

Chapter 4: System Requirement Analysis

4.1 Introduction

System Requirement Analysis is the detailed documentation of the system services and constraints. These requirements should be precise and may serve as a contract between the consumer and the software developer. These are loosely divided into functional requirements and non-functional requirements.

4.2 Functional Requirements of EWSS

These are statements that define the services provided by the system, how the system should react to particular inputs and how the system should behave in particular situations.

The functional requirements of EWSS are divided into six broad categories:

- Web Services functional requirements
- Database System requirements
- Data Entry User Requirements
- Data Processing User Requirements
- Data Retrieval User Requirements
- Data Analysis User Requirements
- Security User Requirements

The first two of these requirements are to be implemented on the Web Server for exposing the Web Services. The other modules are client modules for consumption of the Web Services.

4.2.1 Web Services functional requirements

This is the crux of the Web Services that must be provided for exposure to client modules for consumption. This set of functionality does not have a user interface, and

resides in the Web Server, ready for consumption by the clients. The requirements can again be grouped into the following four broad categories:

- (a) Authentication Web Services
- (b) Data Retrieval Web Services
- (c) Data Update Web Services
- (d) Data Processing Web Services
- (e) Data Analysis Web Services

4.2.1.1 Authentication Web Services

There must be a service to enable the client to send in a set of user name and user password. The service will check against the database for verification of the user login, returning a success or failure of the login.

There must be a set of services to enable the client with administrative rights to update the user database, which is providing services for adding, updating and deleting users.

The authentication module must determine the user permissions for the purposes of restricting certain functions to only those users with the proper security permissions, such as read-only permissions, or read-write permissions.

4.2.1.2 Data Retrieval Web Services

This group of functionality enables users with read-permission rights to retrieve data for the purpose of viewing the marks for individual students or for the whole class. The services should return a set of data for retrieval by the client modules. The type of the set of data can be in any form that can be implemented with the selected database access technology, but must be compatible between the Web Service and the client.

The services should provide data retrieval for the following functionalities:

- The marks for an individual student
- The marks for all students in a Class
- The top 5 students for each Class
- The top 5 students for each Subject

The data retrieval should be in report format that can be viewed on the screen as a print preview as well as printing on paper. The printing should enable the user to set the printing margins, so that the user can choose from a variety of printing paper for different filing purposes.

The 'top 5' type of reports should be able to generate text data files so that they can be reformatted using standard word processing packages and printed with different formats for a more flexible printing output.

4.2.1.3 Data Update Web Services

This group of services is designed for users with read-write permission to update the database. The update requirements are to provide functionality for

- Entry of Student details
- Entry of Class Details
- Entry of Teachers Details
- Entry of Class Marks

4.2.1.4 Data Processing Web Services

There must be a set of services that can process the data to calculate the following values:

- Calculation of grades, averages, and total
- Arranging the students in each class according to alphabetical order or position in class.
- Arranging the students from Form Remove to Form Three, according to position in Form.

4.2.1.5 Data Analysis Web Services

This group of services is for the purpose of performing analysis of the results. The functionalities that are required of this group are as follows:

- Analysis of the performance of each subject for the whole Form, selectable by Form.
- Analysis of the performance of each subject for each Class, selectable by Subject.
- Analysis of the Top students in each class and in the whole Form, selectable by Form.
- Analysis of the Top students for each subject for each Form, selectable by Form.

4.2.2 Database System Requirements

The Web Server will host the database, which must provide tables for entering of data for Teachers, Classes, and Students. These data should have user permission rights. In addition, the database must be able to hold data for the users, their passwords and their user access privileges.

The database should be able to allow many workstations accessing it through the Web Services server. It should allow almost simultaneous access by up to 20 workstations.

The selected database management system should be able to support the SQL language for the data processing functions of the system.

4.2.3 Data Entry User Requirements

There should be a user interface that enables the user to enter data into the database tables. This module should be allowed only for users with update, that is, read/write access privilege. The system must enable the user to enter data into the following set of information:

- **Class Details**

The system must enable the user to enter information regarding the names of each class as attached to their class codes, the Teacher Code, and the subjects offered for each class.

- **Teachers Details**

The system must enable the user to enter data on the teacher names and other relevant data.

- **Students Details**

There should be a minimal amount of information regarding each student that must be entered into the system prior to the entry of marks. This is to facilitate the actual process of entry of marks. This should include their names and the class that they are in.

- **Marks Details**

The system must enable the user to enter the marks of each subject for each student. It is not necessary for the user to enter the grades, averages, and positioning in class. The calculation modules should handle these.

4.2.4 Data Processing User Requirements

The system must provide the user to call upon Web Services functions to perform some vital calculations and processing on the data entered by the user. The necessary calculations involve the following data processing requirements:

- **Calculation of grades, averages and positioning in class**

The system should enable the user to calculate the grade of each subject, the average marks for the student, and be able to set the position in class, bearing in mind the following criteria:

- a) Students who pass the Bahasa Melayu subject will be arranged at the top group

of the class.

b) Students who are present for all subjects will be put in the top group of the class. This would mean that students who are absent for any one subject will not be considered for prizes for position in class, unless all students in that class failed in Bahasa Melayu and are absent for at least one subject.

c) When the above criteria are met, the positioning is based upon the average of all the marks attained, which is the total marks divided by the total number of subjects.

d) The 'Grade Purata Mata Pelajaran' (GPMP) should be used for positioning for students having the same average. This shall be applied only to the Form Four and Form Five Classes. This GPMP is based upon the following allocation of points:

Table 4.1 GPMP allocation of points

Grade	1A	2A	3B	4B	5C	6C	7D	8E	9G
Points	1	2	3	4	5	6	7	8	9

- **Positioning in Form**

The system must provide the user a means to sort the students from Form One to Form Three according to position in form. The criteria for the sorting follow the same requirements as position in class, except that it applies to the whole form.

4.2.5 Data Retrieval User Requirements

There must be a user interface to view or print the results in a suitable format. This forms the basic reporting module of the system. The views must be available to be seen on the screen or to be printed out. The various views of the data should include the following functionality:

- *View of Marks for individual students*

The system must enable the user to select a student, and view all the results for this student. This module should be available to Teachers or to a particular student with the right permissions.

- *View of Marks for the whole Class, selected by class code*

This part is to be designed for producing the mark sheet for each class. The system must enable the user to select a class, and view the marks for all students in the class. It should allow the user to view the mark sheet based upon position in class or by alphabetical listing. The alphabetical listing should list out the male student names before the female student names.

- *View of the Top Five Students in each class*

The purpose of this module is for selecting students for prize-giving. The system should list out a view of the top, or the top five students, for each class, after selecting the Form. Each list should be based upon the whole Form.

- *View of the Top Five Students for each subject in each Form*

This module is also designed for prize-giving. The system should enable the user to enter a Form, and select whether to display the top student, or the top five students, in case there are multiple ties of marks.

4.2.6 Data Analysis User Requirements

The system should provide features for analyzing the results of each class and for the whole school. The analysis modules that the system should provide are as follows:

- Report on Analysis of the performance of each subject for the whole Form. Table 4.1 should be used to calculate the GPMP for each subject, and for the whole Form.

- Report on Analysis of the performance of each subject for each Class. Table 4.1 should be used to calculate the GPMP for each class for the subject.

4.2.7 Security User Requirements

The system should provide a means to enter user names and passwords. Only the top user with the administrative rights should be allowed to add, modify and delete users.

For general usage, the user name as implemented in SMCW should be 'chanwa'. Those users using this user name should be allowed only to enter information pertaining to entry of marks of the students. It should not have administrative rights.

4.3 Non-Functional Requirements

Non-functional requirements do not directly govern the specific functions to be delivered by the system. They relate to certain performance and reliability issues, as well as the constraints under which the system must operate.

4.3.1 Product requirements

- **Platform.**

The system shall execute on the Microsoft Windows platform. This should be necessary for consistency of user interface in the initial implementation of the system. Future enhancements should enable the web services to be accessible from other platforms, such as Linux Workstations and mobile devices. The design should take into consideration of these future requirements.

- **Reliability of database.**

The system should use a reliable database management system. All database updates must be dependable. As such the database should be relational and use the current form of database access methods.

- **Robustness.**

The system shall be built with robust error recovery routines to handle system failures. The system should be able to guide the user out of a situation where an error occurs. This is important to avoid human help support, which is costly.

- **Recoverability.**

Should there be errors in accessing various parts of the routines, such as database access, the system must provide a recovery routine. This routine should guide the user through the recovery process.

4.3.2 User Interface Requirements

The system must provide a user interface that is intuitive and does not cause confusion or ambiguity to the user. Users today are accustomed to the Windows type of interface, and expect the same look and feel, which this system should follow. It is also preferable that the users can expect what the system should be able to provide, and provide those expectations. The users have used similar systems before. So the users should be able to easily find the same features without difficulty. In addition, the user interface should meet the following requirements:

- Consistency of interface between various modules. Each module should be designed with a similar look-and-feel, with similar type of buttons and icons.
- User Familiarity based upon previous software systems. The user should know the capabilities of the system as a result of using previous systems, and expect at least those features which were previously present. The system can then provide newer features.
- User Guidance. There should be context-sensitive help to guide the user through the various modules.

- Web-page style of user-interface. The data entry user interface should be displayable on a Web browser, as the system must support typical on-line interfaces.

4.3.3 Organizational requirements

- **Reliability of access.**

The system should be reliably accessed over the school intranet system. It can be assumed that the hardware linking the computers is dependable.

- **Conformance.**

The database to be used shall closely conform to the current database system used by the school, namely Microsoft ACCESS 2000.

- **Scalability.**

The system shall use a database that is scalable to Microsoft SQL Server 2000. It is expected that SQL Server 2000 will be used in the future when budgetary requirements are met.

4.3.4 External requirements

- **Interoperability.**

There are many systems already in use in the school. The system should provide features to enable data to be transferable between these systems. In particular, wherever possible, text data formats should be provided for all reports.

- **Satisfaction.**

The system should make the students, teachers and administrators of the school satisfied, which leads to increased productivity.

- **Modularity.**

The system should be able to operate on its own. It is independent of all other software systems except the underlying operating system.

- **Affordability.**

The system should use technology that is affordable to the school. There is no need to use high-end technology, as long as it performs the tasks well.

4.3 Decisions on the choice of Technology, Software and Development Tools

4.3.1 Development Platform

The choice of the development platform is between using Java technology and Microsoft Visual Studio.

- **Microsoft Visual Studio.NET**

Microsoft Visual Studio.NET 2003 offers a variety of languages to build Web Services. The standard development platform comes with Visual Basic.NET, C#, C++ and J#. Microsoft actually offers two platforms, namely, the .NET Framework Software Development Kit (SDK) and Microsoft Visual Studio.NET. The SDK is free, but the Visual Studio.NET provides a complete Integrated Development Environment (IDE). Both platforms uses propriety code, most of which is hidden from the programmer. Visual Studio.NET does most of the work behind the scenes to make developing web services for the beginner very easy. It means higher productivity and faster development.

- **Java technology**

Developing Web Services using Java comes in the form of a variety of development tools. Sun Microsystems offers the Java Web Services Developer Pack (JWS DP). This is Sun's counterpart of Microsoft's .NET SDK, and was released in response to it. International Business Systems (IBM) offers the Web Services Toolkit (WSTK). It also offers the IBM WebSphere SDK for Web

Services V5.0 (WSDK), which requires the use of the IBM WebSphere development environment. All of these tools require a steep learning curve. The programmer needs an excellent command of the Java programming language. It is also necessary to learn the use of JAX-RPC, a thorough understanding of programming for XML and programming Enterprise Java Beans (EJBs).

Table 4.2 shows a comparison of the .NET framework over the Java Platform to build Web Services for EWSS. This table indicates a clear choice of using Microsoft Visual Studio.NET for the development of this project based upon the fact that the project must be completed within a short period of time, as well as the ease of use of the platform. Developing EWSS using the other platforms will require a much longer development time.

Table 4.2 Comparison of .NET and Java Platforms

Metric	Microsoft Technology	Java Technology	
	Visual Studio.NET	Sun J2EE (WSDP)	IBM Websphere 4.0
Development Tools	One integrated tool	Collection of tools	One integrated tool + database tool
Names of Tools	Visual Studio .NET	Web Services Developer Pack (WSDP)	IBM WebSphere Studio Application Developer Database development tool (e.g Oracle DBA Studio)
Estimated software purchase costs to deploy Web Services on a single server with full authenticated per-	\$5,998 [a]		\$64,000 [a]

user access			
Development time	Two months	1 Year	1 Year [b]
Languages	C#, C++, Visual Basic.NET, J# (Over 20 languages)	Java (limited support of other languages through JNI interface)	Java
Stored Procedures Editor	Integrated	No	No

[a] Source: .NET Framework Community Website

[b] Estimate for EWSS development.

Figure 4.1 shows one of the performance charts published by the Middleware Company in its report entitled 'J2EE and .NET Application Server and Web Services Benchmark', dated October 2002. It indicates the superior performance of .NET over J2EE Web Services.

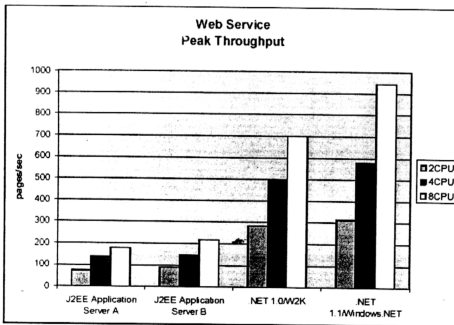


Figure 4.1 Peak Throughput Comparison between J2EE and .NET platforms

Four months was spent on understanding the technology of Java Web Services in terms of literature review and hands-on experience. Sun Microsystems did not have a coherent set of tools to develop Web Services until March 2003. It was decided that it was not possible to use Java Web Services to complete this dissertation within a reasonable time frame.

All these factors weigh in the decision to choose the Microsoft Visual Studio.NET as the development platform. Visual Studio .NET provides some very functional tools to develop web services as quickly as possible. In April 2003, Microsoft released Visual Studio.NET 2003, which is the platform used in this dissertation.

4.3.2 Development Web Server

The choice of the development Web Server is between Apache Server and Microsoft Internet Information Service.

- **Apache Server**

Apache Server is an open source Web server used widely in the Linux environment. It is a secure, reliable, and scalable platform for web-enabled enterprises. It is freely downloadable from the web at <http://apache.org/>. User authentication is completely separate from the security domain of the system running the Web server. For example, Apache lets the network manager store realms, user names and passwords in simple text files or, when a large number of users are involved, in a database.

However, there are many finer points of using Apache Web Server which can consume a lot of time resources to fine tune its performance and this information is not well documented, being known to very experienced WebMasters.

- **Internet Information Server (IIS)**

Microsoft's IIS is fully integrated with the Windows security architecture and authorization databases. Users authenticating themselves to IIS must have a user

name in an Active Directory domain. IIS bases all security decisions on the rights and privileges of that user name. Active Directory's groups and access control lists are used to determine whether a Web server client can see pages.

Microsoft's Internet Information Server is chosen because it integrates well with the Microsoft .NET Framework, and is easier to configure, especially within the time constraint to complete this research.

Table 4.3 Comparisons of Web Servers

Metric	IIS	Apache Web Server
Platforms	Windows	Windows, Linux, Unix
Cost	Part of Windows 2000	Free, therefore highly popular.
Documentation	Very Good	Good
Ease of use	Very Good	Good
Management Interfaces	An intuitive set of management tools, using Windows-based interfaces. It has a subset of management available via Web browsers.	The most primitive and least usable, which relies on a set of poorly documented configuration files, typically modified with a text editor, to tell it what to do.
Managing, monitoring performance	The Windows Performance Monitoring tool lets network managers visually monitor load and throughput, and capture performance information for short- and long-term analysis with familiar tools. It can export statistics via an SNMP subagent.	Relies on the operating system for any performance optimization.

Roll over of log files	Automatically roll over log files at predefined intervals	None
Bundled example applications	None. Relies on Microsoft FrontPage Extensions with no documentation.	Has a small but respectable kit of sample applications. But little definitive documentation. This makes Apache a high-overhead product: free to acquire, but expensive when you want to push the boundaries.

The Development Web server chosen is Internet Information Server running in Microsoft Windows 2000 Advanced Server. IIS is the natural choice for .Net Web services, and is critical in developing this project within the time schedule.

4.3.3 Database Server

The selection of database server is narrowed down to three:

- Microsoft SQL Server
- IBM DB2
- Oracle 9i

Table 4.4 Comparisons of Database Servers

Metric	MS SQL Server	IBM DB2	Oracle 9i
Price (1 CPU)	\$5000 (Standard Edition)	\$7500	
OLAP and Data Mining	Included in Enterprise Edition (\$20,000)	With Enterprise Edition (\$113,000)	
SQL dialect	Transact-SQL (T-SQL)	DB2 SQL	
Platforms	Windows Only	Unix, Linux, Windows, OS/390	Unix, Linux, Windows, OS/390

Microsoft SQL Server is chosen as the Database Server. There are various versions of Microsoft SQL Server, and the version chosen is SQL Server 2000 Enterprise Edition. This is the easiest to configure, and to blend in with the Microsoft .NET Framework.

4.3.4 Data Access Technology

The choice of Data Access Technology is among Microsoft Active Data Objects (ADO), and ADO.NET

- **ADO**

Active Data Objects uses the Recordset object to manipulate data in a database, and is extensively used in ASP. However, there are difficulties in using ADO for interoperability data access over the Internet.

- **ADO.NET**

One very nice new feature of ADO.NET, which is very much used in EWSS, is the concept of DataSet, which enables accessing records and tables in the same set. In fact, ADO.NET uses three different objects, namely, the DataSet, the DataReader and the DataAdapter. It is based upon the widely accepted XML, and they provide functionality to create distributed applications.

The Data Access Technology chosen is ADO.NET because it integrates well with the .NET Framework and provides better objects for a distributed environment.

4.3.5 Development Language

The development languages considered for use in EWSS were C#, Java, J# and Visual Basic.NET.

- **C#**

C# is a strongly typed object-oriented language designed to give the optimum blend of simplicity, expressiveness, and performance. The C# language was built

with the hindsight of many languages, but most notably Java and C++. Programs written in C# runs fastest on the .NET Framework, as it is best optimized for this platform

- **Java**

Although Java runs on many platforms, there is almost no documentation on using Java on the .NET Framework. Java will run on a pure Windows Operating System Environment, just as it runs on Linux and Unix. Java is interpreted code, and performance will be slower.

- **J#**

J# comes with Visual Studio.NET 2003. It adds rectangular arrays and features to support the .NET Framework, such as .NET class libraries. It supports the Visual J++ 6 extensions to the Java language, such as delegates, conditional compiling and a few attributes added by Microsoft. VS.NET 2003 allows building of Windows Applications, Web Applications and Web Services, among other projects, using J#.

- **Visual Basic.NET (VB.NET)**

This language is best suited for those programmers with a background in using MS Visual Basic 6. Programs run slower than C#.

The Development Language of choice is C#, as it is best suited for the .NET Framework. C# is also closest to the C++ language which has been used extensively in past projects.

4.4 Hardware Requirements

The development requires several IBM compatible Personal Computers. The hardware requirements of EWSS depend on the specific requirements of the various components that make up its architecture, and can be divided into two main components:

- The Development Machine requirements
- The Web Server hardware requirements
- The Client Components hardware requirements

4.4.1 The Development Machine requirements

The main development is done on a machine with a 900 MHz Intel Celeron Processor with 512 Mbytes of Random Access Memory. This is the minimum requirement to run the development tools with acceptable speed.

4.4.2 The Web Server hardware requirements

The Web Server requires a machine with at least 256 Mbytes of Random Access Memory. The processor should be a 900 MHz Celeron or higher. This acts as the Server to host the Web Services, running IIS 5.0.

In the development of EWSS, the development components and the Web Server actually run on the same machine.

4.4.3 The Client Components hardware requirements

The workstations consist of any number of IBM compatible Personal Computers which can run Internet Explorer, or some other Internet browser.

A notebook computer is also required for demonstration of the system away from the development systems at home and in the school environment.