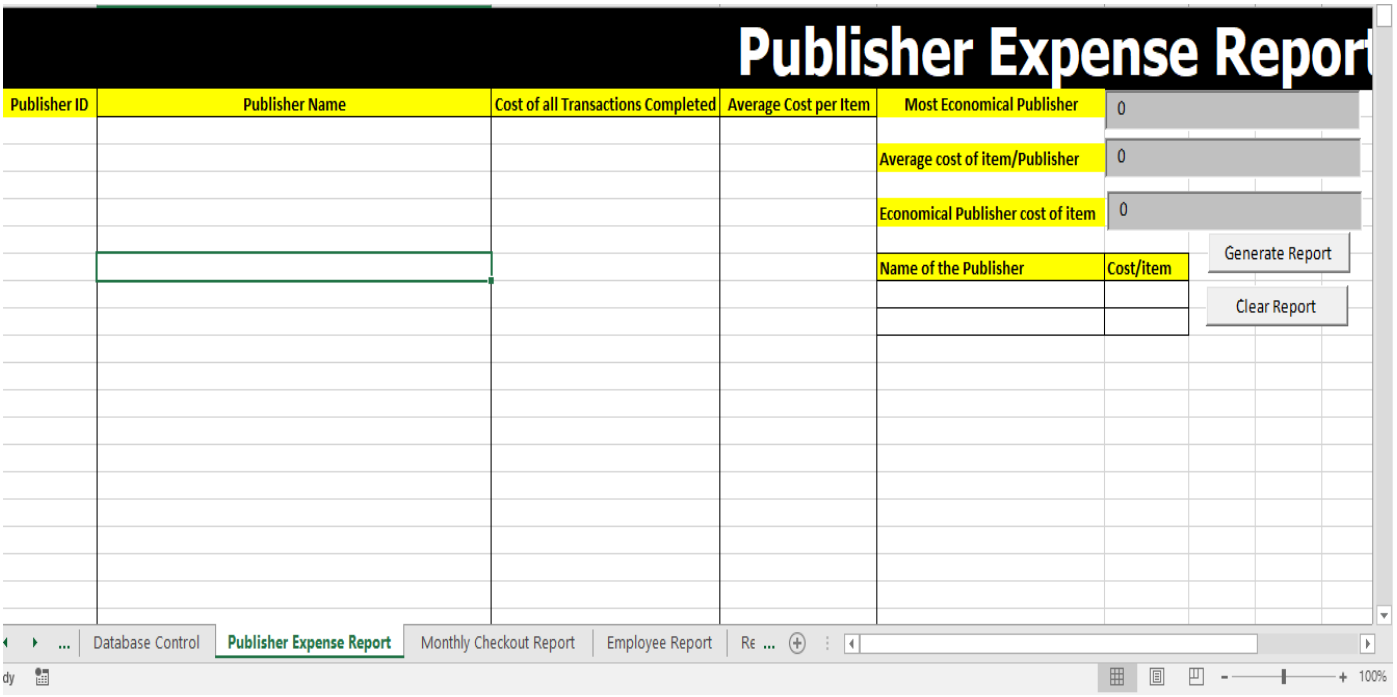
This report looks at the number of employees on leave every month. The results can be combined with the results used in the Monthly Checkout Report to guide decisions based on workforce scheduling to make sure the library is never understaffed. The cross connectivity between the two functions is provided using control buttons to make navigation between the two functions easier.

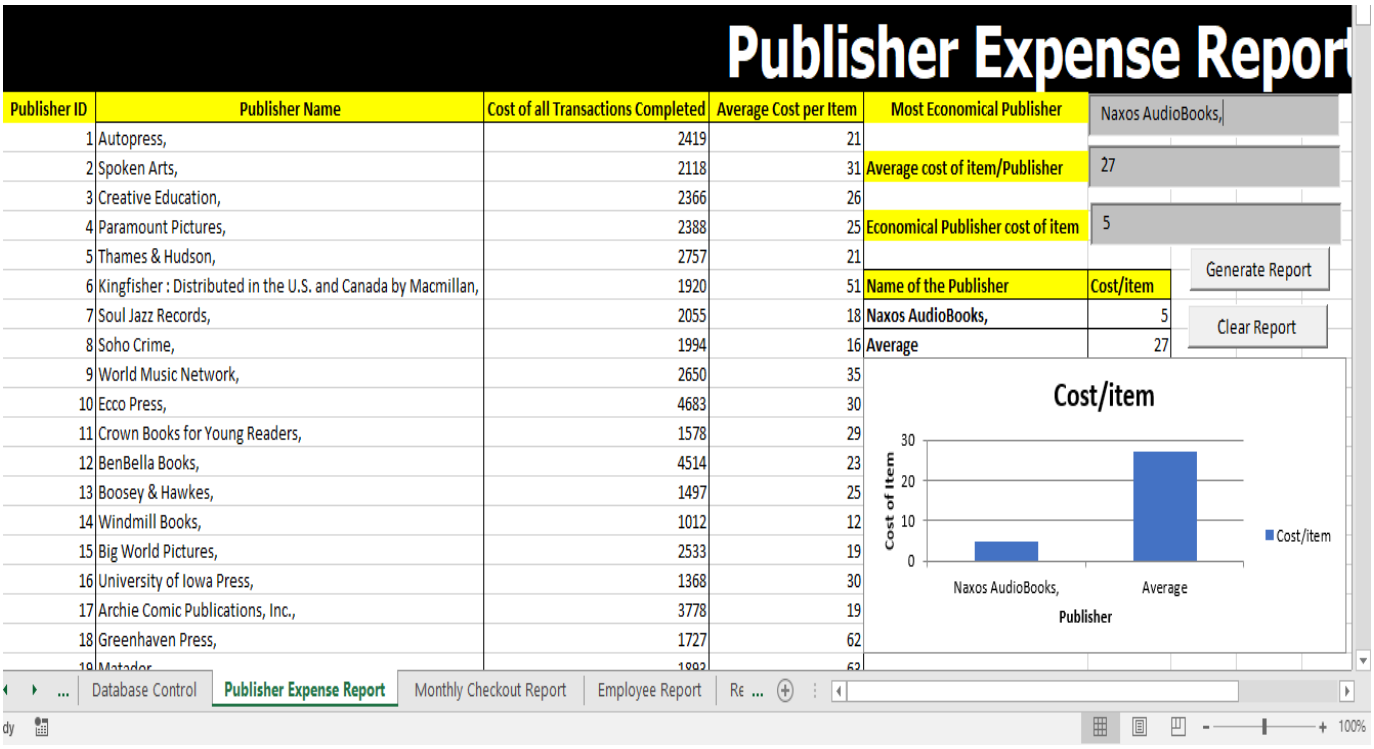




5.2.5.3 Publisher Expense Reports

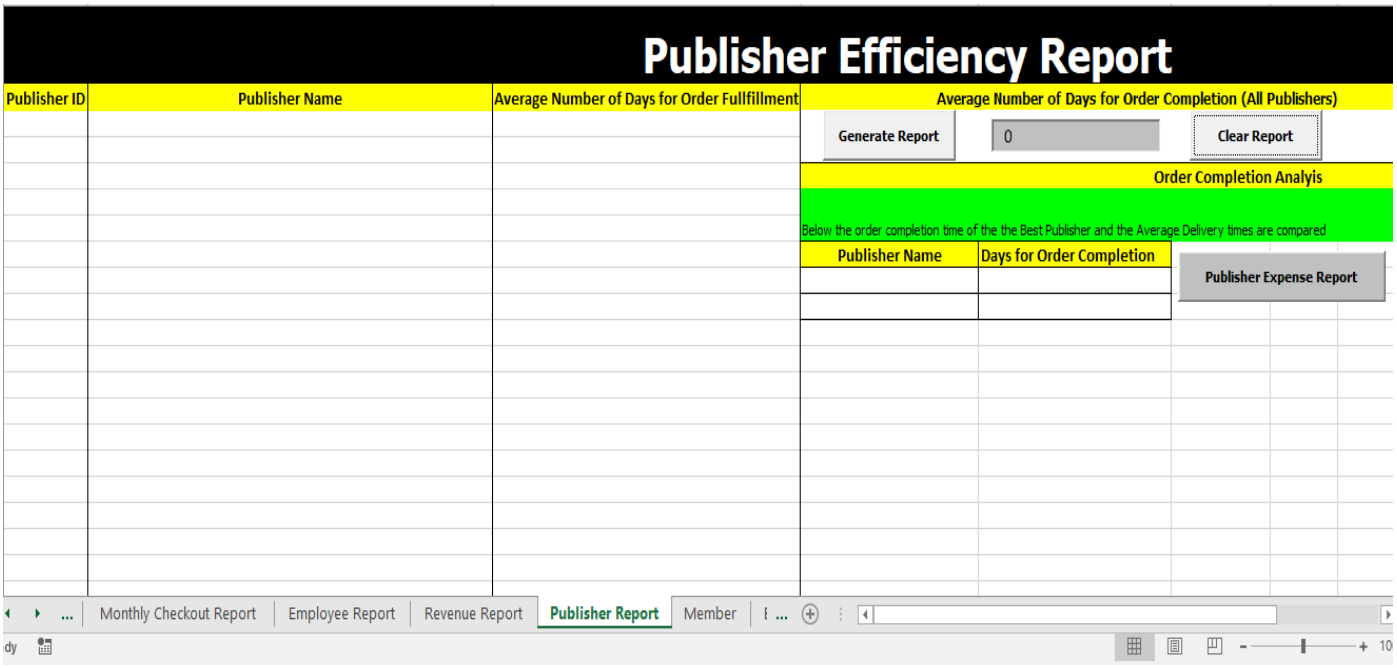
This function provides data to supply chain professionals to make decisions on publishers. It provides the data on the cost of the buy transactions and the cost per item of the transaction to help them gain some insight on how expensive a transaction is to help them negotiate the prices in the future or switch to other low costing alternatives.

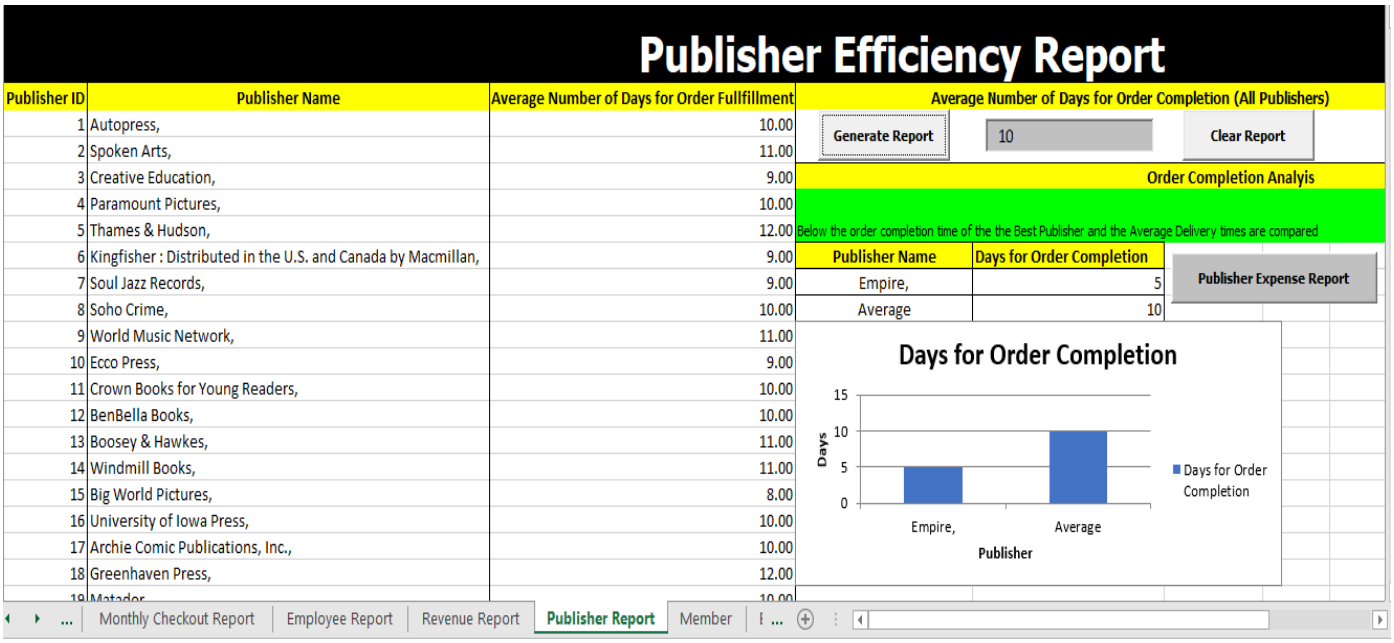




5.2.5.4 Publisher Efficiency Analysis

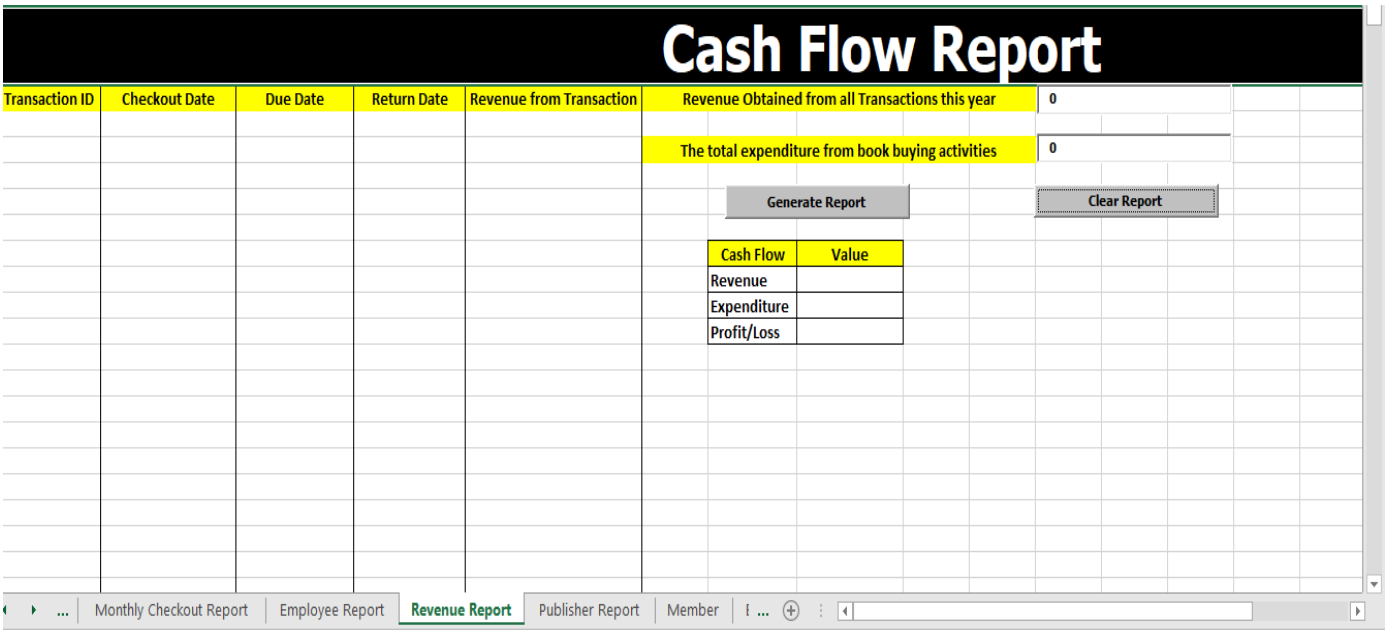
This function is used to analyze the delivery times of all the publishers and present data in a concise pictorial representation so that it can aid the supply chain professionals in their decision-making process. This function can be used simultaneously with the Publisher Expense Report function to single out the best publishers and increase their buy transaction volumes to improve supply chain metrics.

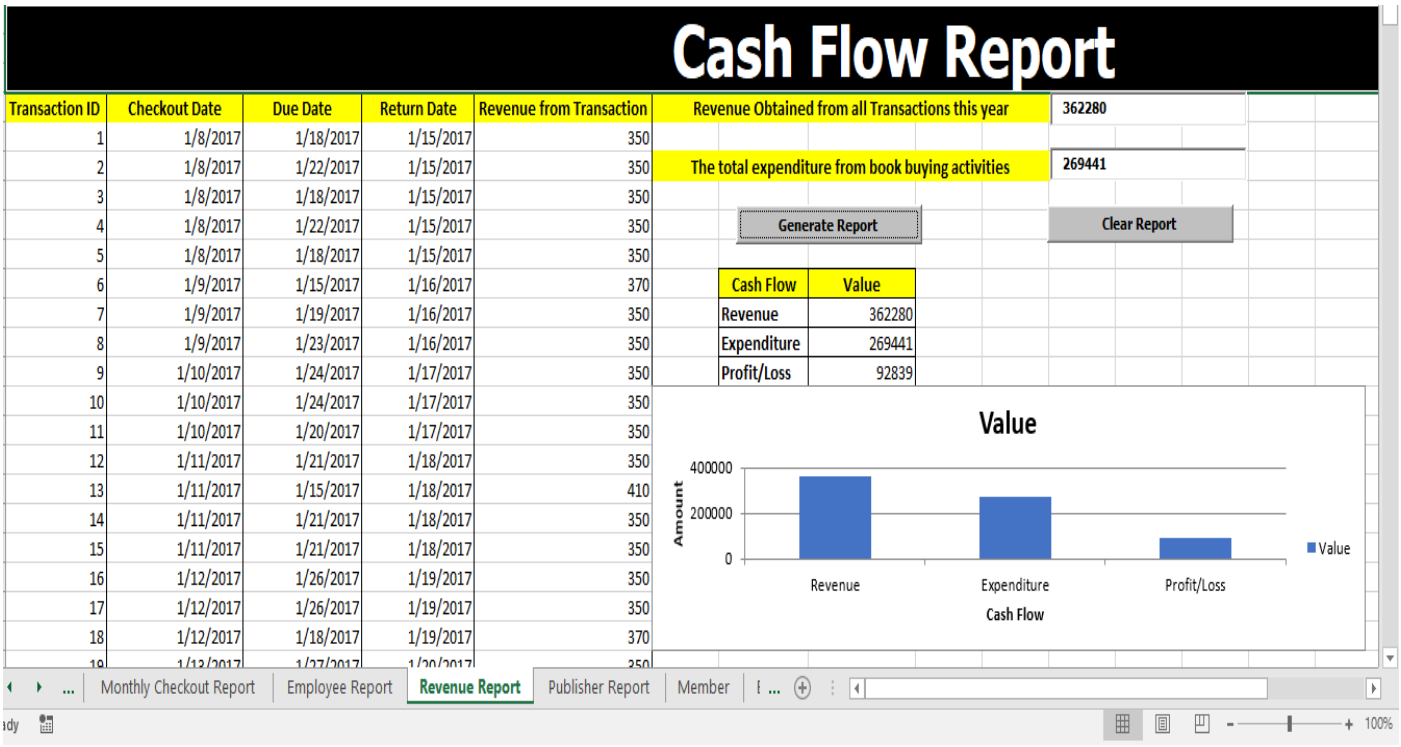




5.2.5.5 Cash Flow Report Function

This function is used to report the revenue gained from the lending activities and the expenditure that has occurred due to the buy transactions of the library. It calculates the revenue from regular lending as well as overdue books and reports them along with the expenditure. The profit/loss from the two major cash flow activities of the library operations is calculated and represented in a pictorial fashion in the form of a chart. The data that is obtained from this can be certainly used by the library management to determine if the operational activities are running at a profit or loss and then plan for the next financial year to improve the financial performance of the library.

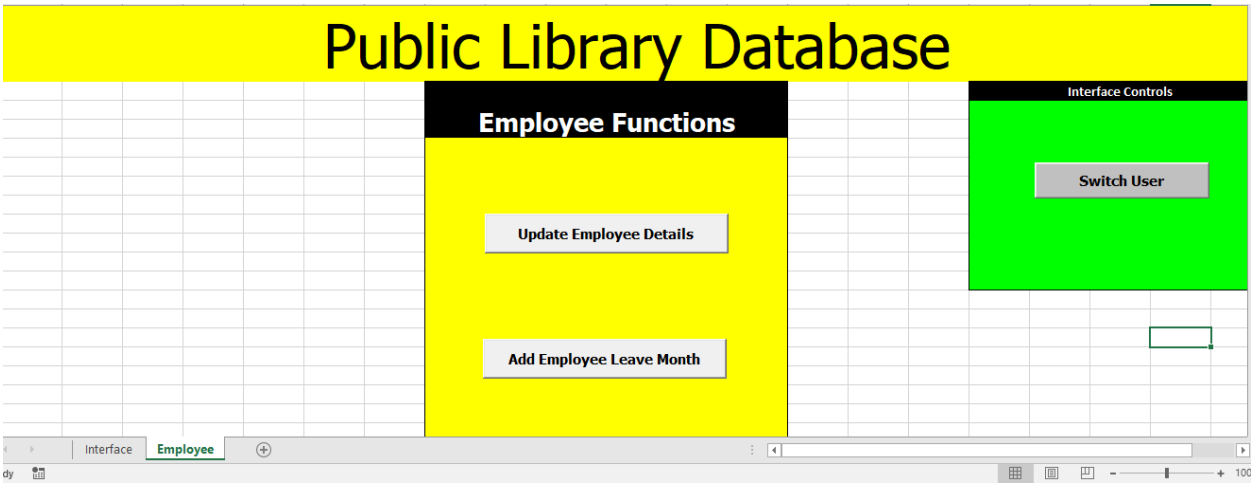




We next consider the functionality that an employee has access to once he logs on using his login credentials.

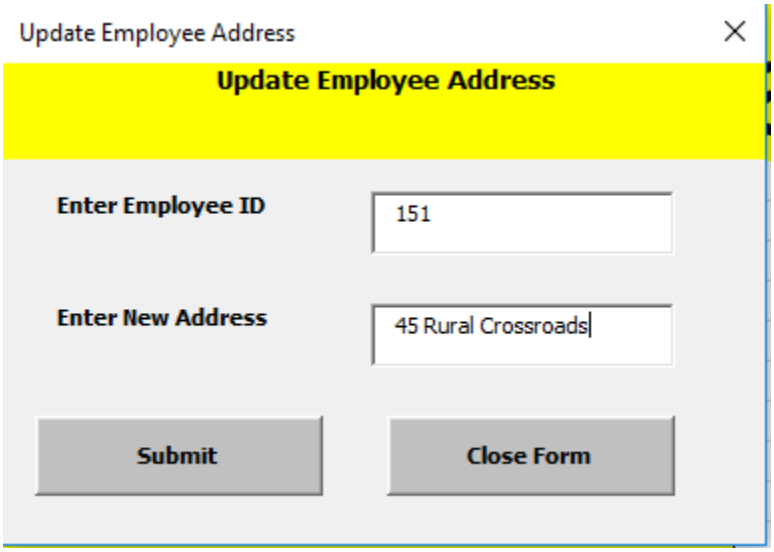
5.3 Employee Login Options

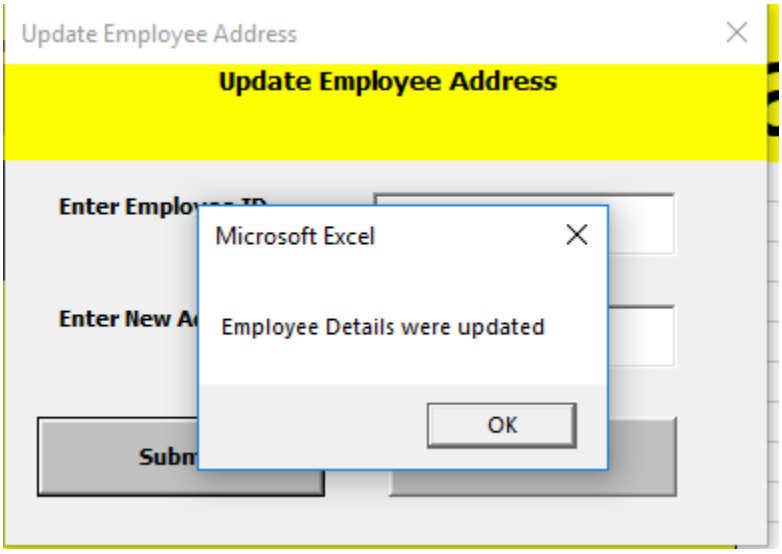
The options that are available to a member on login has already been discussed in the signup form section where the entire process was documented. In this section we discuss the options available to an employee if he logs in through the database.



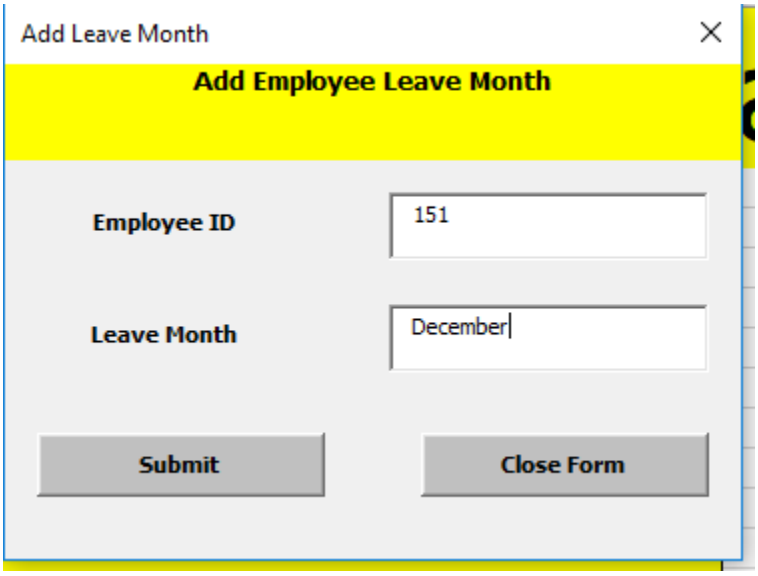
The two functions offered once an employee logs in using his credentials are discussed below.

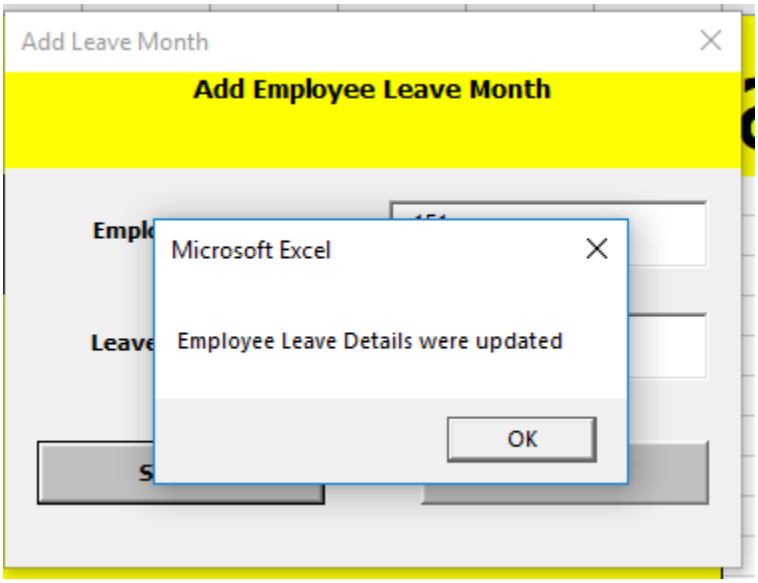
The **Update Employee Details function** is used to update details of existing employees in the database. The screenshots below document the process.





The **Add Employee Leave Month function** allows the employ to either add the month that he plans to go on leave so that the HR Admins you have all the data they need to make workforce scheduling decisions. The screenshots explain the process in detail.





Similarly, for the different types of users like HR Admins and Supply Chain Professionals, the appropriate sheet permissions are granted, and the functions are executed. Since these functions have already been documented as a part of the admin database functions, it would be redundant to mention them here again.

6. Conclusion

The quality of a tool is not defined by what role it plays in the implementation of a decision process but the role that it plays in the decision-making process. During this project the goal has always been to deliver on a tool that performs the basic functionality of a database with relative ease (updating, deletion, addition of records). The basic functionality was always meant to be a foundation stone to perform advanced database functions that manage the real-time inventory and to build further into the realm of decision support.

The data was represented in a concise pictorial form which will make extracting value from the data easy and will make the decision-making process better informed. During the project, competencies in DDL and DML was certainly enhanced using MYSQL. The use of Excel VBA helped us understand that coding in VBA can be a challenging and a rewarding experience. The sheer amount of possibilities to manipulate data that has been extracted from the database is endless.

The key lessons learned here would be that:

1. Data is key to having a good database. Good clean data helps us to maximize the amount of value you can extract from a database. On combining it with a software like Excel VBA, the sky is the limit on what can be accomplished.
2. The GUI in a database is as important as the data that gets stored in it. The GUI allows the user to quickly perform the tasks that he needs to with stunning accuracy which leaves him more time to use the outputs of the database for core decision-making processes.

The project has helped us cover the breadth of the course by involving all the stages of database development from the conceptualization right unto the implementation.

7. Future Scope of the Project

The project set out to achieve the fundamentals and has delivered on them quite efficiently. The next logical step would be to build on them further by adding added functionality to the database. We plan to implement other aspects of the revenue and expenditure paradigm so that the data analysis would be accurate and can estimate future course of action accurately. We plan on incorporating various optimization algorithms into the database as well to aid with improving the existing supply chain metrics.

8. References

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9. Appendix

9.1 List of Figures

9.2 List of Screenshots