ABSTRACT

In this modern world, Information Technology and Information Services are critical factors for an organisation to succeed against other competitors. **CEMS (PVT) Ltd.** is one such organisation exploring the possibilities of applying IT and IS based solutions gradually to replace their current manual system to improve performance, visibility and reliability thus increased profits. As the name suggests, it’s an energy saving construction company located in Sri Lanka. They undertake many construction projects and their projects are mostly handled using installation and assembly materials. Company is provide necessary spares to these installations and other necessities required for construction projects.

This professional project is an attempt to develop a **Stock Management System** for CEMS (PVT) Ltd. to efficiently control the movement of materials within the company’s warehouse, replacing their current manual file-based system. This will automate all of its company’s manual processes such as,

* producing GRNs and Issue notes
* managing stock and supplier details
* summarizing stock receipts and issues

This current system is designed for the organization to obtain above services without manual intervention. It has the ability to categorize stock materials, stock intelligently by assigning different patterns of unique codes to each of them, thus enabling centralized management of tasks such as stock management. It also has the ability to generate Good Received Notes (GRN), Issue Notes and other necessary reports required quickly without any delays. One of the functions of the system is the option to analyses the material stock and generate reports.

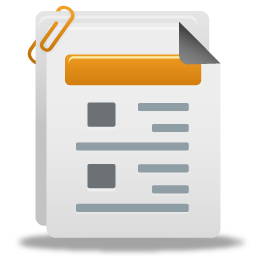
The new system will be implemented on several networked computers, with a centralized database. All users of the system are capable of real-time processing since they are all connected with the intranet. A local copy of the database will also be held at every machine, in case of communication error. New system will be developed using modern programming techniques like Design Patterns, Object Oriented Programming etc. Developed system uses Java as its main language and MySQL as the database. Reports will be generated using Jasper Reporting technology.

1. INTRODUCTION
   1. **ORGANISATION BACKGROUND**

CEMS (PVT) Ltd. is an energy saving construction company located in. They undertake many power saving construction projects, supply and installation of Switch boards. Company’s projects are mostly handled using industrial hardware items and electrical components. Company warehouse’s main purpose is to provide necessary electrical components and other necessities required for the project. The staff members will be assisting me for the rest of the project, describing the processes & providing user requirements.

* 1. **CURRENT SYSTEM**

**Issue Note**



**GRN**



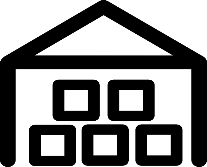
**Purchase Order**



**Supplier**



**Projects**



**Stock**

Figure: 1.2

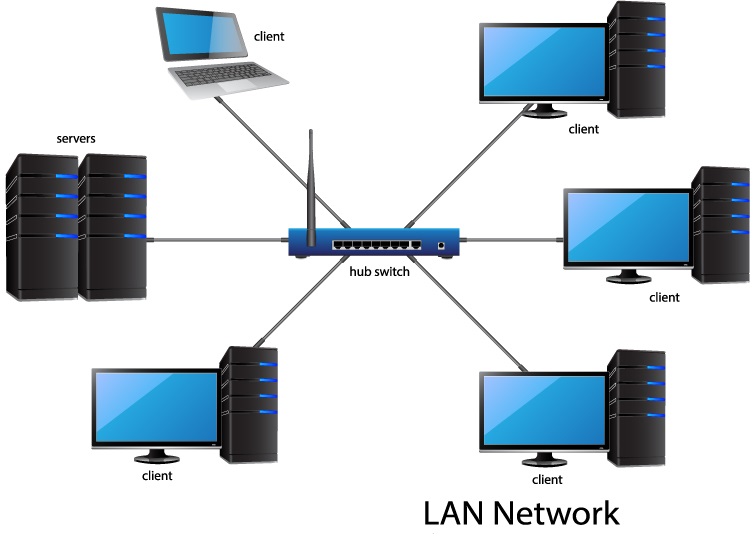
Above figure (figure 1.2) represent a summary of the overall system and processes carried out. A supplier delivers stock to the Company’s warehouse according to the Purchase Order and then manually recorded in GRNs. Stock can be of any kind. Once received, they are stored in the company’s warehouse until a stock requisition from maintenance work or construction sites/projects. Requested goods are then issued to maintenance work by Issue note and carried to the project. The Store Manager records all inputs and outputs in a file-based system. Copies of Purchase Orders, GRNs and Issue Notes are also filed in.

1.2.1 WEAKNESSES IDENTIFIED

* One of the major disadvantages of using a file-based system is the immense amounts of time wasted in order to search for a previous file or record.
* No history of suppliers, thus requiring re-analysis of prices when reordering items.
* Poor stock management leads to excess levels of stock and wastage of money.
* Difficulties in maintaining the coordination between stock ordering and issuing.
* Due to no proper reorder system, number of orders is high and use many transport arrangements daily.
* Employees do not have continuous improvement program due to volume of the work load by manual work type thus demotivating the staff.
* Employees waste time gathering always at the stores searching information, waiting for materials and other services.
* Frequent complaints are made by suppliers for payment delays.
* Lots of calculation errors since it is done manually.
  1. **PROPOSED SYSTEM**

Proposed system is a Stock Management System, which will automate all the manual functions carried out at the Company. The developed project is to eliminate manual intervention as much as possible to improvise visibility into the system work flow. Visibility will be obtained by system generated reports, such as Good Received Notes (GRNs), Issue Notes, Stock reports, Purchase Orders. These system generated reports will reduce the work of the staff as well as save their time and cost.

Proposed system will run on a networked environment with a centralized database which uses Java as its main language and MySQL as the database. It is based on the client-server architecture and will use a Local Area Network (LAN) to connect all users in the company.



Client

Server

Client

Client

Client

Client

1.3.1 OBJECTIVES

* Stock categorised using a material code system.
* Receivables input by system generated GRNs which is 1 of 3 way matching document for payment.
* Unit price is automatically updated smartly.
* Quick search facility.
* Remove all paperwork and all other manually recorded files.
* Reduce data redundancy
* Generate daily/monthly reports of Stock summaries for Stock Manager
* Reporting Module.
* Improve stock management performances

1. REQUIREMENTS ANALYSIS & SPECIFICATION
   1. **INTRODUCTION**

“The problems that software engineers have to solve are often immensely complex. Understanding the nature of the problems can be very difficult, especially if the system is new. Consequently it is difficult to establish exactly what the system should do. The descriptions of the services and constraints are the requirements for the system and the process of finding out, analysing, documenting and checking these services and constraints is called Requirements Engineering. “– Quoted from a book.

Proposed system for the construction company is developed from scratch, since a file-based system is automated. Therefore understanding the nature of the problem and listing down the user requirements is a very important phase for the overall success of this project. Before the requirements were finalised, the developer had first discussed with selected users about the scope and requirements. Store manager of the company will assist me in gathering user requirements. This phase was essentially focused on requirements gathering and finalizing, since in research it was discovered that “incomplete user requirements” and “lack of user involvement” were the top two reasons for IT project failure.

The purpose of requirement analysis is to get a clear and correct understanding about the business process. Thorough understanding of the business process helps to fulfil the organizational needs from the developed system. Various techniques are used to identify or extract problems in the current system and to gather solution requirements from the users. The problem analysis is the activity of identifying the problem, understanding the problem solution (including causes and effects) and understanding any constraints that may limit the solution. After analysing the problem then the requirements must be gathered.

* 1. **REQUIREMENTS ELICITATION**

A wide range of requirements elicitation techniques exist for requirements development. It is essential to understand what is available to you and then choose your techniques based on your situation and your organization. Using multiple techniques to elicit requirements information can be very powerful and produce higher quality results. Requirements elicitation techniques are grouped into the following categories;

* Interviews
* Observation
* Focus Groups
* Forms Used
* **Interviews** are the traditional method of eliciting information from people. Interviews are simple to conduct and provide insight into user needs. They also support in-depth understanding of the user requirements.
* I made number of visits to the company in order to observe their current process and identify any weaknesses. Through **observation,** I was able to gather more requirements for the proposed system. Detailed tasks are difficult to clearly describe in spoken words. Observation allows us to shadow the users to see first-hand how they interact with systems, processes, and each other. Observation is a way to fill in the blanks when you think something might be missing from what is being said.
* A group of employees from CEMS (Pvt) Ltd. were setup on a meeting with me to discuss user requirements. They had different views and different ways of expressing the same requirement. Through **focus groups,** I was able to gather more specific user requirements.
* Current manual file-based system uses many **forms** to collect information about GRNs, Issue Notes and Invoices etc.. I got a copy of all these forms to get a better idea of the system, and what kind of data they input into the system
  1. **FUNCTIONAL REQUIREMENTS**

Functional requirements are functions or features that must be included in the developed system to satisfy the business needs and be acceptable to the users. Functional requirements are expressed by the users of this system. As a result of the requirements elicitation techniques I’ve used, I was able to capture several key functional requirements.

* **Add New Stock**

One major functional requirement is to store basic stock details. All incoming stocks are assigned a unique stock code and it’s easy to categorize stock materials.

* **Stock item list**

List of all stock items in the company’s warehouse, with its unit price, selling price and the quantity on hand which can be sorted according to users wish.

 **Add New Supplier**

Function of adding new suppliers and storing their contact details.

* **Supplier list**

A list of all current suppliers dealing with the company.

* **Issue GRNs and Issue Notes**

To automate the issue of GRNs and Issue Notes. Items selected from the stock. Smart calculation of unit price and handling of quantity on hand. This process speeds up issuing of GRNs and Issue Notes.

* **GRN list**

List of all GRNs entered into the system.

* **Issue Note list**

List of all Issue Notes entered into the system.

* **Manage Entry Details**

Allows to keep the track of record of users who entered data into system.

* **Search previous records**

The developed system should have the ability to search for any previous records easily.

* **Generate Reports**

Generate reports for Purchase Order, Issue Note, GRN and stock summary report

* **User Management**

Allows the creation of user profiles for their system.

* 1. **NON-FUNCTIONAL REQUIREMENTS**

It was found in many projects, non-functional requirements are not considered at all or only at a very superficial level for system development. Non-functional requirements deal with the behaviour of a system or the technical aspects. On the surface these may not seem important to the business user or customer who have a greater interest in the functional requirements. Non-functional requirements define system properties and constrains, such as Performance, Maintainability, Robustness, Efficiency, Availability and reliability. Therefore the developer has identified the following as non-functional requirements.

* **Centralized Database System**

A centralised database management system (DBMS) allow all the networked machines to access one database, reducing data redundancy and will give rise to central administration of all the functionalities.

* **Performance**

System should have fast response when accessing the system through intranet. Therefore Java Design patterns are used for optimization

* **Availability**

This is to make sure there is very low downtime of the database server and assuring the system is always available and ready.

* **Reliability**

Since calculations are involved, higher reliability of the system is highly expected by the users. System should be able to perform all the relevant functions and produce correct outputs.

* **Robustness**

Meaningful error messages should appear when incorrect data is fed in, allowing the user to understand the problem.

* **Maintainability**

Ensures new features can be added to the developed system without any difficulties. Efficient and quality programming practices will increase the maintainability of the system.

* **Security**

Security requirements can come in many different forms. According to the privacy, requirements can dictate protection for sensitive information which include data encryption for database tables such as passwords of users.

* 1. **HARDWARE& SOFTWARE SPECIFICATION**

2.5.1 DEVELOPMENT ENVIRONMENT

Requirements needed for the development environment, where the developer develops the system.

Hardware requirements

* Intel Pentium Dual Core 2.03GHz processor CPU
* Computer memory 1526MB
* 128MB AGP/VGA card
* 200GB Hard Disk Drive
* Internet connection

Software requirements

* Microsoft Windows 7 Ultimate
* JRE 6.0
* JDK 6.0
* NetBeans IDK 8.0.2
* MySQL Server 5.7
* MySQL Workbench
* Jasper iReport 2.3
* exe4j 4.3
* Setup Factory 8.0

2.5.2 OPERATIONAL ENVIRONMENT

A separate Server operating will have MySQL database server running 24 hours.

Requirements needed for users located in intranet to run the system effectively.

Hardware requirements

* Intel Pentium 4 3.0GHz processor CPU
* Computer memory 1000MB
* 64MB AGP/VGA card
* 80GB Hard Disk Drive
* Internet connection
* Printer
* UPS
* Monitor
* Mouse and keyboard

Software requirements

* Microsoft Windows XP/ Vista or 7
* MySQL Server 4.1
* Jasper iReport 2.3
* JRE 6.0
  1. **OTHER REQUIREMENTS**
* The computer literacy of employees is medium, therefore user-friendliness was highly required. Conduct training programs to all users of the developed system.
* Requirement for quality documentation arises to increase user satisfaction and reflects the clarity of the project activities to the development and maintenance teams.
* Since the system is totally based on open source software, such as Java and MySQL, development is done at low costs.
  1. **WORK SCHEDULE**

1. DESIGN
2. **INTRODUCTION**

After requirements analysis and specification, the developer will design a plan for a solution. This chapter mainly concentrates on how the system will be designed. Many design concepts are inherited, such as Modularity, Data structure, Encapsulation etc. Mainly object-oriented concepts are integrated into the system.

1. **UML**

“The Unified Modelling Language (UML) is used to specify, visualize, modify, construct and document the artefacts of an object-oriented software-intensive system under development.” Developer used UML to design the proposed system. UML combines techniques from data modelling (entity relationship diagrams), business modelling, object modelling etc.

3.2.1 DIAGRAMMATICAL NOTATIONS

* Use case Diagrams

Use Case Actor

* Activity Diagrams

Action Branch Transition

Start State End State

3.2.2 USE-CASE DIAGRAMS

There are mainly 3 Actors/Users in the proposed system.

1. Administrator
2. Store Manager
3. Clerk

* Use case diagram for Administrator

Manage User Profiles

**Administrator**

Backup & Restore Database

Administrator is responsible for the smooth running of the system. Admin’s main responsibility is to manage user profile/accounts. Only the Admin has access to edit User Accounts. Admin has been granted with all user privileges. Recoverability of the system with the help of Backups is also another responsibility of the Admin.

* Use case diagram for Store Manager

**Store Manager**

* Use case diagram for Warehouse Manager

**Clerk**

3.2.3 ACTIVITY DIAGRAMS

1. Activity Diagram for Adding New Stock to Inventory

Adding New Stock to Inventory

Store Manager/Clerk

Supplier

Supply requested items with their invoice

Add items to system via a GRN

Check for product code

Select product code

Save in stock

Define new product code in products

YES

NO

1. Activity Diagram for Adding a GRN

Select

Select

3.2.4 ENTITY RELATIONSHIP (ER) DIAGRAMS

* 1. **DATABASE AND TABLE MODELS**

Database used in the developed system is run on MySQL 5.7 Database Server. The MySQL database has become the world's most popular open source database because of its high performance, high reliability and ease of use. Many Java developers tend to use MySQL, since they are both open source. MySQL is easier to learn and to use, compared to other databases therefore I decided to proceed with MySQL as my Database Management System. MySQL Workbench 6.3 CE is used to manage and alter the database.

* + 1. DATABASE MODEL

Database Name: ims

Tables;

1. currentstocks
2. customers
3. grninfo
4. products
5. purchaseinfo
6. salesreport
7. suppliers
8. users
   1. **USER INTERFACES**

Following user-interfaces illustrates how the user interacts with the system. User friendliness and system flexibility are greatly exaggerated by the fine use of GUI and appearance. Images were designed and edited using Adobe Photoshop Version CS3.

* 1. **REPORT DESIGNS**

The following reports were designed using JasperSoft iReport Version 2.03 Reporting software.

4. IMPLEMENTATION

1. **INTRODUCTION**

"Implementation is the systematically structured approach to effectively integrate software based service or component into the workflow of an organizational structure."

This chapter focuses on how the deliverables of the project will be implemented in the live environment, which is a completely functioning Stock Management System. Furthermore this chapter emphasizes on the implementation process, how it was done, implementation requirements and how users were trained.

1. **IMPLEMENTATION PROCESS**

Since the new system should be integrated to the current work flow of the company, its’ a high risk. Therefore the integration was done according to an incremental way, which is implementing as manageable steps. Result of integrating the new developed system into the current system is known as Parallel Adoption.

“Parallel adoption is a method for transferring between a previous legacy system to a target (IT) system in an organization. In order to reduce risk, the old and new system run simultaneously for some period of time after which, if the criteria for the new system are met, the old system is disabled. The process requires careful planning and control and a significant investment in labour hours.”

Parallel adoption is a 3 step process. Define implementation process, Prepare organization and Conversion. Defining the implementation process includes how the developer plans to integrate newly developed system into current system so that it will support parallel adoption without any collisions. Efforts should be placed on data-consistency and preventing data corruption between the two systems. Not only for the conversion process itself, but also in training them for handling the new system. Preparing the organization includes training the staff, buying necessary equipment and other supportive software required. This also includes restructuring of the organization hierarchy. If the user requirements are met and are happy with the new system, conversion process takes place, where closing the old system and proceeding with the new system.

1. **HARDWARE & SOFTWARE INSTALLATION**

Software Installation

Hardware Installation

Install Software

Test Software

Test Hardware

Install Hardware

Hardware and Software configuration has to be done according to specifications defined in the Requirements Analysis stage, before moving on with the implementation process: prepare organization. Before implementing the newly developed system, it was pre-tested in the developer environment. This test was carried out to identify proper hardware and software requirements for smooth and efficient performance of the developed system. These specifications were then included in the proposal report, which is given to the company to buy required hardware components and establish these machines with full configuration, ready to be installed in their company. Completion of the implementation leads to the next step, which is testing. This will be discussed in the next chapter.

Following is a brief summary of all the necessary checks:

* Setup Checks on software.
* Verify installation readiness of client machines.
* Verify correct hardware and operating system configuration.
* Verify Successful network connectivity to main server.
* Software Installation.
* Confirm pre-installation checks are successful.
* Confirm connection to server
* Finalize hardware and software installation

For the newly developed system to be integrated to the current process, organization should consist of following hardware and software specifications.

4.3.1 HARDWARE SPECIFICATIONS

The hardware configuration is tested to assure proper functioning. System was installed on all the machines including the Server which has the database. Server had a higher performance machine. After hardware installation, the system was tested on each of these machines.

* Intel Pentium 4 3.0GHz processor CPU
* Computer memory 1GB
* 64MB AGP/VGA card
* 80GB Hard Disk Drive
* Internet connection
* Printer
* UPS
* Monitor
* Mouse and keyboard

4.3.2 SOFTWARE SPECIFICATIONS

Since the new system uses client server architecture, all other client machines must be connected to this one server which has the database. The clients should be configure the .config file which has been given with the software, by providing the server machine’s IP to connect to the database.

Java runtime environment (JRE 6.0) was installed in each machine along with other required software. These software were then tested on each machine to check their performance and reliability.

* Microsoft Windows XP/ Vista or 7
* MySQL Server 4.1
* Jasper iReport 2.3
* JRE 6.0

1. **TRAINING**

Training of system users or the staff is very essential for a successful information system. If the system is very well designed and tested, but the not implemented properly, fault is developers. Therefore to achieve company goals and user satisfaction, proper implementation is required. This is mainly User Training. Training is required to make the users of the system understand the current process and compare it with the new developed system. With this, they’ll get an idea of how the system will function.

A successful information system requires a proper Training for the users, Managers and IT staff when implement the system it is essential to provide the tight training for the right people at right time. System training will also teach users the keystrokes and transactions required to run the system. The developer will then test the users understanding of the system. Training as such is not enough for adopting an information system. The users have learning needs. Computer literacy is a must. Users should be used to handling of keyboard and mouse. If they fear the system due to its difficult handling they may not be able to understand steps needed to successfully carry out the tasks. Most critical data handling errors were clearly explained to the users.

Training workshops were carried out during the time of implementation. Each user was taught how to handle the system and how to respond to its messages. After a certain period of time, the training workshops were successfully completed with all the system users. Admins were fully trained, as how to take backups and restore, and other system utilities such as changing user passwords with a help of the user account control panel. They were also given the task to configure the database connectivity for a successful connection to the server which has the database. These administrators were rich in computer literacy, thus allowing them to train any new comers.

5. TESTING

1. **INTRODUCTION**

“Software testing can be stated as the process of validating and verifying that a software program/application/product:

1. meets the requirements that guided its design and development;
2. works as expected; and
3. can be implemented with the same characteristics.”

Testing process is carried out with the intent of finding errors. Software can fail in many bizarre ways. Detecting all of the different failure modes for software is generally infeasible. The scope of software testing often includes examination of code as well as execution of that code in various environments and conditions as well as examining the aspects of code: does it do what it is supposed to do and do what it needs to do. Verification and Validation is the name given to these checking and analysis process. Verification involves checking that the software conforms to its specification, such as functional and non-functional requirements. Validation is to ensure that the software system meets the customer’s expectations.

1. **TEST STRATEGIES**

In the developed Stock Management System, I have used 3 main testing strategies. Black Box testing, Alpha testing and System Testing.

* **Black Box Testing** – This strategy is mostly applied on Unit testing, since the component is too large and less critical. Black Box is carried out by studying system’s inputs and outputs.
* **Alpha Testing** – Developed system is tested in the developer’s site by the end users. This becomes very useful since it is bespoke software. Company’s store manager assisted me with this process.
* **System Testing** – This includes Recovery Testing and Security Testing. In recovery testing, I forced the MySQL database to crash and used the restore function to recover the database. Security testing is used to prevent unauthorized entry to the system, that is basic security features are met.

**5.3 TEST CASES**

**5.4 TEST EVALUATION**

Test Cases 3 and 4 were normally carried out on all the Save buttons in every form, since they all had the same 'Expected Output' only one instance of those tests were recorded in the documentation.

6. CRITICAL APPRAISAL

**6.1 INTRODUCTION**

“A review of the Professional Project looking back at both the product and the process”

Critical appraisal is the process of systematically examining developed software to judge its value and relevance. Purpose of this chapter is to argue about the developed system. Stock Management System was developed to automate the current manual system of CEMS (PVT) Ltd. The significant importance of this system is its networked and centralized architecture, allowing several clients to connect and access the same data of this system. Critical analysis of the developed system will be discussed next.

**6.2 SYSTEM EVALUATION**

In order to justify the evaluation, the developer carefully compared the developed system against the project proposal. As a result of that it was observed, the implemented networked desktop application for CEMS (PVT) Ltd is functioning according to the project proposal.

6.2.1 OBJECTIVES COVERED

* Stock categorised using a material code system.
* Receivables input by system generated GRNs which is 1 of 3 way matching document for payment.
* Unit price is automatically updated smartly.
* Quick search facility.
* Remove all paperwork and all other manually recorded files.
* Reduce data redundancy
* Generate daily/monthly reports of Stock summaries for Stock Manager
* Reporting Module.
* Improve stock management performances
* Monthly stock valuations.

6.2.2 STRENGTHS AND WEAKNESSES

As a part of the critical appraisal, developer has to review and analyse the developed system in order to discover strengths and weaknesses in it. All information provided in the critical appraisal is based on the facts obtained during the testing phase and from user’s feedback. Developer has attempted to develop the system to the best of his knowledge without any errors or bugs. However, it cannot be 100% error-free. There could be some unknown exceptions which may pop out during the live use of the system.

The following advantages have been acquired by introducing a fully automated networked system with a centralized database accessible by multiple users concurrently.

* Increasing connectivity
* User friendly control panels to easily manage the system.
* Increased flexibility for change and high performance
* Allows multiple hosts to access same files from various operating systems due to use of Java, which supports many platforms
* Easy system recoverability

Weakness

**6.3 LESSONS LEARNT**

6.3.1 PROJECT MANAGEMENT

While the developer was able to complete the project close to originally planned time but for several sections such as development and implementation sections needed much more time than the proposed time duration at the beginning. This was purely due to the under estimation of time needed to learn new Java design patterns and the new Java Version 7. Several new features were needed to be carefully examined and studied in order to implement them in the developed system. The detailed analysis took much time in order to verify the actual requirements of the training process.

The developer had realised that many new skills set to be acquired or unfamiliar technologies introduced in a project could greatly affect the overall project schedule. Hence, if the developer has to re-draw this or draw another project schedule, this can be taken as an important learning point for the overall project planning.

6.3.2 DESIGN AND CHOICE OF TOOLS

“Java is a general-purpose, concurrent, class-based, object-oriented language that is specifically designed to have as few implementation dependencies as possible. It is intended to let application developers "write once, run anywhere" (WORA), meaning that code that runs on one platform does not need to be recompiled to run on another. Java is currently one of the most popular programming languages in use. ”

The reason of using Java as the programming language to code the system instead of C++ or C#, is the popularity and its reduced complexity of the language. I used www.stackoverflow.com to get support and to clarify and resolve my questions. Java and its amazing features along with Integrated Development Environments such as NetBeans made it easier to code. As a Java evangelist, I prefer Java instead of any other languages. I’m a strong believer in open source. Open source enables you to try out different business approaches, and actually evaluate software for its merits. MySQL is also an open source DBMS. However, if the developer has used a far more improved DBMS such as MSSQL, instead of MySQL, developer could’ve added more specific features to manage the database accessibility.

6.3.3 TESTING AND VALIDATION

There were several test case decisions that had to be taken such as;

* It is always important to record all the completed tested modules in order to make much effective the testing strategy when performing black box testing.
* The testing process becomes easier when knowing requirements and the level of achievement of the product at present.
* Include two more testers other than the developer to have random input data to check for any random errors.

**6.4 FUTURE EXPANDABILITY**

As a result of successful implementation of the developed system, the developer was able to collect user’s feedback regarding the short comings of the new system, and issues and improvements the user has seen by using the new system. Collected data was stored for future reference. Developed Stock Management System is used to manage stock at the company’s warehouse. The company is willing to automate their other manual tasks, such as connecting with accounts section, getting orders from customers etc. Therefore the developer is willing to extend this system into Supply Chain Management software. Rather than using a Java Swing application, developer is willing to go for a Web based system using JSP and servlets.

**6.5 CONCLUSION**

The reason why I chose CEMS (PVT) Ltd. over some other organization or an ecommerce website is because to get industrial training in creating ERP applications. While working with a real client, its gives me a lot of experience and ideas.

This approach is expected somewhat different from standalone system since it supports an Intranet than a normal local connection to a database.

However, considering the given reasonable time for this project and having met the user’s requirement and expectations, this system can be considered successful and serves its purpose.