ONLINE BLOOD DONATION RESERVATION AND MANAGEMENT SYSTEM

TEH GEOK TUAN

This report is submitted in partial fulfillment of the requirements for the Bachelor of Computer Science (Database Management)

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
KOLEJ UNIVERSITI TEKNIKAL KEBANGSAAN MALAYSIA
2006

ABSTRACT

Online Blood Donation Reservation and Management System (OBDRMS) is a web database application that enables the public to make online session reservation, to view nationwide blood donation events online and at the same time provides centralized donor and blood stock database. This application is developed by using JSP/Servlet technology from J2EE with the MySQL 5.0 as the database management system. The methodology used to develop this system as a whole is Object Oriented Analysis and Design; whilst, the database for OBDRMS is developed by following the steps in Database Life Cycle. The targeted users for this application are the public who is eligible to donate blood, system moderator, administrator from National Blood Center and the staffs who are working in the blood banks of the participating hospitals. The main objective of the development of this application is to overcome the problems that exist in the current system, which are the lack of facilities for online session reservation and online advertising on the nationwide blood donation events, and also decentralized donor and blood stock database. Besides, extra features in the system such as security protection by using password, generating reports, reminders of blood stock shortage and workflow tracking can even enhance the efficiency of the management in the blood banks. The final result of this project is the development of web database application, which is the OBDRMS.

ABSTRAK

Sistem Penempahan dan Pengurusan Pendermaan Darah secara atas Talian (OBDRMS) adalah aplikasi pangkalan data web yang membolehkan orang awam untuk membuat penempahan sesi secara atas talian, melihat kempen perdermaan darah untuk seluruh negara dan pada masa yang sama menyediakan pangkalan data penderma dan stok darah secara berpusat. Aplikasi ini dibangunkan dengan menggunakan teknologi JSP/Servlet dari J2EE dengan MySQL 5.0 sebagai sistem pengurusan pangkalan data. Metodologi yang digunakan untuk membangunkan keseluruhan sistem ini adalah Analisa dan Rekabentuk Berorientasikan Objek; pada masa yang sama, pangkalan data untuk OBDRMS dibangunkan dengan mengikuti langkah-langkah dalam Kitar Hayat Pembangunan Pangkalan Data. Sasaran pengguna untuk aplikasi ini adalah orang awam yang layak untuk menderma darah, penyelenggara utama sistem, pentadbir dari Pusat Darah Negara dan staf-staf yang bekerja di tabung darah dalam hospital yang mengambil bahagian dalam sistem ini. Objektif utama pembangunan aplikasi ini adalah untuk mengatasi masalah-masalah yang terdapat di dalam sistem semasa, iaitu ketiadaan kemudahan untuk membuat penempahan sesi secara atas talian dan pengiklanan untuk kempen perdermaan darah untuk seluruh negara, dan juga ketiadaan pangkalan data untuk penderma dan stok darah yang berpusat. Di samping itu, ciri-ciri tambahan di dalam sistem seperti perlindungan sekuriti dengan menggunakan kata laluan, penghasilan laporan, peringatan untuk kekurangan stok darah dan penjejakan aliran kerja boleh menambahkan keberkesanan pengurusan di tabung darah. Hasil akhir dari projek ini adalah pembangunan aplikasi pangkalan data web, iaitu OBDRMS.

CHAPTER I

INTRODUCTION

This chapter describes about the project background, problem statements, objectives, scopes, project significance, the expected output and finally the conclusion for this chapter.

The project background describes about the general idea of this project or system that is going to be developed. Meanwhile, the problem statements describes about the problems faced by the blood bank with the current system whereas the objectives are the aims to solve the problems. The project scope covers the system functionalities, the targeted users, the technologies used, system deployment and the chosen methodology to develop OBDRMS. The project significance states the importance of this project and the parties that will gain benefits from it. On the other hand, the expected output is about the functions and the features that the system will offer and lastly is the conclusion that concludes this chapter.

1.1 Project Background

The system that is going to be developed is Online Blood Donation Reservation and Management System (OBDRMS). This is a web-based database application system that is to be used by the hospital blood bank or blood center as a means to advertise the nation wide blood donation events to the public in order to

raise up the public awareness on the events and at the same time allows the public to make online reservation on their desired session. In addition, the system also provides functions for the hospital administrators to manage the appointments made by the donors, the blood stock and donor. This system also has the ability to keep track of the donor's donation records and the blood stock in the blood bank.

This project intends to computerize the blood and donor management system in a hospital blood bank in order to improve the record management efficiency due to the grown size of records of data.

1.2 Problem Statements

Currently, the public can only know about the blood donation events through conventional media means such as radio, news paper or television advertisements. Even if there is electronic means, it is only used to publicize about that hospital or medical center blood donation drives provided if that hospital or medical center is having an online portal. There is no nation wide information regarding the blood donation drive available on any of the portal.

Besides, for those who want to make blood donation, they cannot make early reservation or booking on the session and day that they are free online. It is a very important facility for those who are very busy and yet enthusiastic people to know and be sure when they can make blood donation rather than trying to figure out where and when they can make blood donation when they are free.

The current system that is using by the blood bank of most of the government hospital is manual system. With the manual system, there are problems in managing the donors' records. The records of the donor might not be kept safely where there might be missing of donor's records due to human error or disaster such as fire or flood. Besides that, human errors might occur when the staff keeps more than one record for the same donor.

There is also no centralized database used to keep the donors' records. Each blood bank is having their own records of donors. If a donor makes donation in different hospital, no previous records can be traced except if the donor brings along the donation certificate. Hence, the donor is considered to be a first-timer if they make blood donation in a new place.

Without an automated management system, there are also problems in keeping track of the actual amount of each and every blood type in the blood bank. Man-made error such as forget to record the usage or input of the blood can cause the inaccuracy in the amount of certain blood type available in the blood bank. In addition, there is also no alert available when the blood quantity is below its par level.

1.3 Objectives

After defining the problems exist in the current system, the objectives of the OBDRMS are as follows:

1. To provide a means for the hospital's blood bank to publicize nationwide information about the blood donation events to the public.

2. To allow the public and organization to make online reservation on the day and session that they want or free to make blood donation.

3. To provide an efficient donor and blood stock management functions to the blood bank by providing the logging functions in order to control and trace the workflow.

4. To provide authentic and authorized features to the current system where private and confidential data can only be viewed by authorized user.

5. To provide the recording functions for every process of the blood in order to keep track of the blood stock accurately.

6. To provide backup and recovery and data integrity features to the database.

7. To improve the efficiency of blood stock management by alerting the blood bank administrator when the blood quantity is below its par level.

8. To provide synchronized and centralized donor and blood stock database to the blood bank.

1.4 Scopes

The deliverable of this project is the OBDRMS, which is a web-based database application system. The scope of the project will cover the system functionalities, technologies used, the targeted users, system deployment and methodology.

1.4.1 Scope of System Features and Functionalities

The scope of system functionalities is based on the functions and features available in the system. The first part described about the features available in the system database and the latter part describes about the modules available in this system.

1.4.1.1 Database Features

The effectiveness of a system relies a lot on the features provided by the database. Generally, there are three main (3) features available in the database of the OBDRMS, which are:

1. Data Encryption

The database encryption is a very important feature to protect the data from being attacked by the intruders especially the sensitive and confidential data such as the passwords.

2. Backup and Recovery

This feature ensures the availability of consistent data in the event of data loss. Periodic data backup will be used to ensure the minimum loss of data.

3. Data Integrity

The data integrity feature is enforced with the proper use of primary and foreign key rules where it reduces redundant records in the database.

1.4.1.2 System Functions or Modules

The functions or modules that the OBDRMS will provide are described as follows:

1. Login

The system provides security features through password security where only authorized user can access to the system with different authorization level.

2. Publication of nation wide blood donation event

This module allows the blood bank administrator to publicize the nation wide blood donation events online. The public can view the venue and time of the blood donation drives to be held.

3. Online Reservation and Management

The public can make online reservation on their desired session and date. The blood centers' administrators can then manage their appointments by either to approve or reject the appointments.

4. Blood stock management

The blood bank administrators can manage the blood stock starting from the blood collection, to blood screening, processing, storage, transference and lastly transfusion through this system. Moreover, there is also logging function available so that each process or workflow can be traced from the database. The system will also give an alert to the administrator whenever the blood quantity is below its par level.

5. Donor Management

The records of all donors and their history are kept in one centralized database and thus reducing duplicate data in the database. Donors can make blood donation in any blood center and their records are maintained by the OBDRMS.

6. Reporting

The system is able to generate pre-defined reports such as the list donors, staffs, and hospitals, the blood quantity in a blood bank, and the workflow for each blood donation process.

7. Others

Other management functions such as the management of participated hospitals or medical centers and system users and their authorization levels are also available in this system.

1.4.2 Scope of System User

The targeted users for OBDRMS are divided into two (2) main parties, namely the public and the administrators.

1. Public

The public are those who can view the blood donation events and make online reservation on their desired session.

2. Administrators

The administrators are divided into a few parties that each is having different authorization access level. The privileges can be assigned by the administrator at runtime. New position can be added as desired by the administrator. The following are the basic position and level of authorization assigned:

i) **Moderator:** has full privilege on the system's functions.
ii) **National Blood Center administrator:** has full privilege on the system's functions.
iii) **Blood bank top-level management administrator:** accessible to all modules.

1.4.3 Scope of Technologies

The technologies used to develop OBDRMS are listed as below:

1. **Operating System:** Windows XP Professional
2. **Integrated Development Environment (IDE) tool:** Eclipse 3.1.2
3. **Database Management System (DBMS):** MySQL 5.0
4. **Server/Servlet Container:** Apache Tomcat 5.5.15
5. **Technology:** JSP/Servlet from Java 2 Platform, Enterprise Edition (J2EE)

6. **System Architecture:** Model-View-Controller (MVC)
7. **Browser:** Internet Explorer 6.0 and above
8. **Graphical User Interface (GUI) design:** Macromedia DreamWeaver MX 2004
9. **Documentation:**
    i) **Report:** Microsoft Word 2003
    ii) **Unified Modeling Language (UML) Diagrams:** Rational Rose 2000
    iii) **Database Design:** ER-Assistant 2.10
    iv) **Gantt Chart:** Microsoft Project 2003

1.4.4 Scope of Deployment

The OBDRMS will be deployed in the National Blood Center, which is the center to manage and co-ordinate the blood bank, blood stock, staffs and donors. Other places such as the participating hospitals' blood bank and the branch blood centers are linked to the National Blood Center through the Internet.

1.4.5 Scope of Methodology

There are two (2) types of methodologies to be used in developing OBDRMS, namely the Object Oriented Analysis and Design (OOAD) and the Database Life Cycle (DBLC). OOAD is used as methodology to develop OBDRMS as a whole while DBLC is used in database development and maintenance. The detail explanation of both methodologies will be presented in the coming chapter.

1.5 Project Significance

Inadequate blood supplies at the hospitals and medical sectors have always been a problem. To create awareness among public of importance of donating blood, an **effective** means that available at all the time plays a crucial role in providing such information.

With the implementation of this project, the blood bank is the organization that will gain the most benefits from. This is because of the risen of the public awareness on the blood donation events by advertising the blood donation events at 24 hours a day and 7 days a week basis. Moreover, the system also provides convenient way for the public to make online reservation on their desired session.

The National Blood Center administrator will be able to manage and co-ordinate the blood supply among the blood banks of the hospitals and medical center more efficiently as they can view the records of blood stocks in all participating hospitals.

Besides, the blood bank top-level management staff can manage the blood and donor records more efficiently with better security and added automation function in alerting the administrator when the blood quantity is below par level. In addition, the administrator can also trace the person responsible in case of human error such as fault blood transfusion and blood screening result. The top-level management staff can also manage the system user more efficiently by giving each staff different access level.

The blood bank medical lab technicians also gain the advantage of having an automation system in assisting his/her work. This is because works can be done in more systematic and organized way when managing the blood stock in blood banks.

This system also creates a convenient and paperless environment for the doctors and nurses in managing and processing the incoming donors and the blood stocks as the donors' records have been centralized. The registration time for old donor is shorten as the records is retrievable from the system.

The suggested approach to develop this system, which is the Object-Oriented approach, is the best approach as the system will be more maintainable. According to Sommerville (2001), objects are independent and thus they may be understood and modified as stand-alone entities. Changing the implementation of an object or adding services should not affect other system objects. Another advantage of using object-oriented approach in developing a system is reusable. By reusing the standard objects or objects that have been created in the previous project, both the cost and the risk of developing the software can be reduced.

1.6 Expected Output

The expected output from this project is the Online Blood Donation Reservation and Management system which has two (2) main portals, one for the public and another one for the administrator.

The public portal has the functions of displaying the blood donation events to be held and allowing the public to make online reservation.

On the other hand, the administrator portal has the functions for the administrator to manage appointments, publicize the blood donation events, manage system users, donors and blood stocks and generate reports. Besides, some automation function such as giving alert to the administrator when the blood quantity is below par level is also provided.

The kinds of reports that will be generated by the system are the blood quantity in the blood bank and workflow for each blood donation process.

1.7 Conclusion

After defining and identifying the project background, problem statements, project's objectives, scopes, project significance and lastly the expected output, the features and functions provided by the OBDRMS, which are allows for online publication of blood donation events, online reservation and records management system, are adequate to solve the problems faced by the hospital blood bank such as inefficiency in publication by using solely traditional advertising media or the publication of just the donation drives for that particular hospital or medical center and inefficiency in records management. By developing this application, the hospital will benefit from having a more efficient and effective OBDRMS to manage the database in blood banks.

This chapter will serve as input for the next chapter, which is the Literature Review and Project Methodology.

2.2.1 Case Study 1

According to Li *et al.* (2005), the barcode technology had been widely applied in blood bank and other transfusion facilities. Barcode technology provides effective blood product administration and management. Whilst, with the wide use of computer and information technology in blood bank environment, it is essential to label blood and blood products for electronic data processing systems.

The major functions of applying barcode technology in blood bank are:

1. Controlling workflow
2. Managing blood and blood components
3. Tracking donation and transfusion

Now, it is even more advanced where the ISBT 128, an international barcode and labeling standard for blood and blood products, is used to substitute the widely used Codabar, a uniform labeling of blood and blood components. The Codabar has the disadvantage of deficiency in providing blood donation and transfusion service once the service is out of its application area.

ISBT 128 promotes the worldwide acceptance of barcode labeling technology in the field of blood manufacturing and blood transfusion. The objectives of uniform blood component label by using barcode technology is to reduce the danger of incompatible transfusions caused by human errors, to provide accurate transfer of information and to ease in tracking the blood through all steps from donor to recipient.

The barcode generated by the formerly Codabar contains the critical information of the donor blood group, component name; for example Red Cell; unique donation number, the expiration date and the center identification name. The unique donation number, on the other hand, comprise of donation number; which in turn composed of the year and sequential number; product name and blood group. For example, in Figure 2.1, the donation number is 240390823, 24 is the year, 03908

is the sequential number, 2 represents the product name (red cells) and 3 represents the blood group (O+).

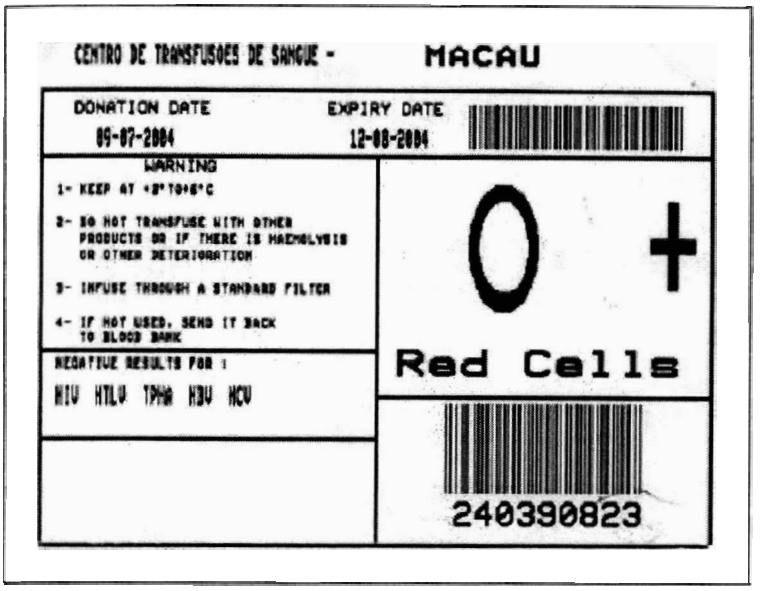

Figure 2.1: Blood product label using Codabar

On the other hand, the improved version of barcode technology by using the ISBT 128 is able to print more information compared to the Codabar and it contains the donation identification number, blood group, product code, expiration date and other optional data such as collection date, as shown in Figure 2.2. The text printed is more eye-readable and contains more information. The data structure of ISBT 128 is differs from the one in Codabar.

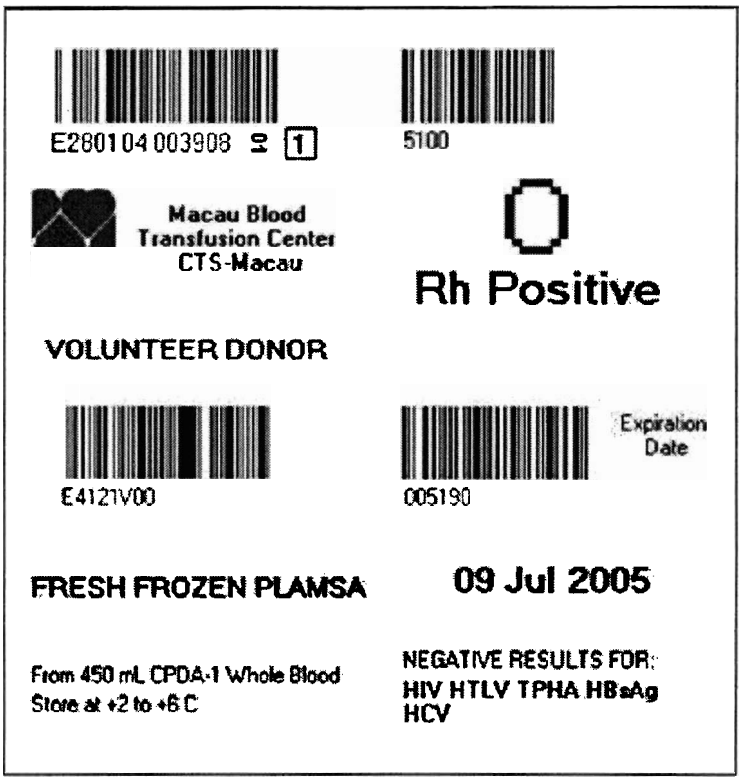

Figure 2.2: Blood product label using ISBT 128

2.2.2 Case Study 2

Based on Marinos (1999), the Web-based Patient Record and Appointment Management System had been designed and installed in NHS Trust Hospital and after being assessed; its results indicated user satisfaction, saving in time and effort as well as process automation. This is a system that covered patient's appointments, bed management, letter and report generation, and maintenance of electronic records.

By uploading the patient's records online, patient information registration time can be reduced where records can be retrieved from the system database.

2.2.3 Backup and Recovery

Nowadays, as information system is becoming more and more important for an enterprise operation to conduct business, the tolerance of failure is getting lower and lower. Hence, backup and recovery is a very important process in order to make sure that the database's availability, integrity or usability is guaranteed.

There are many tools, techniques and ways available to perform backup and recovery especially where the DBMS nowadays is able to provide sophisticated utilities to perform such functions. Referring to Mullins (2002), there are six (6) common approaches being used today to backup and recover the database, namely by creating image backup, performing logical backup, using Storage Management Software, using standby database, using data replication and lastly by using disk mirroring.

The backup utility in DBMS such as COPY, BACKUP, DUMP and EXPORT can provide image copies of database that are used for recovery purpose. Things to be backed up are the database objects such as the indexes and tables and also the log files. The more often the backup is performed, the more current data can be recovered in the event of database failure. One thing that needs serious consideration is the consistency in backing up the database that includes the relationships between database objects.

Another approach that can be used to backup the data in the database is by exporting the data into sequential file. This logical backup has the advantages of easing in restoring the data back upon inadvertent delete or during the DBMS release upgrades and it facilitates the movement of data.

The third approach to perform backup and recovery is by using Storage Management Software. This approach requires extra attention to be paid on concurrent issues where during this backup, the write operation must be stopped. DBMS utilities or commands will not be used during recovery process.

Another alternative to backup and recover database is by using standby databases. It provides a similar copy of data content of online production database. It is only opened when failures occur and the control is transferred to it. However, this approach is not a perfect solution for database recovery as it is not 100% up-to-date and the possibilities of it being unsynchronized is high as it is the mirror of the online production database. Any problem exist in the online production database exist in the standby database too.

Data replication stores and maintains redundant data in different locations. It is very useful for disaster recovery but it also suffers the same problem as standby database approach does as the problems affect the master database will affect the replica too.

The sixth approach is by using disk mirroring. Whatever data modification made in primary database, the secondary database will be affected too. One advantage of using this way is system can still run as usual even the database failure occurs as the database will be switched to the secondary database. This approach also faces the same problem as in standby database.

2.2.4 Importing and/or Exporting Text File

There are several ways in importing and exporting a text file from the database, namely through the application programming (in servlet) or through the facilities provided by the DBMS. Refer to Mullins (2002), using DBMS utility is less error-prone than writing application program.

With the use of DBMS utilities to populate table data; such as the LOAD utility; the effort of writing, testing and debugging the program logic can be reduced as the logic already exist in the utility. In addition, the LOAD utility is more efficient than the multiple SQL INSERT statements during initial data insertion as the LOAD utility is optimized to insert bulk of data efficiently.

To export the database data, a very common DBMS utility is UNLOAD utility. This utility avoids the application programmer to include SQL SELECT statements in the program that will cause the program to react slowly for large quantities of data and it is error-prone too. Besides, writing the program logic to create files is less flexible and time-consuming.

However, according to DuBois (2003), the utilities provided by MySQL is only suffice if no preprocesses such as validation and data type reformatting required. By writing ones own program, they have the freedom to write the program to export file in their desired data format or to import portion of the file contents so that the output file is easier to work with and is understandable by other program. Even if the complete program is not being written, a script used to validate or reformatting the input or output file is sufficient. The regular expression or pattern is a very useful way in making sure that the data of the input or output file conform to valid or legal format.

2.2.5 Model-View-Controller (MVC)

According to Bennett *et al.* (2002), Model-View-Controller (MVC) is a system architecture that separates application into three main components, namely the model, view and controller, each playing different roles. Model is the main functionality or the domain-specific representation of the information, views are the user interfaces and the controllers are the ones who respond to user actions and invoke appropriate changes on the model and view.

The purpose of separating the application is to make sure that the modification to one component will cause the least impact to the others (in http://en.wikipedia.org/wiki/Model-view-controller) and thus promoting system maintainability.

This architecture is especially useful in a system where there exist many types of users with many different levels of authorization. Different styles of display

or data are required to facilitate different types of users. No duplicate user interface needed to be created as the model and controller will detect and react according to user role. This is because MVC architecture supports multiple presentations of data and separate styles of interaction with each presentation (Sommerville, 2001).

2.2.6 Facts and Findings Summary

In Case Study 1 and 2, the interest is based on the features available on the systems, which are the barcode technology (Case Study 1) and the advantages to upload system database so that it is available online. For OBDRMS, although the barcode technology is not implemented in it, but one thing similar that can be done is to make the system to auto generate serial number in order to ease in blood stock management.

In the latter part, the facts and findings are based on the extra features that are going to be added to the OBDRMS if the time is enough. After studying so many approaches and ways to backup and recover database, the best way to consider is to export the database data into text file and then import the data back to repopulate the database. This way also offers other advantages such as the ease in inserting bulk of initial data into the database, better database performance and also more convenient for data movement.

The findings on ways to import and export text files aid in affirming that although using the DBMS utilities offers more advantage than using application program, but this decision is really DBMS dependent as not all the DBMS provide sufficient utilities and tools that able to facilitate all kind of requirements especially those that cater for validating data format. Consequently, for OBDRMS, may be a mix of database utilities and program logic will be used in order to make sure that the application takes advantage of the database utilities but at the same time perform validation and reformatting on the input and output file.

Besides, the system architecture that is going to be used is also studied in order to make sure that the choice is the correct one. As the OBDRMS has a wide range level of users, each with different roles and access right, so it is wise to use the MVC as the system architecture in order to make the system more maintainable, stable and portable.

2.3 Project Methodology

The project methodology plays an important role in influencing the system quality. Hence, the approach to be adopted must be chosen carefully before going into the analysis phase. For this project, the Object-Oriented Analysis and Design (OOAD) approach has been chosen as the project methodology after weighing the advantages to be gained and its suitability for the OBDRMS, which is the application to be developed for this project.

The advantages of using the object-oriented approach are:

1. decreases the development time by reducing the amount of code
2. improves programmer productivity by making the code reusable

The methodology involved in database development of the OBDRMS is the Database Life Cycle (DBLC). According to Coronel (2002), the DBLC contains six (6) phases, namely database initial study, database design, implementation and loading, testing and evaluation, operation, and maintenance and evolution.

1. Database Initial Study

The overall purpose of the first phase of DBLC, which is the database initial study, is to analyze the blood bank situation, define the problems, constraints, objectives, and scopes and boundaries. When analyzing the blood bank situation, the blood bank's operational components, how they function and how they interact are discovered. This then leads to problem definitions. During problem discovery

process, the problems solutions or the objectives are defined. After that, the scope and boundaries of the database design that includes data structure, the type and number of entities (for example, blood, staff, donor, etc.), the physical size of the database, the software to be used and so on are identified.

2. Database Design

During this phase, the database conceptual, logical and physical designs are performed. The conceptual design requires the end-user views, outputs, and transaction-processing requirements to be determined. Then, the entities, attributes and relationships are defined by using Entity Relationship Diagram (ERD) followed by the process of normalizing the tables in the database till third normal form (3NF).

The next step to perform during this phase is to select DBMS software to be used based on its cost, features and tools available, portability, underlying model and the hardware requirements. The database design phase is then continued by performing the logical design where the conceptual model is translated into definitions of tables, indexes and views. Only certain tables such as blood details and system users need to have view as not all of the records are made visible to all users.

Lastly, the physical design is performed where the data storage and data access characteristics are defined. Such design is crucial as it will affect the performance of the system.

3. Database Implementation and Loading

During this phase, the performance, security, backup and recovery, integrity and concurrency control are the aspects needed to be taken into account. The factors that affect database performance are the data placements, access path definition, the use of index and the buffer size.

Security must be applied during database implementation as data must be protected from access by unauthorized users. This can be done by using physical

security, password security, access rights, audit trails, and data encryption on the private and confidential column such as password.

Data backup and recovery is a very important process in order to ensure the availability of the consistent data as the database can be subject to data loss through unintended data deletion or power outages. The OBDRMS may use logical backup as the backup and recovery strategy.

Data integrity is enforced through the use of primary and foreign key rules. With the enforcement of concurrency control, the simultaneous access to a database is allowed while preserving data integrity.

All of the stated factors above can be implemented by using the Data Definition Language (DDL), Data Manipulation Language (DML) and Data Control Language (DCL).

4. Database Testing and Evaluation

After the data have been loaded into the database, the database is tested for its performance, integrity, concurrent access, and security constraints. Normally, the testing and evaluation phase occurs in parallel with application programming. The testing covers the database connectivity with the application program and the successfulness of executing the Structured Query Language (SQL) statements embedded in the application program.

5. Database Operation

The database is said to be in operational stage after it passes evolutionary stage. At this point, the database, its management, users and the application program forms a complete information system. It is also a stage where the problems that had not been foreseen during testing phase begin to surface and thus the fixing of problems also takes place.

6. Maintenance and Evolution

The periodic maintenance activities such as backup and recovery, security role assignments, security audits and performance enhancements are performed in order to make sure that the database functions as it supposed to be.

2.4 Project Requirements

This section describes about the software, hardware and network requirements for the development of OBDRMS. Each component plays a crucial role in succeeding the implementation of this web database system.

2.4.1 Software Requirements

There is a number of software needed to develop the OBDRMS. Starting from planning, through to analysis, design, implementation and testing phase, different types of software are needed in order to accomplish the tasks in each and every phase. Each software plays a different role in assisting the accomplishment of this project. The description on each software and the reason of choosing it will be described in the next chapter. The required software and their usage are listed as follows:

1. Development Tools:

i) Operating System: Windows XP Professional
ii) Integrated Development Environment (IDE) tool: Eclipse 3.1.2
iii) Language: Java Development Kit (JDK) 5.0
iv) Database Management System (DBMS): MySQL 5.0
v) Server/Servlet Container: Apache Tomcat 5.5.15
vi) Browser: Internet Explorer 6.0 and above

vii) Graphical User Interface (GUI) design: Macromedia DreamWeaver MX 2004

2. **Documentation Tools:**

i) Report: Microsoft Word 2003
ii) **Unified Modeling Language** (UML) Diagrams: Rational Rose 2000
iii) Database Design: ER-Assistant 2.10
iv) Gantt Chart: Microsoft Project 2003

2.4.2 Hardware Requirements

The basic hardware required to develop and run the project is a Personal Computer (PC) with the following specifications:

1. Computer Monitor
2. **Computer Processor** Unit (CPU) with the following requirements:
   i) **Intel Pentium IV, 2.0 GHz**
   ii) 512MB of RAM
   iii) **40GB of hard disk space**
3. Keyboard
4. Mouse
5. Network Interface Card (NIC)

Additional PC is needed during the setting up client-server environment for testing purpose.