ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

SCHOOL OF ELECTRICAL ENGINEERING AND COMPUTING

DEPARTMENT OF COMPUTING

WEB BASED CONSTRUCTION MANAGEMENT SYSTEM FOR TEKROM CONSTRUCTION PLC.

BY:

Akmel Denboba	**GSR/5289/06**
Amir Hagos	**GSR/5291/06**
Kemal Demedu	**GSR/5303/06**

JUNE, 2015

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY
SCHOOL OF ELECTRICAL ENGINEERING AND COMPUTING
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A MASTER'S PROJECT

ON

WEB BASED CONSTRUCTION MANAGEMENT SYSTEM FOR TEKROM CONSTRUCTION PLC.

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE DEGREE

OF

M.Sc. in Technical Teachers Education in Information Technology Management

Advisors:

ATO: Frezewd Lema(Major)

ATO: Belayneh Mengistu(Minor)

BY:

Akmel Denboba	**GSR/5289/06**
Amir Hagos	**GSR/5291/06**
Kemal Demedu	**GSR/5303/06**

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Approval sheet

A. Candidate

1. Student Name	sign.	Date
2. Student Name	sign.	Date
3. Student Name	sign.	Date

B. Approved By

1. Advisor Name	sign	Date
2. Co-Advisor Name	sign	Date
3. External Examiner's Name	sign	Date
4. Internal Examiner Name	sign.	Date
5. Chairperson Name	sign.	Date
6. Department Head	sign.	Date
7. School Dean	sign.	Date

Declaration

We, the undersigned hereby declare that the Project report entitled Tekrom construction management system is designed, written and submitted by us in partial fulfillment of the requirement for the award of the degree of Master of Information technology management is our original work. The empirical findings in this report are based on data collected by us through discussion with the project guide.

We understand that, any such copying is liable to us punishment in way the university authorities deem fit.

Name	ID	Signature
1. Akmel Denboba	**----------GSR/5289/06**	**----------**
2. Amir Hagos	**----------GSR/5291/06**	**----------**
3. **Kemal Gemedu**	**----------GSR/5303/06**	**----------**

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Last but not least ,we would like to thank our department. We really could face a real world problem in full confidence .We would like to pass our great gratitude to all our teachers and stream coordinator.

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List of Acronym and Abbreviations

BR ---------- Business Rule

CMS ----------Construction Management System

CPM ---------- Construction Project Management

CRC ---------- Class Responsibility Collaboration

EU ---------- Engineering Unit

ERD ---------- Entity Relationship Diagram

GB ---------- Giga Byte

GUI ---------- Graphical User Interface

RAM ---------- Random Access Memory

SQL ----------Structured Query Language

UC ----------Use Case

UML ----------Unified Modeling Language

SE ----------Site Engineer

SS ---------- Site Supervisor

EU ---------- Engineering Unit

PM ---------- Project Manager

OO ---------- Object Oriented

SDLC ---------- System Development life cycle

CASE- ----------Computer Aided System Design.

QA ---------- Quality Assurance

UI ----------User interface

HTML ---------- Hyper text mark-up language

CSS ---------- Cascading Style Sheet

HD ---------- Hard Disk

MS ---------- Microsoft

SW ---------- Software

HW---------- Hardware

PLC ---------- Private Limited Company

HQ ----------Head Quarter

CPU ---------- Central processing Unit

DBA ---------- Data Base Administrator

PY ---------- Person Years

N/A---------- Not Applicaable

AEC/FM---------- Architecture, Engineering,Construction, and Facility Management .

NIST ---------- National Institute of Standards and Technology

FSR ---------- Feasibility Study Reports

BIM ---------- Building Information Models

RDF ---------- Resource Description Framework

RFID ---------- Radio Frequency Identification

Abstract

In this project, we propose an Online Construction Project Management System. Construction is a multi-organizational process that is heavily dependant on exchange of large and complex data. Successful completion of a project depends on accuracy, effectiveness and timely Communication and exchange of critical information and data between the project teams . The need for effective information processing and exchange increases with the increasing degree of task-uncertainty, number of organizational units involved, and extent of interdependence among the units.

Despite an explosive growth of the Internet usage during the last seven years in many areas of business and commerce, the construction industry has not kept pace to the same degree. procedures for gathering construction project information as well as coordinating and communicating the information amongst all the stakeholders in the process are extremely bureaucratic, confusing and awfully time-consuming. The problem has been exacerbated by the increasingly complex and large nature of construction projects with a large number of participants. Most of the time there is a lack of a systematic approach and system that can effectively manage all information concerning construction projects to ensure a faster and more efficient and transparent process. This ultimately results in problems regarding project performance. e.g. extreme delays in construction, loss of information and increasing costs.

Implementing an online construction project administration system that can provide round the clock information about the project such as project status; directory of contractors, consultants; project drawings and specifications; project schedule and the facility to submit on-line change orders .By sharing information within the organizational units as well as among the participating organizations significant integration in construction processes can be achieved. This system also allows construction managers access specific project information in desired formats in an accurate, timely, and pertinent form from any where across the globe and this too at particularly any time.

Chapter One Introduction

The convergence of information services, communication and computing functionality in the Web technologies allows practitioners in construction to perform a Web-based project management over the Internet. A number of construction companies all over the world have adopted this technology either because they realized its competitive advantages or they are being forced by their clients to adopt it.

The on-line project administration systems can provide round the clock information about the project such as project status; directory of contractors, consultants, vendors and suppliers; project drawings and specifications; project control reports and the facility to submit on-line change orders. A number of construction companies are adopting such systems to facilitate better communication between the head office and the remote project sites, which could result in both time and cost-savings. The introduction of Web technology provided a way to make dispersed construction groups to work collaboratively together as an effective single team sharing pictures, documents, and real-time videos. Significant benefits could be realized by developing appropriate Web-based solutions and applying them correctly to construction industry problems. Construction firms and construction project site offices can be run more effectively and a greater cost-saving can be materialized with the use Web-based techniques.

The technology is maturing and getting more affordable day-by-day creating an unprecedented opportunity for effective project management in construction.

1.1 Background of the Organization

Techrom Construction Private Limited Company is A Category - II General Construction Company, established in 1998 in Addis Ababa, Ethiopia. The Company is registered under Ethiopian law and become among the giants in the field of construction of Building, Road, Real Estate, and Water works. Ever since its establishment the Company has successfully accomplished different construction works estimated at hundreds of millions of Birr for the Federal Government, Regional Governments and the Private sectors of Ethiopia. For instance building construction for Addis Abeba University, Adama University and Arsi University. In road construction Bale to Harer and Metu 90 km are some them. Backed by a strong management team and skilled man power that strive for the satisfaction of customers, currently the Company is undertaking a number of construction activities in different parts of the country. The Company is engaged in both building and road construction works.

1.2 Statement of the problem

Managers of construction programs in Tekrom construction plc face complex problems administering a wide range of activities .Construction management covers activities such as surveying, inspecting, quality control, documenting payment and related filed activities. As a result of the complexity of the work, there is a need for a comprehensive Contraction Management System (CMS) which can be adapted for use by the construction company.

Information Processing and the contract Administration functions in the current system of the engineering office in Tekrom construction is done almost all in manual system. The result of this situation leads the company for the following Problems:

- The department does not have a single, reliable system with which to manage all construction Project activities.Information is in multiple systems, including small desktop databases.
  In some cases, the most current data is contained in paper files with in the sites and are not easily accessible when required by headquarters or Site staff.
- Procedures for gathering construction project information as well as coordinating and communicating the information amongst all the stakeholders in the process are extremely bureaucratic, confusing and awfully time-consuming.
- Extreme delays in construction.
- Inappropriate costs - extending the planned schedule because of the problems mentiond above needs additional budget.
- Construction documents or Information may be loss .While construction documents are in process they may be lost before reaching the destination for different reasons or documents may disappear by carelessness.
- There is a gap between project plan and the result. This means most of the time there is a mismatch between the planned and the actual. This problem arises because of lack of good time management. The lack of good time management may affects the overall project process.

1.3 Objectives

1.3.1 General Objectives

The general objective of this project is to develop web based construction management system software for Engineering Unit of Tekrom construction.

1.3.2 Specific Objectives

In addition to the general objectives, we provide some specific objectives in the following manner:-

- To allows construction project team access specific project information in desired formats, in an accurate, timely, and pertinent form from anywhere.
- Automation of and increased access to critical construction information through reporting function
- providing an efficient central data facility through which to create and maintain goals, schedules, standards policies and procedures that are shared by all of those involved in the construction process
- To increase the efficiency of the overall construction programs
- To provide the user-friendliness in all possible ways.
- To store data in a centralized location to reduce redundancy and increase consistency.
- To enhance the planning and staffing work methods, monitoring and updating the system.
- To access project information from anywhere and at any time through the Internet.
- To make handling of data be cost effective, not prone to errors and delays caused in duplication.
- Protect the organization's data from unauthorized access.
- Host web-map to make project management easier and better.

1.4 Scope of the Project

The scope of the CMS business requirements phase of the project encompasses functions and processes under the purview of the Department's Division of Engineering, as follows:
Documentation of process descriptions, system flows and business requirements for the functions listed below :

1.Start-Up Activities

This functional area includes the following:

- Creating and Modifying Users
- Managing Resources
- Establishing Project

- Assigning Resources
- Tracking Submittals

2. Daily Diary / Inspection Process

This functional area includes the following:

- |Assigns inspection work
- Inspecting work
- Entering / Updating Diary into CMS
- Review Diary Report
- Daily Diary Reports

1.5 Limitations of the project

Due to time and budget constraints the project team determined detailed system requirements to be out of scope for this phase of the Project. These Includes:

- Quality Control / Quality Assurance (QC / QA)
- Contract Management and
- Payment Estimate

1.6 Significance of the project

Our proposed system has has got a big solution for the problems stated in statement of the problems section of this document. The purpose of the project is to develop a system which is user friendly, easy to use, maintain and satisfies all the requirements of the user. The project will support the organization in many ways. From those ways some of them are:-

- ✓ Online project management can speed construction by tightening the gap between time zones. For example, if head office worker in AA updates a document in the early evening, by the time he or she arrives in the office the next morning, a collaborator in Adama site may have already viewed it and posted comments.
- ✓ Allows construction managers access specific project information in desired formats in an accurate, timely, and pertinent form from anywhere
- ✓ The Project management System provides real-time cost data that helps the company's administrative bodies and workers make profitable decisions
- ✓ The Construction Management system provides a standardized method of managing jobs
- ✓ Provides a systematic method for documenting, tracking and following up on critical issues.
- ✓ Protect the organization's data from unauthorized access.
- ✓ Facilitate better communication between the head office and the remote project sites

1.7 Methodology

1.7.1 Method of Data Collection

1.7.1.1 Fact Finding Techniques

Fact finding is the formal process of using research, document analysis, interviews, questionnaires, and other techniques to collect information about systems, requirements, and preferences. It is also called gathering or data collection. Among those methods we used interview, observation and document analysis.

1.7.1.1.1 Interview

This is one of data collection method that enables to gather information from the organization directly by asking question and getting answers for those questions. So, we have used this method to gather information by asking both employees at Site and employees in the Head office.

1.7.1.1.2 Document Analysis

This is another data collection method that enables to gather information from the organization by directly looking the written document. Among those documents we have seen contract agreement document, check list document and a document which contains terms and their definition and interpretation, submittal.

1.7.1.1.3 Observation

This is also another data collecting method that seeks to find out what is actually done in order to Contrast it with what is documented and also helps to examine relationships between people in the organization. This method is done by observing and understanding how the contractor is managing construction works or related activities at the site as well as the head office. In fact we have also used this observation method to gather data.

1.7.2 System Development Methodology

A system development methodology refers to the framework that is used to structure, plan, and control the process of developing an information system. There are different types of system development

methodologies to develop information system; among these we select Object Oriented Analysis and Design system development method

1.7.2.1 Object-Oriented Systems Development Methodology

Object-oriented development offers a different model from the traditional software development approach, which is based on functions and procedures. In simplified terms, object-oriented systems development is a way to develop software by building self-contained modules or objects that can be easily replaced, modified, and reused.

1.7.2.1.1 Object Oriented Systems Development:

A Use-Case Driven Approach

The object-oriented software development life cycle (SDLC) consists of three macro processes: object-oriented analysis, object-oriented design, and object-oriented implementation. The use-case model can be employed throughout most activities of software development. Furthermore, by following the life cycle model of Jacobson, Ericsson, and Jacobson one can produce designs that are traceable across requirements, analysis, design, implementation, and testing (as shown in Figure 2.1). The main advantage is that all design decisions can be traced back directly to user requirements. Usage scenarios can become test scenarios. Object-oriented system development includes these activities:

- ☞ Object-oriented analysis-use case driven
- ☞ Object-oriented design
- ☞ Prototyping
- ☞ Component-based development
- ☞ Incremental testing

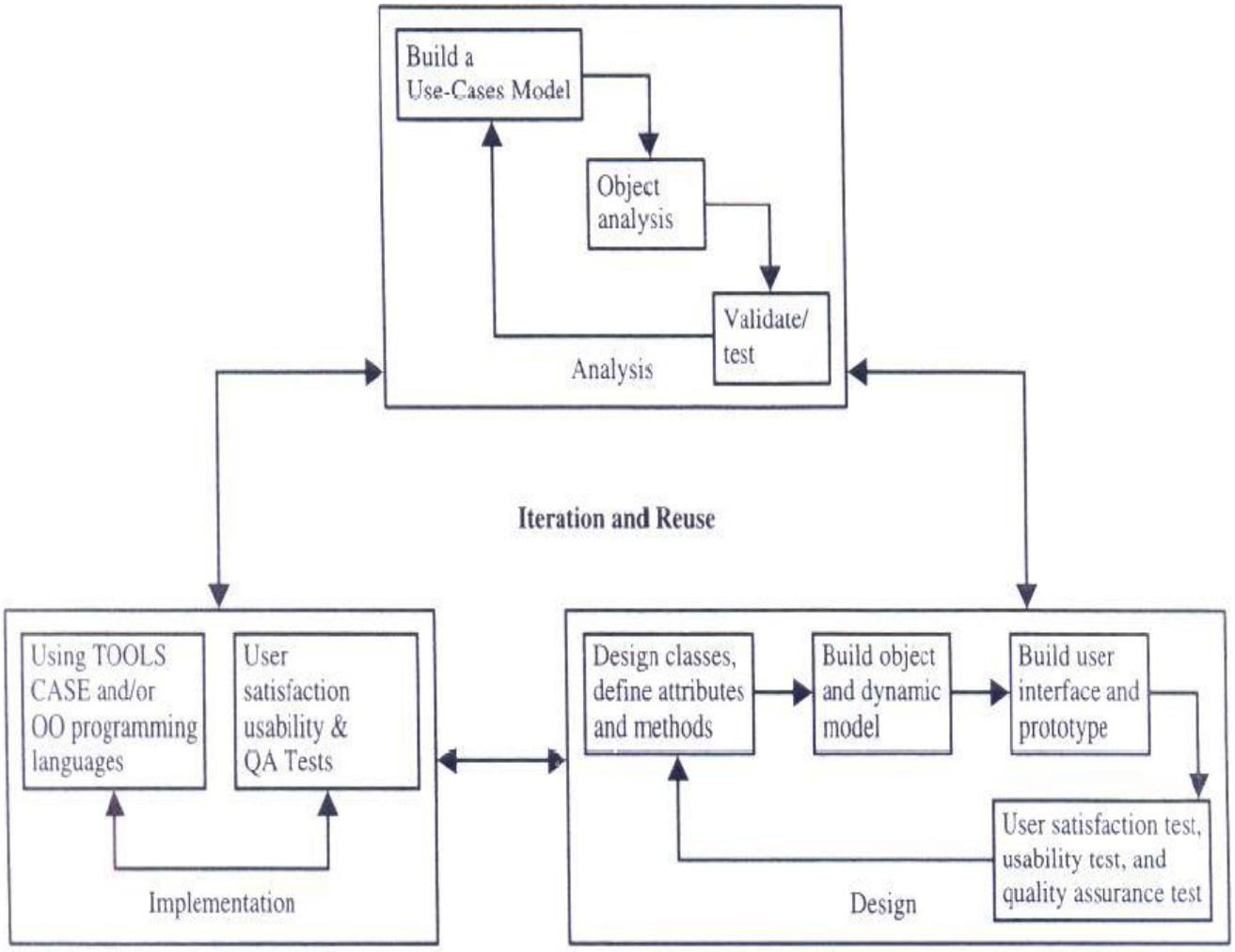


Figure 1: The object-oriented systems development approach.

1.8 System Development Tools

The hardware and software requirements of the system gong to develop are listed below;

⇨ Software:

- Platform :Win XP/7/8/server2003/2008
- Back-end (Used) : My SQL v5.1.36.
- Front-end (Used) : HTML, CSS, PHP v5.3.0, Java Script.
- Web Server : Apache Server v2.2.11.
- Development Tools :

- Adobe Photoshop CS3.
- Adobe Dreamweaver CS5.
- Wamp Server 2.0.
- Notepad ++

⇨ **Hardware:**

- PC with a Pentium IV-class processor, 600 MHz processor
  3.1 GHz processor with 2GB RAM or onwards Recommended.
- DVD/CD-R/RW

⇨ **Languages:**

- English repute

1.9 Feasibility Study

Much of the feasibility studies are included within the project group members and many ideas have been raised. As a result most of the ideas raised are taken as an appropriate option and the ideas mention the solution to the way we can go through our software (project). Among these most of the ways are studied under the following techniques.

1.9.1 Technical Feasibility

Technical feasibility centers on the existing manual system of the test management process and to what extent it can support the system. According to feasibility analysis procedure the technical feasibility of the system is analyzed and the technical requirements such as software facilities, procedure, inputs are identified. It is also one of the important phases of the system development activities.

The system offers greater levels of user friendliness combined with greater Processing speed. Therefore, the cost of maintenance can be reduced. Since, processing speed is very high and the work is reduced in the maintenance point of view management convince that the project is operationally feasible.

1.9.2 Operational Feasibility

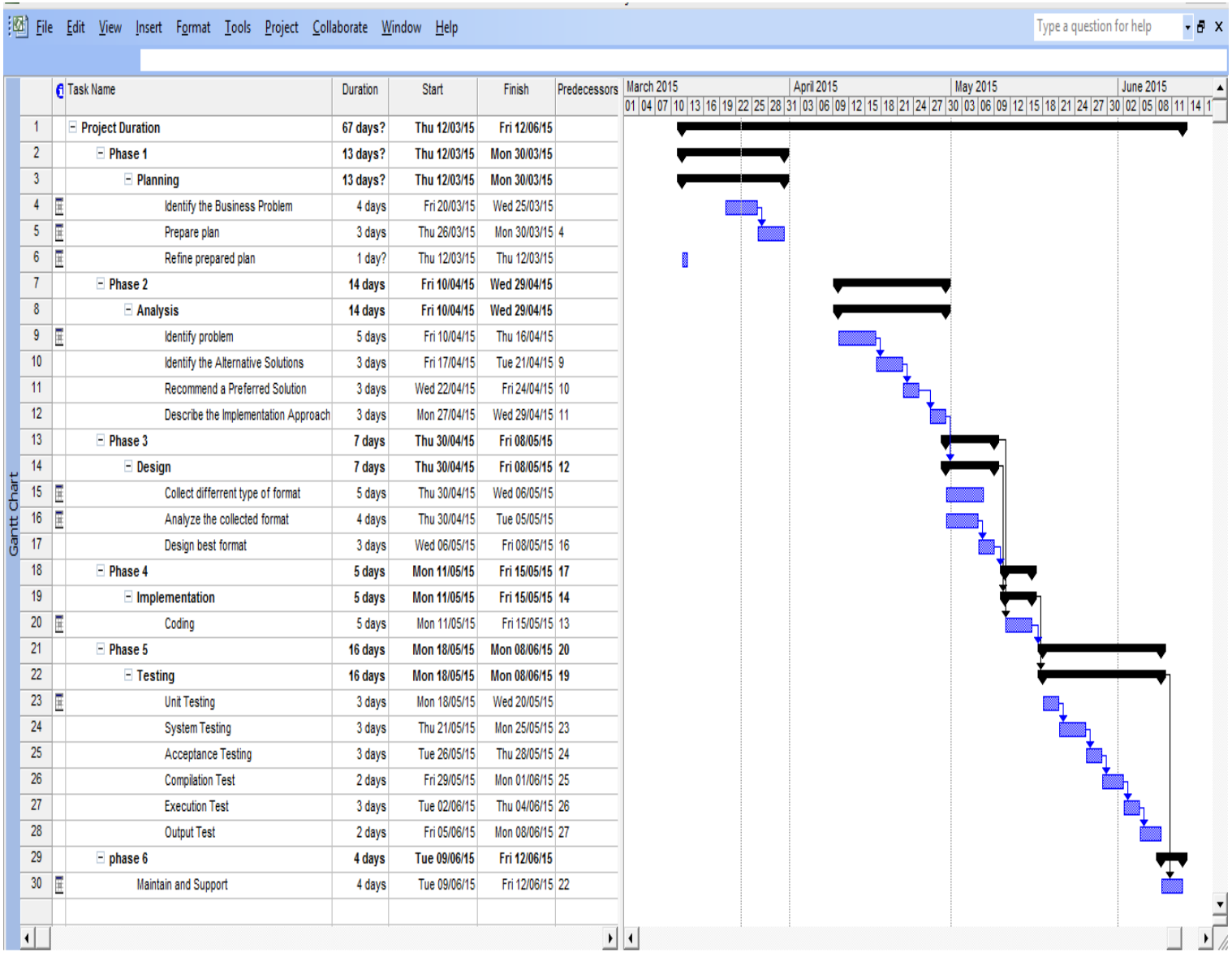
This test of feasibility checks if the system works with least difficulties when it is developed and installed. The technical staffs have sufficient knowledge of general computer skills and professional skills being used, and users need to get quality services within less cost, and our system will be easily manageable. The system also provides helpdesk for users. Hence it is concluded that the system is operationally feasible.

1.9.3 Economic Feasibility

Economic analysis is the most frequently used method for evaluating the effectiveness of a new system. More commonly it is known as cost/benefit analysis. The software used in this project is freeware so the cost of developing the tool is minimal. It requires very easy technique and minimal software. So it does not need much cost and software. So, it can be used in any environment.

1.9.4 Schedule Feasibility (using Gantt chart)

This involves questions such as how much time is available to build the new system, when it can be built (i.e. during holidays) interference with normal business operation etc. The schedule for this project is feasible due to rich information exchange between the organization (client) and the developing team. In addition to the time set to develop the system is enough to complete the project on time.



	Task Name	Duration	Start	Finish	Predecessors
1	**Project Duration**	**67 days?**	**Thu 12/03/15**	**Fri 12/06/15**	
2	**Phase 1**	**13 days?**	**Thu 12/03/15**	**Mon 30/03/15**	
3	**Planning**	**13 days?**	**Thu 12/03/15**	**Mon 30/03/15**	
4	Identify the Business Problem	4 days	Fri 20/03/15	Wed 25/03/15	
5	Prepare plan	3 days	Thu 26/03/15	Mon 30/03/15	4
6	Refine prepared plan	1 day?	Thu 12/03/15	Thu 12/03/15	
7	**Phase 2**	**14 days**	**Fri 10/04/15**	**Wed 29/04/15**	
8	**Analysis**	**14 days**	**Fri 10/04/15**	**Wed 29/04/15**	
9	Identify problem	5 days	Fri 10/04/15	Thu 16/04/15	
10	Identify the Alternative Solutions	3 days	Fri 17/04/15	Tue 21/04/15	9
11	Recommend a Preferred Solution	3 days	Wed 22/04/15	Fri 24/04/15	10
12	Describe the Implementation Approach	3 days	Mon 27/04/15	Wed 29/04/15	11
13	**Phase 3**	**7 days**	**Thu 30/04/15**	**Fri 08/05/15**	
14	**Design**	**7 days**	**Thu 30/04/15**	**Fri 08/05/15**	**12**
15	Collect differrent type of format	5 days	Thu 30/04/15	Wed 06/05/15	
16	Analyze the collected format	4 days	Thu 30/04/15	Tue 05/05/15	
17	Design best format	3 days	Wed 06/05/15	Fri 08/05/15	16
18	**Phase 4**	**5 days**	**Mon 11/05/15**	**Fri 15/05/15**	**17**
19	**Implementation**	**5 days**	**Mon 11/05/15**	**Fri 15/05/15**	**14**
20	Coding	5 days	Mon 11/05/15	Fri 15/05/15	13
21	**Phase 5**	**16 days**	**Mon 18/05/15**	**Mon 08/06/15**	**20**
22	**Testing**	**16 days**	**Mon 18/05/15**	**Mon 08/06/15**	**19**
23	Unit Testing	3 days	Mon 18/05/15	Wed 20/05/15	
24	System Testing	3 days	Thu 21/05/15	Mon 25/05/15	23
25	Acceptance Testing	3 days	Tue 26/05/15	Thu 28/05/15	24
26	Compilation Test	2 days	Fri 29/05/15	Mon 01/06/15	25
27	Execution Test	3 days	Tue 02/06/15	Thu 04/06/15	26
28	Output Test	2 days	Fri 05/06/15	Mon 08/06/15	27
29	**phase 6**	**4 days**	**Tue 09/06/15**	**Fri 12/06/15**	
30	Maintain and Support	4 days	Tue 09/06/15	Fri 12/06/15	22

Figure 2: Schedule for the project

1.10 Team role and responsibilities

Table 1: Team role and responsibilities

Project Title	Tekrom Construction management system	
Advisor	Ato Frezewd Lema and Ato Belayneh Mengistu	
Role	**Responsibilities**	**Coordinator**
Requirement Gathering	✓ Work with the project manager, product manager, and/or project sponsor to document the product's vision and the project's scope. ✓ Identify project stakeholders and user classes. ✓ Elicit requirements using interviews, document analysis, site visits, business process descriptions etc..	**Akmel Denboba**
System Design	✓ Work with analysts on the feasibility of a conceptual design by taking technical specifications prepared by the analyst and designing system components to meet the set requirements. ✓ Talk with other team members (analysts and programmers) to ensure functionality according to systems specifications, and develop solutions as problems or issues arise.	**Kemal Gemedu**
Implementation	✓ Analyze objectives and problems specified by analysts and/or designers.	**Amir Hagos**

	✓ Translate the solutions provided by systems designers into detailed program specifications ✓ Prepare documentation for other programmers, users of the system and other support services workers ✓ Undertake program design activities including definition of data and error message arrangements ✓ Modify and document program code to correct errors or to enhance a program's capabilities. ✓ Test the programs and make amendments.	
Testing	✓ Identifying the most appropriate implementation approach for a given test. ✓ Implementing individual tests. ✓ Setting up and executing the tests. ✓ Logging outcomes and verifying test execution. ✓ Analyzing and recovering from execution errors.	**Akmel Denboba**
Maintenance	✓ Review and approve maintenance and repair policies and procedures. ✓ Manage availability and performance of application software. ✓ Install Software maintenance releases and software upgrades, unless otherwise mutually agreed by the	**Amir Hagos and kemal Gemedu**

	parties. ✓ Perform routine application management, including application tuning, bug fixes, answer inquiries into functions and tools. ✓ Coordinate with managed other group member to perform application maintenance Services, including application tuning, bug fixes, and answer inquiries into functions and tools. ✓ Manage availability and performance of application Software. ✓ Provide critical procedures and scheduling choices during crisis times caused by abnormal conditions.	

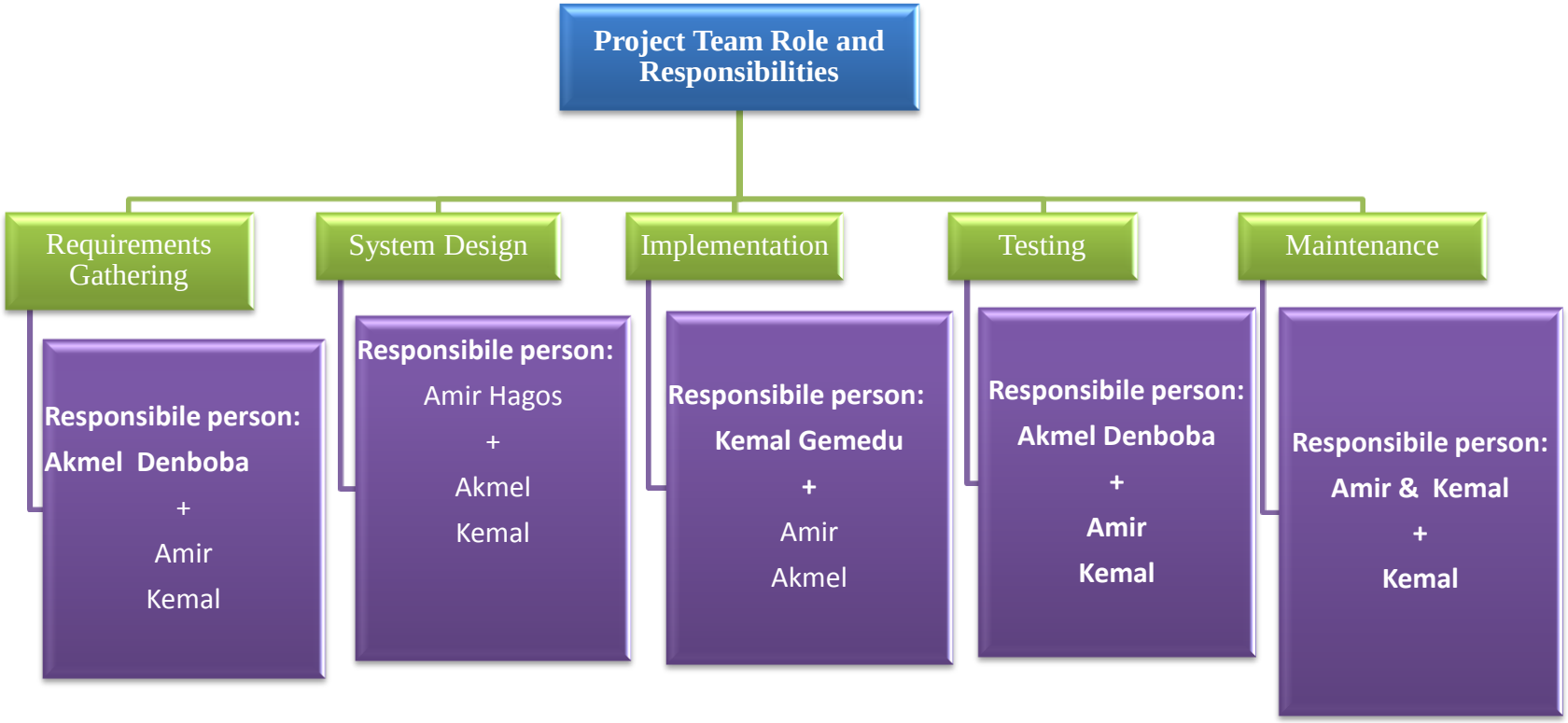


Figure 3: Team role and responsibilities

Chapter Two Literature Review

2.1 Introduction

Due to deep changes in technology, demographics, business, the economy, and the world, we are entering a new age where people participate in the economy like never before. A new business rule for competitiveness is to “collaborate or perish” .

To prolong the network lifetime of a WSN there are two possible directions, the first option is energy harvesting.According to an industrial survey on the Canadian construction IT industry , “the most frequently identified issue is related to collaboration (including communications,document manageme nt, and interoperability).” It is considered to be the most important“opportunity for improvement to the Canadian construction industry.” From the same survey on a question related to “the trends in information technology that will be important for the construction industry over the next 10 years”, the strongest response was for “Web-based collaboration and project management systems” (67%) followed by “integration of software tools across the project lifecycle” (43%).

Because of the complexity of the construction industry, the multiple phases of the construction project life-cycle, and the involvement of multidisciplinary teams (including owners, architects, consultants, engineers, contractors, sub-contractors, and suppliers) using various heterogeneous systems, systems integration becomes an important and imperative step to achieve efficient and effective collaboration. In fact, systems integration is all about interoperability. Under the context of this paper, interoperability refers to the ability of diverse software and hardware systems to manage and communicate electronic product and project data smoothly. Interoperability problems in the capital facilities industry stem from the highly fragmented nature of the industry and are further compounded by the large number of small companies that have not yet adopted advanced information technologies .

Systems integration and collaboration are not new research topics. With the rapid advancement of information and communication technologies, particularly Internet and Web-based technologies during the past 15 years, various systems integration and collaboration technologies have been developed and deployed to different application domains, including architecture, engineering, construction, and facility management (AEC/FM). After many years of R&D, the AEC industry has now started to embrace and adopt software systems that support and promote the concepts of integration and interoperability .

However, due to the unique nature of the construction sector, the development and deployment of

systems integration and collaboration technologies in AEC/FM are somewhat behind other sectors (e.g., manufacturing sector). This paper provides a research literature review on systems integration and collaboration in AEC/FM, and discusses challenging research issues and future research opportunities. The rest of the paper is organized as follows: Section 2 briefly describes the current problems and requirements on systems integration and collaboration in AEC/FM; Section 3 discusses challenging research issues and the current state-of-the-art; Section 4 reviews related standards and commercial tools; Section 5 presents major international initiatives, programs, and projects; Section 6 identifies future research opportunities; Section 7 provides some brief concluding remarks.

2.2 Current Problems and Requirements

The US National Institute of Standards and Technology (NIST) published a study that identified and estimated the efficiency losses of $15.8 billion in 2002 in the US capital facilities industry resulting from inadequate interoperability among computer-aided design, engineering, and software systems. Of these costs, two-thirds are born by owners and operators, which incur these costs predominantly during ongoing facility operation and maintenance.

According to FIATECH , some major problems on systems interoperability in the construction industry include (paraphased based on):

- It is difficult to access to accurate data, information, and knowledge in a timely manner in every phase of the construction project lifecycle.
- There is a lack of interoperability between systems, with several standards competing for managing data. A common methodology for managing a project's information assets does not exist.
- Tools for project planning and enterprise management are maturing, but an integrated and scaleable solution that delivers all needed functionality for any kind of project is not available.
- The ability to assess uncertainties, risks, and impacts of failures is not mature, partly due to the lack of knowledge to support evaluations, and partly due to the limitations of available tools.

In order to address these problems, FIATECH has created a roadmap (partcilarly its Element 6) to integrate all functions of a project/facility planning and management system and all required information in a unified project/facility management environment . The Roadmap presents a vision for the capital projects industry and a strategy and plan for achieving that vision: “a highly automated project and facility management environment integrated across all phases of the facility lifecycle.” .

2.3 Challenging Research Issues and State-of-the-Art

The very basic idea for integrating two or more software systems is to enable them to communicate, share or exchange information, and then to inter-operate in order to achieve a common objective. In this section, we first discuss the systems interoperability from two different perspectives: data interoperability and frameworks interoperability. Then we review some challenging research issues and related state-of-the-art technologies in this area.

2.3.1 Interoperability

2.3.1.1 Data interoperability: data modeling and integration

Data interoperability is the ability that data generated by any one party can be properly interpreted by all other parties. It is the first step towards any systems integration and optimization. The enabling technology for data interoperability is data modeling. In the construction industry, data models are called building information models (BIMs). Various data models can be classified as either proprietary, developed and controlled by individual vendors, or neutral (open), developed by a consortium of efforts and available to all.

As a building project typically involves a number of software tools from different vendors to carry out specific tasks by individual parties, e.g., to create the design and structural frame of the building, or the analysis of the structural strength of the building, etc., the demand to share data/information among the project parties has increased. Sharing data in such a multi-party heterogeneous environment requires all parties to have a common data model so that each party knows how to generate and interpret the data created by any party among them. A common neutral model enables data sharing or integration in heterogeneous applications. Then it is possible for building information to be created once and used many times.

2.3.2 Systems integration approaches

2.3.2.1 Web-based systems

The World Wide Web was originally developed to allow information sharing within internationally dispersed teams and the dissemination of information by support groups. It uses a centralized information integration approach through a shared Web server or a database behind the Web server. It is currently the most advanced information system deployed on the Internet .

According to the industrial survey on the Canadian construction IT industry , about half (49%)

of the construction IT tools developed in Canada use Web-based systems as their implementation technology.

In fact, a number of commercial Web-based software systems have been made available and used by many construction companies. There is no need for doing advanced research in this area. While there were many publications on Web-based collaboration systems in the 1990s, a paper reporting Web-based system development is not publishable these days.A simple Web-based system may be adequate for daily construction project management, but it is not sufficient to meet the requirements described above.

2.3.2.2 Distributed objects / components

An Object-oriented programming paradigm can be traced back to the 1960s and has been popular for about two decades. It emphasizes programming efficiency by stressing modularity of data structures and code sharing. It also uses a centralized integration approach. It has been widely used for the implementation of integrated systems, particularly after the development and deployment of three major Distributed Objects standards: CORBA by the Object Management Group (OMG), COM/DCOM by Microsoft and Java RMI. In fact, most of the so-called agent-based systems are implemented using Distributed Object technologies.

This section provides a review of some recent projects on the application of distributed object technologies in AEC/FM.

- Faraj and Alshawi presented an object-oriented implementation of a rapid prototyping environment called SPACE (Simultaneous Prototyping for an Integrated Construction Environment) which supports a subset of a construction project lifecycle. It integrated a number of commercial software packages including AutoCAD/AEC (for design), World Tool Kit (for visualization in virtual reality), and Super Project Expert (for planning) as well as several other applications developed in-house. A centralized (modularized) project model is used to connect all these applications.
- Halfawy and Froese proposed to build integrated AEC systems using smart objects. In the proposed approach, smart objects are 3D parametric entities that combine the capability to represent various aspects of project information required to support multidisciplinary views of the objects, and the capability to encapsulate “intelligence” by representing behavioral aspects, design constraints, and lifecycle data management features into the objects. In fact, the smart object concept is similar to the software agent concept discussed in the next subsection.

2.3.2.3 Software agents

Software agent technology was applied to systems integration and collaboration before the Web became available . Parunak has analyzed where agent technology can be best used in industrial applications: “agents are best suited for applications that are modular, decentralized, changeable, ill-structured, and complex”. The reasons often given for adopting an agent approach are linked to their being proactive object systems and to the simplification of the architecture of the software systems. In addition, agents can cope with a dynamically changing world by performing dynamic linking, allows them to handle ill-structured or rapidly changing situations in a more economical way . This section provides a brief review of recent projects on the application of agent technology for systems integration in AEC/FM.

- Bilek and Hartmann presented an agent-based approach to support complex structural design processes in AEC. The proposed workbench aims at assisting design experts according to their specific tasks during project work and furthermore detecting typical deficiencies and conflicts that may occur in collaboration, cooperation and coordination between different structural designers. The workbench consists of a set of software agents that are designed and modeled to integrate typical organizational characteristics of a project, engineering software and data structures in terms of product models. Three agent-based models were proposed: the agent-based collaboration model, the agent-based engineering software integration model, and the agent-based product model, which are connected by an agent-based process model. The proposed approach was validated through the analysis of the design process of an arched bridge which was already built.

- Wing presented some recent research on the application of software agents together with RFID (Radio Frequency Identification) technology in construction. Wing argued that, since software agents need to make autonomous decisions and take necessary action when required, they are totally dependent upon sensors (rather than human intervention) to provide real-time information on parameters such as location, condition and timing: RFID tags are seen as an appropriate sensor type for providing this kind of information. Although there is little evidence presently of RFID adoption in the wider construction sector, the paper concludes that a breakthrough will result from applications that emphasize the management of the building or facility, in particular energy consumption.

2.3.2.4 Web services and Semantic Web

The basic Web servers are passive, i.e., they only reply to requests from users, rather than actively or proactively send data/information to users or other servers. Neither do they cooperate or coordinate. The Web service technology officially proposed by W3C in 2002 is meant to address these shortcomings. In fact, it is very similar to the concept of Active and Proactive Web Servers that we proposed in 2000 . By their definitions, a Web Server is "a software system designed to support interoperable machine-to-machine interaction over a network" and a Semantic Web is "an evolving extension of the Web in which Web content can be expressed not only in natural language, but also in a format that can be read and used by software agents" .
Even though Web Services and Semantic Web have been widely used in systems integration and collaboration in other domains (particularly in e-business applications), very few reported results have been found in AEC/FM, though we strongly believe there will be widespread application of the technology in AEC/FM in the foreseeable future.

- Schevers et al. reported the application of the Semantic Web technology, particularly the Resource Description Framework (RDF) and the Web Ontology Language (OWL) to the implementation of a digital facility model for Sydney Opera House.
- El-Diraby et al. presented a domain specific taxonomy for construction management. The taxonomy is based on the IFC and several other classification systems. It classifies construction concepts in six main classes: Project, Process, Product, Actor, Resource, Technical Topics, and Systems. A prototype ontology was developed using OWL for the construction domain based on a taxonomy of relationships and a set of axioms.

2.3.3 Collaboration Technologies

2.3.3.1 Web-based collaboration

As mentioned above in Section 3.2.1, the Web was originally designed for information sharing and collaboration. It is natural to develop and use Web-based tools to facilitate collaboration in AEC/FM. The Web-based systems mentioned in Section 3.2.1 are mostly for construction project documents sharing and collaborative project management.

2.3.3.2 Agent-based collaboration

Software agents are usually used to facilitate collaboration or interoperation among software systems, but they can also be applied to facilitate communication and collaboration among software system users , organizations , and hardware systems.

- Lee and Bernold proposed agent-mediated communication to overcome the problem of information overload during a construction project.
- Zhang and Hammad presented an interesting approach based on software agents to coordinate crane operations where two cranes are working together, where software agents are used to dynamically control the kinematical actions of the two cranes respecting the functional constraints for safety and efficiency of operations.

2.3.3.3 Collaborative virtual environments

Rosenman et al. presented a framework for collaborating in a virtual environment including a database, based on IFCs, containing the various models and relationships between them; a virtual world environment for collaboration and an agent-based society for handling the communication between the users, the virtual world and the database.
Aspin proposed an interaction mechanism that enables a group of co-located users sharing a common visualization to collaboratively interact with the visual environment through the use of light-weight personal computing devices operating as bidirectional remote interfaces. Applying an object-based distributed shared memory (DSM) system enables the description of the active session to be distributed to both the collection of services, forming the design/review session configuration, and the remote interface applications that support individual user interaction. This distributed system then forms a synchronized, distributed description of the session content that both informs services of the session content and provides a centralized system for managing user interaction.

2.3.4 Change management

The common operational practice of the construction industry is project-based. A general construction project starts from planning, cost estimation, bidding, contracting, to architect, detail design and engineering, down to the actual building construction phases and the final project delivery stage. During a construction project, many decisions often have to be made based on

incomplete information, assumptions and personal experience of the construction professionals. Currently, project changes or adjustments are a fact of life at all stages of design and construction. In an EPSRC (Engineering and Physical Sciences Research Council, U.K.) report , it states that "the clients' dissatisfaction is due to the fact that over 50% of construction projects suffer from delays and over-spending, while more than 30% of the completed projects have quality defects. Furthermore, some 30% of construction is rework."

Changes in construction projects are very common and likely to occur from different sources, by various causes, at any stage of a project, and may have considerable negative impacts . Most researchers distinguish two kinds of changes: rework and change order . Rework refers to re-doing a process or activity that was incorrectly implemented in the first place and is generally caused by quality defects, variance, negligence, and poor design and on-site management. Rework is usually pure waste and can be improved by an effective change management practice.

The impact of changes to a construction project needs to be evaluated case by case in order to assist with the decision making process. In general, upper-stream changes have larger impacts. Lu and Issa believe that the most frequent and most costly changes are often related to design, such as design changes and design errors.

A large quantity of research work in change management is carried out in the generic project management domain. However, there is some limited research work addressing change management issues specifically in the construction project management context.

- Sun et al. designed a change management toolkit for construction projects that includes a change dependency framework, a change prediction tool, a workflow tool, and a knowledge management guide.
- Web-based integration and collaboration approaches. Lottaz et al. proposed using constraint satisfaction techniques to express possibly large families of acceptable solutions in order to facilitate and abbreviate the collaboration and negotiation processes, ultimately to improve the change management and the productivity during phases of design and construction. By combining Web services and intelligent agents, collaborative workflow technologies can be used to handle dynamic and complex business processes on the Web and can be applied to construction project management systems for effective and flexible change management..

2.4 Standards and Commercial Tools

2.4.1 Standards for interoperability

In the past 15 years, due to the large number of multidisciplinary partners involved in a building project, the AEC industry has been actively developing international and industrial standards. Some of the standards developed are for the design and specification of buildings. Some are for the interoperability between a specific industry with the AEC industry such as the structural steel industry and the pre-cast concrete industry. Many of these standards share a common technology base with the international standard ISO 10303, Standard for the Exchange of Product Model Data (STEP). This section provides an overview of the two major standards in this area.

The Industry Foundation Class (IFC)

The IFC has been developed by the International Alliance for Interoperability (IAI) since 1994. Its latest release is IFC 2x3. The IFC 2x release has also introduced the ifcXML specification by using XML schema to define the IFC models in parallel with EXPRESS. The target application of this standard is to provide a comprehensive description of the building and the construction site. It will be mainly used by architects to communicate the conceptual and detail design of a building to various partners.

Implementations of IFC have been reported in various construction IT system integration projects.

CIM Steel Integration Standards (CIS/2)

CIS/2 is a multi-part industrial standard for the exchange of engineering information of a steel framed building. It supports the analysis, design and detailing of the steel frame as well as the transfer of the resulting design information to the shop fabrication. Its latest release, CIS/2.1, was released in 2003. The data model of CIS/2 is called Logical Product Model (LPM). The latest release of this model is LPM/6 which has achieved full harmonization with STEP. LPM/6 is defined in EXPRESS. It aligns with the STEP Generic Resources and the STEP AP225.

2.5 Major Efforts / Programs / Projects

There have been some major international initiatives / programs / projects in the subject matters. We will provide an overview of two major initiatives: FIATECH in North America and ECTP in Europe. We will also briefly review the Lean Construction initiative which is considered to be relevant to the scope of this paper.

Large-scale initiatives / programs / projects have also been carried out by research organizations and universities in several other countries such as Australia , UK , France , and Finland .

2.5.1 Construction Industry Institute (CII) and FIATECH

The Construction Industry Institute (CII) , based at The University of Texas at Austin, is a consortium of more than 100 leading owner, engineering-contractor and supplier firms from both the public and private sectors in North America. These organizations have joined together to enhance the business effectiveness and sustainability of the capital facility life cycle through joint research, related initiatives and industry alliances. Because of the strong involvement of more than 30 leading U.S. universities in collaboration with industrial partners, CII R&D projects have made important contributions to academic research literature through a large amount of published reports and to the construction industry through best practices. At the time of writing this paper, CII members have completed about 120 joint projects and are working on 15 ongoing projects. FIATECH (Fully Integrated and Automated TECHnology) is a spin-off organization (or a subunit) of the Construction Industry Institute (CII). It was formed in 1998 based on a CII project called Fully Integrated and Automated Project Process (FIAPP). At the time of writing this paper, FIATECH members have completed 9 joint projects and are working on 9 active projects. The most important FIATECH project is the Capital Projects Technology Roadmap (CPTR) which is a cooperative effort of associations, consortia, government agencies, and industry.

2.5.2 European Construction Roadmap Projects

There have been a number of construction technology roadmap projects within the European Union. The most recent one is ECTP – the European Construction Technology Platform project. It is “an initiative to mobilise the whole construction sector – contractors, authorities, architects and other designers, purchasing bodies, and the full range of suppliers, clients and users – to arrive at a clear set of common priorities” .

From its strategic research agenda, the Priority H on “New Integrated Processes for the Construction Sector” is specifically related to the scope of this survey. ECTP considers “process renewal, supported by ICT, as one of the main vehicles towards the vision of the ECTP.” Our understanding of this “process renewal” is that it is focussed on the innovation of construction process technologies. In fact, the majority of the 8 items proposed under the ECTP Priority H are

highly related to the scope of this survey, particularly interoperability and collaboration support.

2.6 Future Research Opportunities

Based on detailed analysis of the research literature and the current construction IT industry, as well as our experience on systems integration and collaboration in manufacturing, we believe research opportunities exist in the following areas:

- Integration of multiple wired and wireless sensor networks for real time information collection in order to support decision making processes in construction sites for real time project management (including dynamic scheduling) and during the operation and maintenance of built facilities for intelligent real time facility management.
- Development of a systems integration and collaboration framework for the AEC/FM industry with emerging implementation technologies like software agents and Web services and leading industrial standards like IFC, ISO 15926, and CIS/2, with further extension of ontology-based integration (including Semantic Web).
- Global optimization over the entire project lifecycle, particularly considering all direct costs (design, materials, pre-fabrication and transportation, labor, equipment, etc.) and indirect costs (overheads, financial loss caused by delayed completion, facility operation and maintenance after completion, etc.). It may be particularly interesting to apply global optimization to Green building projects.
- Change management during the construction phase, with a focus on change impact analysis, dynamic scheduling adjustment, collaboration and coordination among partners including owners, architects, engineers, contractors, and suppliers.
- Proactive project information systems in order to efficiently disseminate the information from planning and analysis to project managers and users in the field.
- Computer-supported human-centered collaboration including user modeling, intelligent user interfaces and assistance.
- Project information access control, information security and privacy.

2.7 Concluding Remarks

Systems integration and collaboration are believed to be the key enabling technologies to help the construction industry to improve productivity and efficiency. This paper provides a state-of-the-art survey of these technologies and some applications in this area. Based on the research literature review and industrial requirement analyses as well as our own experience in the related areas, research opportunities are identified.

According to the Canadian construction IT industrial survey , the biggest barrier for construction IT development is related to the acceptance of new technologies by the industry. On the other hand, as pointed out by Tapscott and Williams , and mentioned earlier, a new business rule in the 21st century is to "collaborate or perish". In order to remain competitive and to survive in the increasingly competitive global market, many companies must change the way they do business, adopt new technologies and collaborate with others.

FIATECH-CPTR and ECTP provide a great vision and comprehensive roadmaps for the future of the construction IT industry. Even though it is believed to be difficult, a collaborative network (or virtual organization) of the construction industry (including owners, operators, architects, design, engineering, constructors, and suppliers), academia (including universities and research organizations) and government agencies, may be the way to success.

Chapter Three Requirement Analysis

3.1 Description of the Existing System

The Engineering Department in Tekrom Construction PLC is responsible for overseeing the construction of all capital outlay and major maintenance projects undertaken. Within this structure , the headquarters construction program and Site construction divisions work with external Contractors when needed in building and road construction works.

In Tekrom Construction Management is very crucial and complex activity; because, it contains different sub components such as project quality assurance management, contract management, project time management and project material management are some of them. The system involves three types of actors. These are Client, Consultant (advisor) and Contractor.

The manual way of data handling and running up of the activities is time and human power consuming, resource wasting and boring one.

3.2 Structure of the existing system

There are many types of construction superintendents and their job titles, job descriptions, and responsibilities vary a great deal from one company to another. This can be confusing, and there are no hard and fast rules or definitions which apply to all construction firms, all construction projects, or all supervisory positions. The specific sequence of job titles in Tekrom construction is indicated below.

The Project Manager is the contractor's representative at a construction site. The project Manager directs and coordinates the activities of the various trade groups such as carpenters, equipment operators, iron workers on site, Prepare contracts and negotiate changes to contracts with architects, consultants, clients, suppliers, and subcontractors . Responsibilities include making sure that the work progresses according to schedule, that material and equipment are delivered to the site on time, and that the activities of the various workers do not interfere with one another.

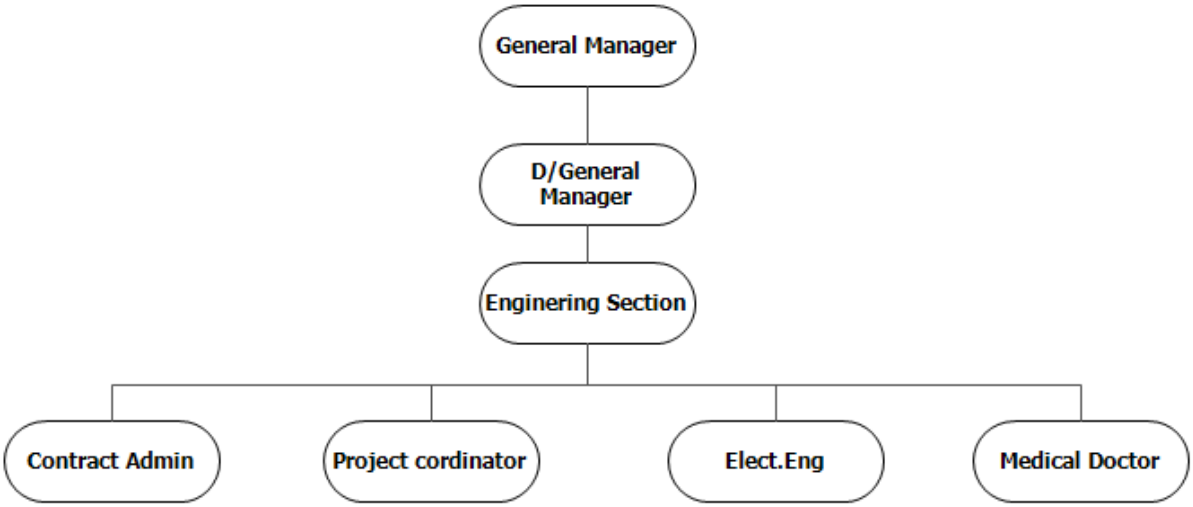
The project Manager supervises all these activities by talking with and directing the foremen for the different trades or craft workers. Some of these foremen and their workers may be employed by the project Manager, while others may be employed by other companies working on the job.

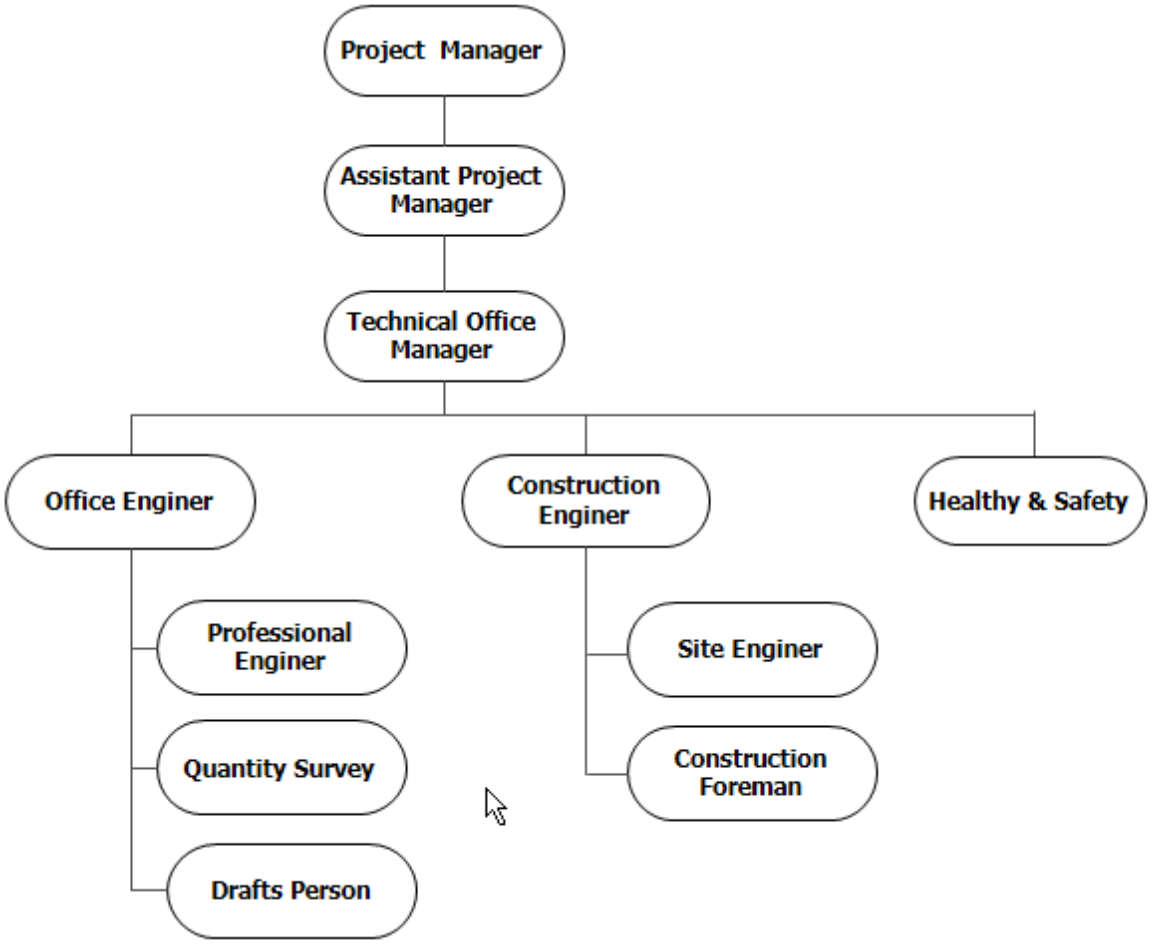
The General Manager may have duties similar to the project manager mentioned above, but with an even broader range of responsibilities. A general manager might direct the work on a number of construction sites with those superintendents reporting to him. A constriction manager is another construction occupation title for a position which again may overlap and, on occasion, be used interchangeably with project manager.

Site Engineer plan, organize, and direct the activities of a construction project, under the direction of a general manager .He has to adhere to the design document, quality of work, prepare diary reports for project manager, the schedule, safety of the people, costs and more over to satisfy the consultant at a personal level . He works on-site most of the time, looking after the day-to-day responsibilities of the project.

The Forman Places orders, receives and distributes materials to specified sections for future work. He recommends repairs, supervises the maintenance of tools and equipment and determines work procedures. He also responsible to review the work of skilled trade's workers and equipment operators and prepare reports on project time, equipment, materials and progress including project cost expenditures and balances.

Figure 4: Structure of existing system at Head Quarter and project site respectively:





3.3 Proposed system

3.3.1 Overview

After a thorough investigation of the current working system, we need able to identify the critical problems clearly observed (that was explained in the limitation of the existing system in the proposal). Therefore, in order to solve these problems we have established a new system that would benefit the organization in doing so.

The major benefit that the new proposed system would provide is: -

- ✓ The system allow information sharing within dispersed teams and the dissemination of information by support groups. It uses a centralized information integration approach through a shared Web server or a database behind the Web server.
- ✓ Improve team communication, collaboration and decision-making through the increased transparency in the management process.
- ✓ Allows construction managers or project team access specific project information in desired formats in an accurate, timely, and pertinent form from anywhere
- ✓ Provides real-time cost data that helps the company's administrative bodies and workers make profitable decisions
- ✓ User-friendly error messages are provided wherever necessary.
- ✓ Standardized method of managing jobs
- ✓ Addition, deletion, modification of records as when needed.
- ✓ Systematic method for documenting, tracking and following up on critical issues.
- ✓ User has complete control as it provides and accept only appropriate and valid data.
- ✓ Protect the organization's data from unauthorized access
- ✓ System design in modular and structured way so as to make the integration with other subsystems easier.

3.3.2 System Requirements

3.3.2.1 Functional Requirements

A functional requirement specifies what the system should do:

"A requirement specifies a function that a system or component must be able to perform."

After building the CMS for Tekrom the system performs the following user functional requirements: This includes:

- **Manage Resource**

- ✓ Add employee: should let the project manager to add employee.
- ✓ Edit employee: should let the project manager to edit employee.
- ✓ Add material: should let the project manager to add material.
- ✓ Edit material: should let the project manager to edit material.

- **Monitor schedule**
  - ✓ Add schedule: should let the project manager to add schedule.
  - ✓ Edit schedule: should let the project manager to edit schedule.
- **Deal with progress**
  - ✓ Add current progress: should let the project manager to add current progress.
  - ✓ Edit current progress: should let the project manager to edit current progress.
  - ✓ Remove current progress: should let the project manager to remove current progress.
- **Start the project**
  - ✓ Add project: should let the project manager to add project.
  - ✓ Edit project: should let the project manager to edit project.
- **Review SE inspection report**
  - ✓ View site engineer inspection: should let the project manager to view SE inspection report.
- **Perform Inspection.**
  - ✓ Add inspection: should let the site engineer to add inspection.
  - ✓ Edit inspection: should let the site engineer to edit inspection.
- **Review Forman daily diary**
  - ✓ View Forman daily diary: should let the site engineer to view Forman daily diary.
- **Control daily diary**
  - ✓ Add daily diary: should let the Forman to add daily diary.
  - ✓ Edit daily diary: should let the Forman to edit daily diary.
- **Manage User**
  - ✓ Add user: should let the database administrator to add user.
  - ✓ Edit user: should let the database administrator to edit user.
- **View report of Project manager**
  - ✓ View schedule: should let the contractor to view schedule.
  - ✓ View employee: should let the contractor to view employee.
  - ✓ View project: should let the contractor to view project.
- **View report of Site engineer**
  - ✓ View inspection: should let the contractor to view inspection.

- ✓ View inspection: should let the consultant to view inspection.

3.3.2.2 Non-Functional Requirements

The non functional requirement concerned with the system that must be carried out in addition to functional requirements stated. These requirements include user interface and human factors, documentation, hardware consideration, performance characteristics, error handling and extreme conditions, quality issues, system modifications, security issue, resource issue, . They are describing as follows:

3.3.2.2.1 User interface and human factors

The system will have consistent interface formats and button sets for all forms. It will have a form based interface for all data entry and viewing formats, and it will generate reports that are formatted in a table for user friendliness. Because of these the system can be easily accessible by any type of user. This means, the user can be expert, intermediate or novice which means there are more than one type of user that will be using the system. It is better to include some basic instructions to assist users who are not very familiar and use to the system.
User Interfaces: - the system will be accessed through an internet browser. No user would be able to access any part of the system without logging in to the system.

3.3.2.2.2 Documentation

The system will be documented, which includes system documentation and user manual. The system documentation is important because this may help in further development of the system and the user manual is necessary because the user may need some basic training or help about the functionality of the system.

3.3.2.2.3 Hardware consideration

In this system, the hardware considerations are very important in order to achieve the systems goal and objectives.
The following sub-sections discuss the various aspects of hardware requirements.

- Processing power
  - ✓ Intel(R) core™i3 CPU 550@3.20GHz

- Memory & Secondary storage
  - ✓ RAM: 2GB and above
  - ✓ 250GB or above Hard-disk: and swap space (if RAM is insufficient).
- Peripherals
  - ✓ CD-ROM drives.

3.3.2.2.4 Performance characteristics

The system runs where an internet connection is available. Any users on different computers can access the system at the same time without any problem. It should be able to respond to the queries submitted by the user without much delay. Most of the requests sent to the system should be answered in less than 30 second.

3.3.2.2.5 Error handling and extreme conditions

The system shall be an integrated system to trap errors. It should be able to respond descriptive error messages. Appropriate error message will be displayed when an unexpected input such as incorrect user name and/or password are encountered. Example: when the expected input is string the user, will not be able to provide numerical values.

3.3.2.2.6 System modification

System modifications refer the ability to add new functionality without requiring major changes to the existing code. The event management system should be extensible in the sense that new features can be easily added or plugged-in without any significant changes to the existing system.

3.3.2.2.7 Security issues

Security requirements are important factors in this system as classified data will be stored in the database. User validation will be done during login to ensure that the user is valid and that the user only has access to his or her permission data. General users will only have access through the user interface.

3.3.2.2.8 Resource issues

- ✓ Desktop /laptop computers.
- ✓ Uninterrupted power supply.
- ✓ Internet connection
- ✓ Database server computers and web server computers.
- ✓ Network devices, etc.

3.3.2.2.9 Supportability

The system needs to be portable on all major platforms that support an internet browser. So, the system should not be restricted by any specific technology. There should always be alternative environment.

3.4 Analysis Activities

3.4.1 Use Cases

A use case provides one or more scenarios that convey how a system should interact with users, called actors, to achieve a specific business goal or function. In this document the use cases are broken down by functional area then by specific process. Each use case includes the following sections:

- Brief Description
  - This section describes what activity is covered by the use case.
- Actors
  - Define a particular role utilized within the use case.
  - Provide role definitions and descriptions.
- Preconditions
  - Describes a list of conditions that must be true before the start of the use case.
  - Often preconditions are the execution of preceding use cases.
- Flow of Events
  - The flow of events is a series of statements listing the steps of the use case from the actor's point of view.
- Post conditions
  - Describes what conditions have occurred as a result of the use case.
  - Post conditions must be true no matter what alternative occurs in the use case. • Alternate Paths
  - An alternate path is one that allows a different sequence of events than what was used for the basic flow of events.
  - Often these are alternate choices made during a use case.
- Business Rules
  - A list of rules used to govern the business processes within the use case.

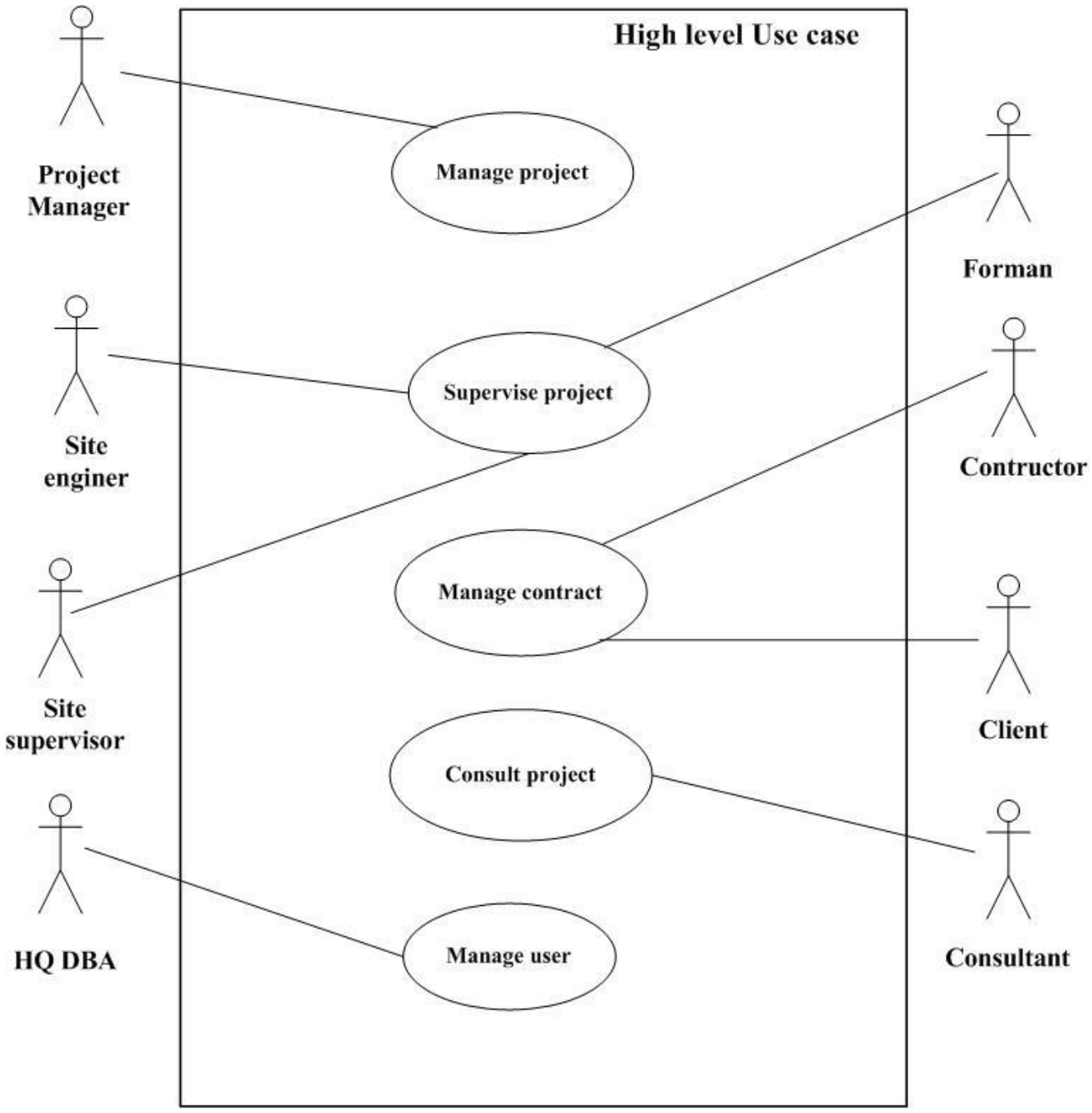


Figure 5: High level use case diagram.

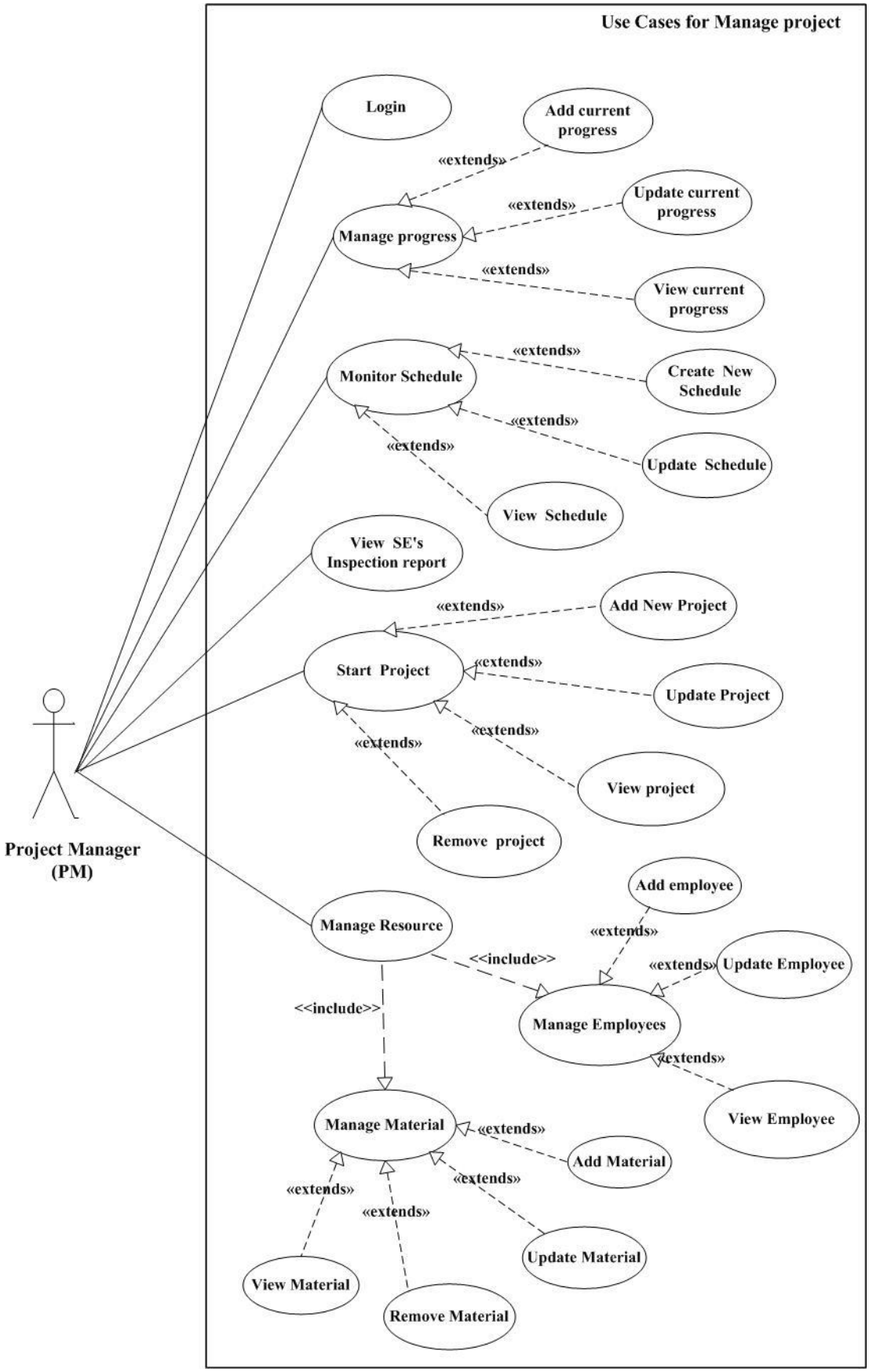


Figure 6: use case for Manage project.

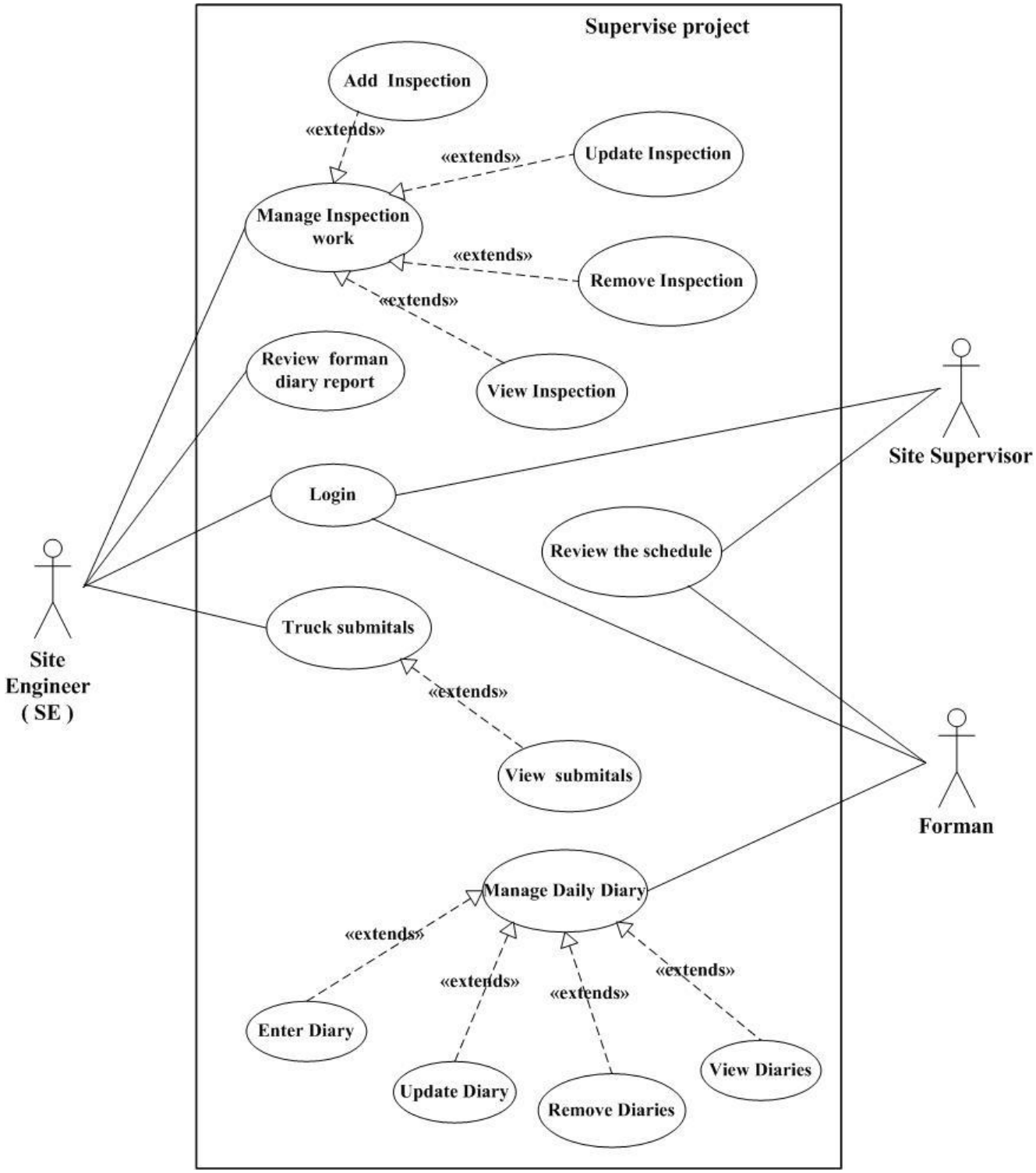


Figure 7: use case for supervise project.

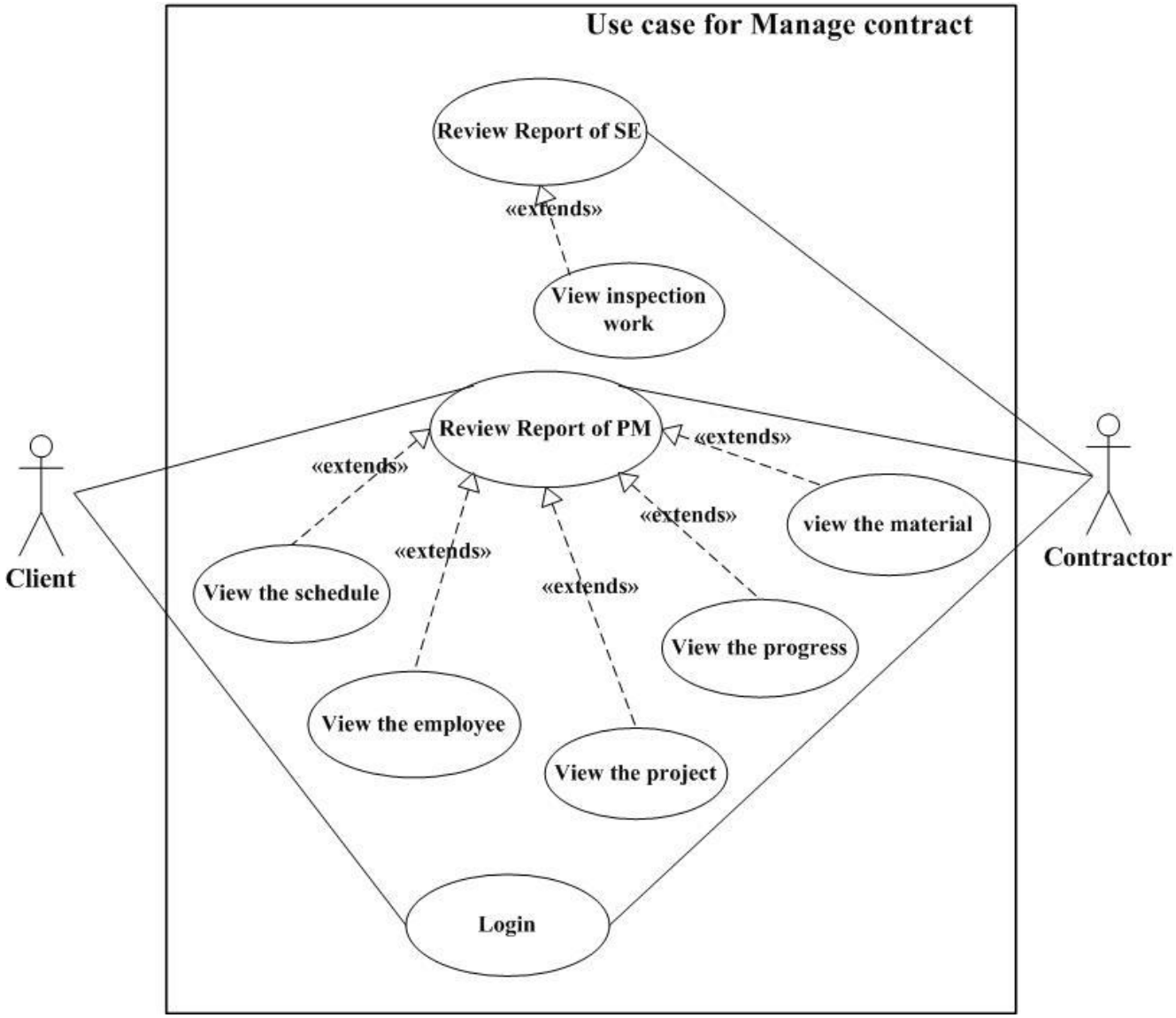


Figure 8: use case for contract management.

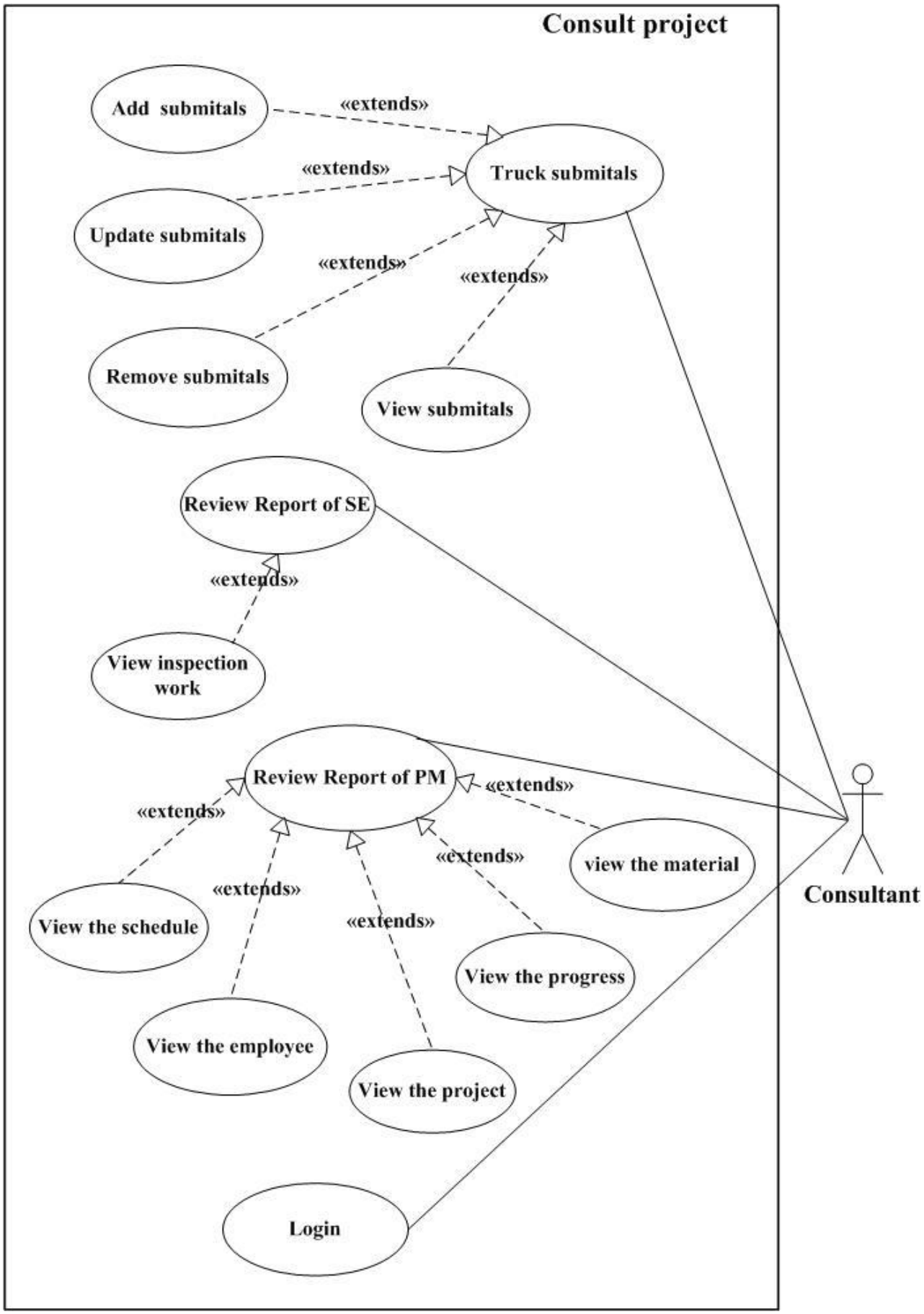


Figure 9: use case for consult project.

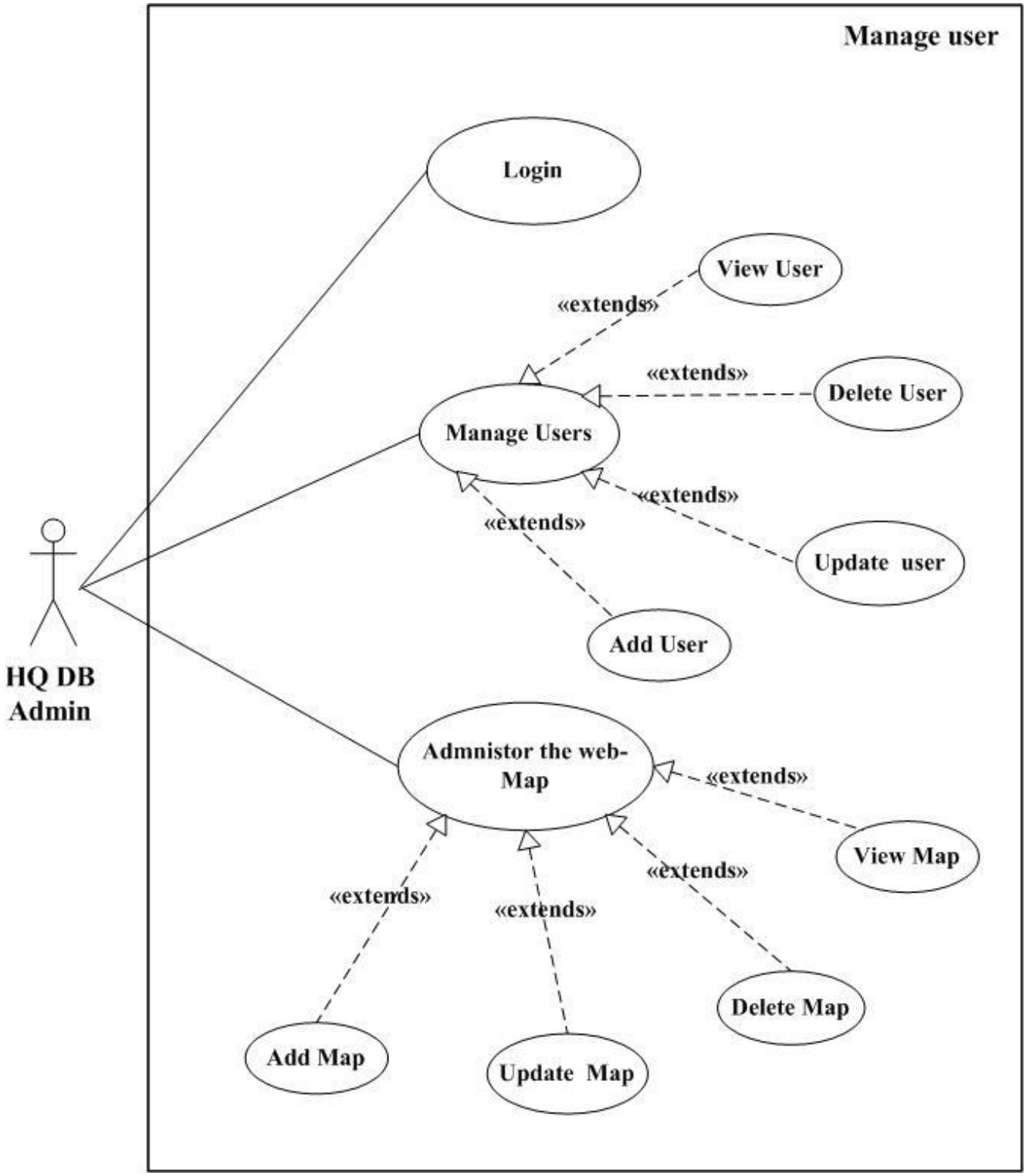


Figure 10: use case for Manage user.

3.4.1.1 Use Case: Create And Modify Users

Brief Description

This process encompasses the function of adding, modifying and deactivating users in the CMS.

Actors

1. HQ Database Administrator – The person designated at the HQ office as system administrator for the CMS.
2. All Construction staff

Preconditions

1. New CMS user is identified.

Flow of Events

1. Notified of Tekrom employee that needs access to the CMS.
2. SE completes CMS User Request Form and sends to HQ Database Administrator
3. HQ Database Administrator adds user's identifier to the CMS.
4. HQ Database Administrator adds user authority and other pertinent data to the CMS.
5. CMS stores user authority.
6. CMS notifies the Tekrom employee of login and password.
7. CMS enforces authorization rules.

Postconditions

1. All persons who will require access to the CMS to comply with project requirements and specifications have been granted user IDs and passwords.
2. All assigned user IDs and passwords have been assigned the appropriate access authority.

Alternate Paths

1. The SE sends a CMS User Request Form to the subcontractor or external user.

a. The SE designates other users and their roles on a CMS User Request (such as Forman, Field Office Engineer Authority, Inspectors).

b. Subcontractor or external user submits the CMS User Request Form to the HQ Administrator.

2. (Alt pat 1) The Subcontractor user already exists.

a. The HQ Administrator adds the appropriate authority andassignments to the existing database user without creating a new one.

b. CMS enforces new user authority.

Business Rules

1. Users must be notified when they've been assigned responsibility within the CMS.
2. Subcontractor access is project specific.
3. Subcontractors must be assigned to a valid project.

3.4.1.2 Use Case: Manage Resources

Brief Description

This process encompasses the function of adding, modifying and removing resources from the resource pool of a Site.

Actors

1.Project Manager(PM)

Preconditions

1. Need to create or modify a resource in CMS.

Flow of Events

1. PM or delegate chooses type of personnel resource to add in CMS
2. For filled position PM or delegate will enter staff information.
3. For unfilled position, PM moves directly to step 5.
4. CMS retrieves personnel data .
5. CM or delegate enters the missing resource data:
6. CMS stores resources with data.

Postconditions

1. A resource is available in CMS for assignment to projects.

Alternate Paths

1. (Step 1) PM or delegate selects a resource to modify.

a. PM or delegate selects a resource.

b. PM or delegate modifies resource.

c. CMS displays projects to which resource is currently assigned that will be affected by modification.

2. (Step 1) PM or delegate chooses to loan a resource

a. PM or delegate creates a loan of the resource.

i. Position number

ii. Unit

iii. Source number

iv. Duration and dates

Business Rules

1. A resource can be filled by an employee or exist as an unfilled PY.
2. Progress must be tracked by timeline and resources planned vs. resources available for reporting purposes.

3.4.1.3 Use Case: Start Project

Brief Description

This process begins when a contract is awarded and loaded to the CMS.

Actors

1. PM or delegate

Preconditions

1. Users have access to the system (UC 1.1).

Flow of Events

1. CMS loaded data from BID information on the contract award.
2. A new project is created in the CMS.
3. CMS notifies the appropriate Actor of new project (based on the type of project).
4. Actor enters any missing data and sets up contract specifics for tracking throughout the life of the project.
5. CMS stores project data entered.
6. An updated project is created in the CMS using data accepted and entered.

Postconditions

1. A new project is available in the CMS database with a minimum of the following:

a. Dates

b. start, duration

c. Engineers estimate in dollars

d. Budget and contract items

e. Preliminary funding breakdown

Alternate Paths

2. Actor modifies existing project (this includes reactivating an inactive project)

a. Actor selects project from list of projects in the CMS.

b. CMS retrieves project data.

Business Rules

1. Actor is notified when key project data in CMS are modified for an active CMS project so they can determine if the CMS project data should be overridden.
2. HQ office performs an oversight function for projects that require only tracking of submittals, status of completion, contacts, consultants, start and finish dates, budgets and actual costs, and not the operation of these functions. They also need to be able to set up an Oversight Diary.

3.4.1.4 Usecase : Enter/Update/Submit Forman Diary Report

Brief Description

This process covers the entry and subsequent updating of the Forman Diary Report data in the Construction Management System (CMS).The Diary process takes place daily and includes the recording of all events that transpire throughout the project, including observation of labor and equipment hours, weather, quantities placed, material testing needs, etc.

Actors

1. **Forman**

Preconditions

1. Data in the CMS from Inspection of Work / Products (UC 3.2).

Flow of Events

1. The Forman completes daily inspection.
2. The Forman enters data in the CMS in accordance with their inspection.
3. CMS stores Diary data and notifies the Forman of completion of Forman report.

Post-conditions

1. Forman report data is in the CMS.
2. Forman notified of the completed Forman Diary ready for review.

Alternate Paths

1. N/A

Business Rules

1. The Diary entries must capture weather conditions to include daily temperature and aspesfic descript -ion of the daily weather in accordance with tracking the Weekly Statement of Working Days.
2. Must allow the recording of observations by location with remark types.
3. Validate equipment and hours between and among projects to ensure overcharging is not occurring.

3.4.1.5 Use Case: Review Forman Diary Report

Brief Description

This process is the review of the Forman Diary report for accuracy, completeness, and objectivity.

Actors

Site Enginner(SE)

Preconditions

1. Entry and submission of the Forman Diary Report.

Flow of Events

1. Review the Forman report for accuracy, completeness, and objectivity.
2. Identify revisions (if any) to the Forman report.
3. If revisions are required route Forman report back to Forman for changes.

4.If no revisions are necessary approve Forman report.

Post-conditions

1. Reviewed Forman report in the CMS.

Alternate Paths

1. N/A

Business Rules

1. This use case uses the same business rules specified in **Use Case 3.2**.
2. When the SE returns the report to the Forman for edits, the Forman must be notified by an approved method (e-mail, instant message, text message / page, notification review screen, etc.).

3.4.2 Class Diagram

The class diagram is the main building block of object oriented modeling. It is used both for general conceptual modeling of the systematic of the application, and for detailed modeling translating the models into programming code. Class diagrams can also be used for data modeling. The classes in a class diagram represent both the main objects, interactions in the application and the classes to be programmed.

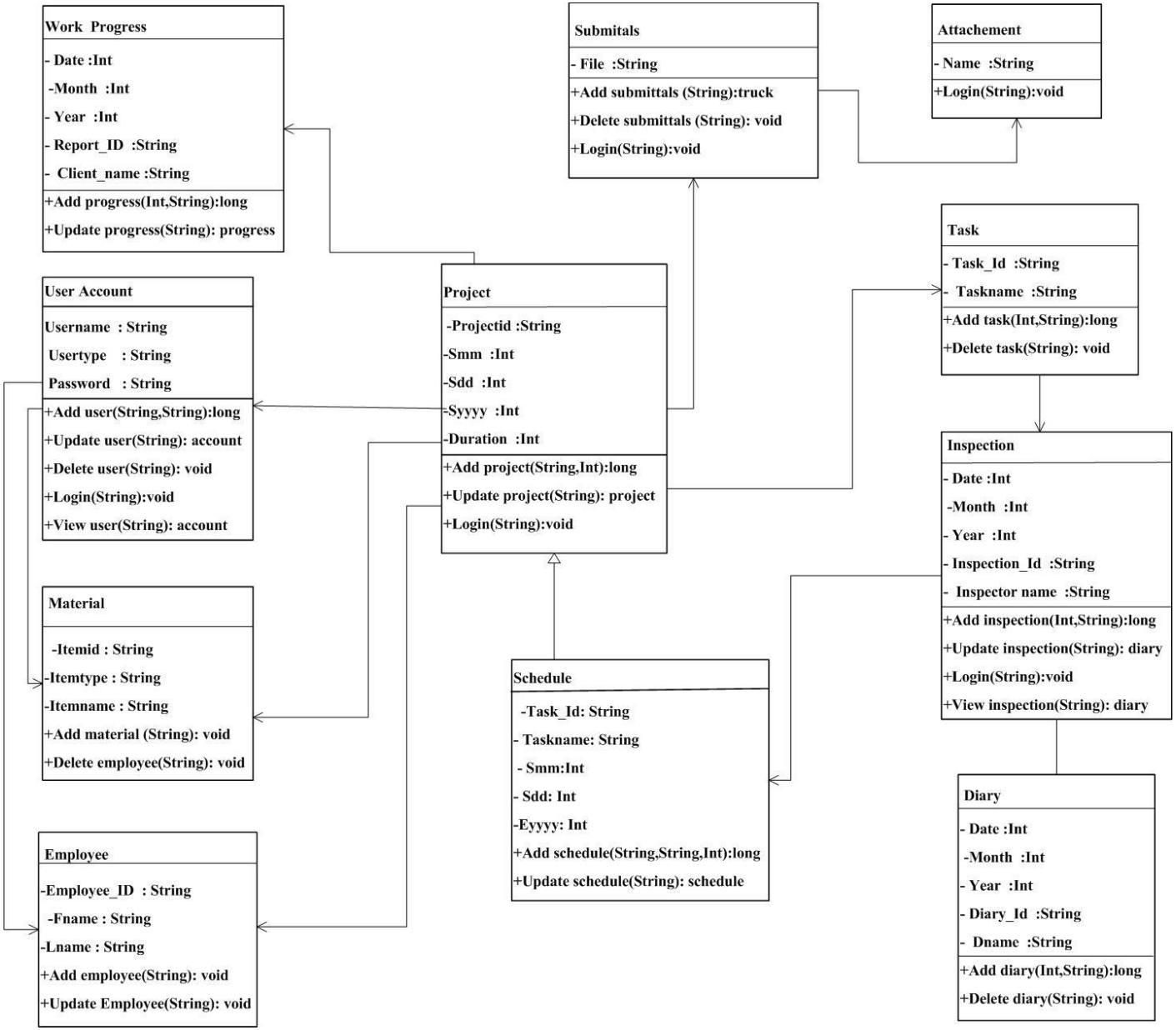


Figure 11: Class Diagram

3.6.3 Sequence diagram

Sequence diagram is one kind of interaction diagrams, which shows an interaction among a set of objects and their relationships. The purpose of the Sequence diagram is to document the sequence of messages among objects in a time based view. The scope of a typical sequence diagram includes all the message interactions for a single use case. The following diagrams are sequence for the event management system.

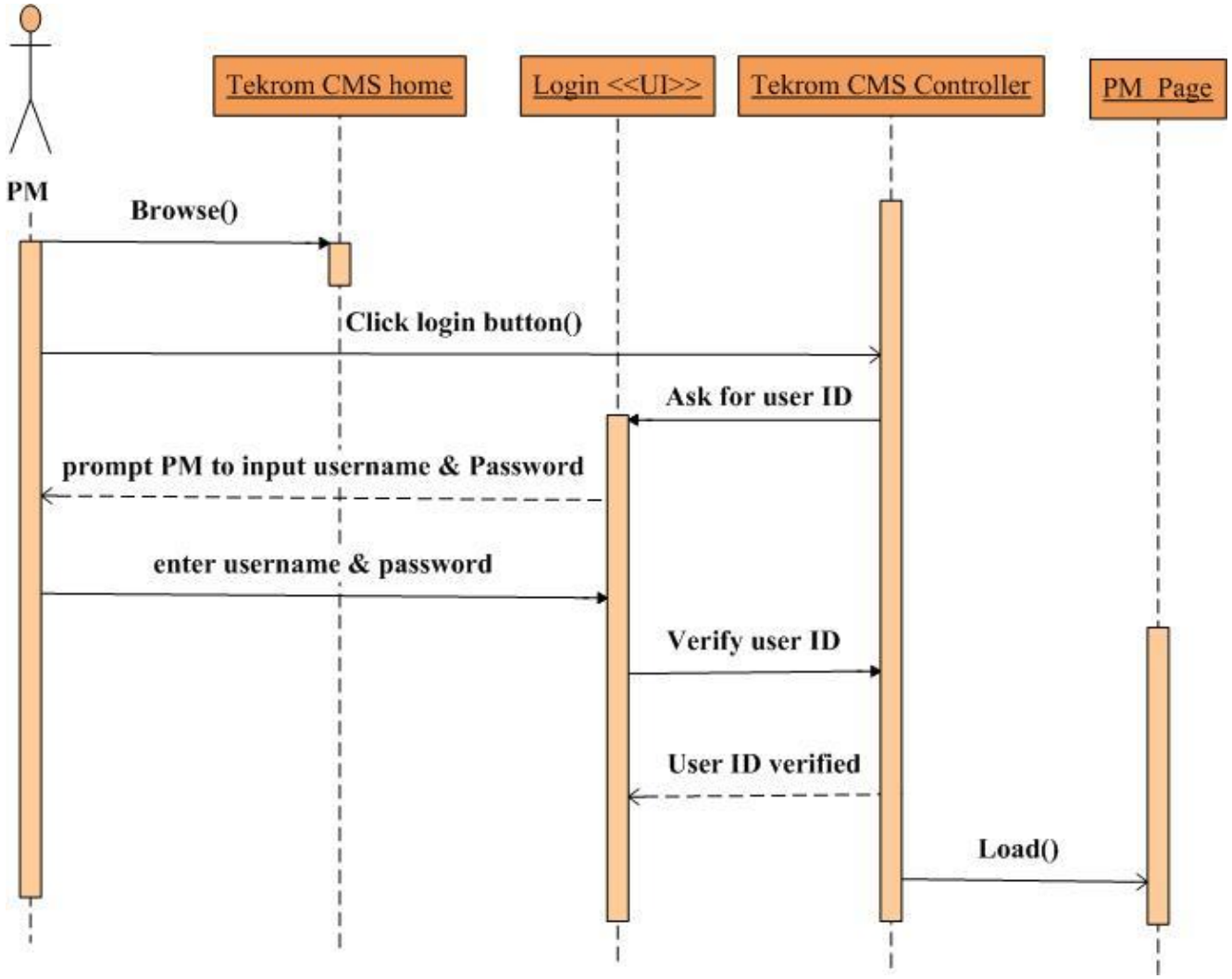


Figure 12: Sequence Diagram for login.

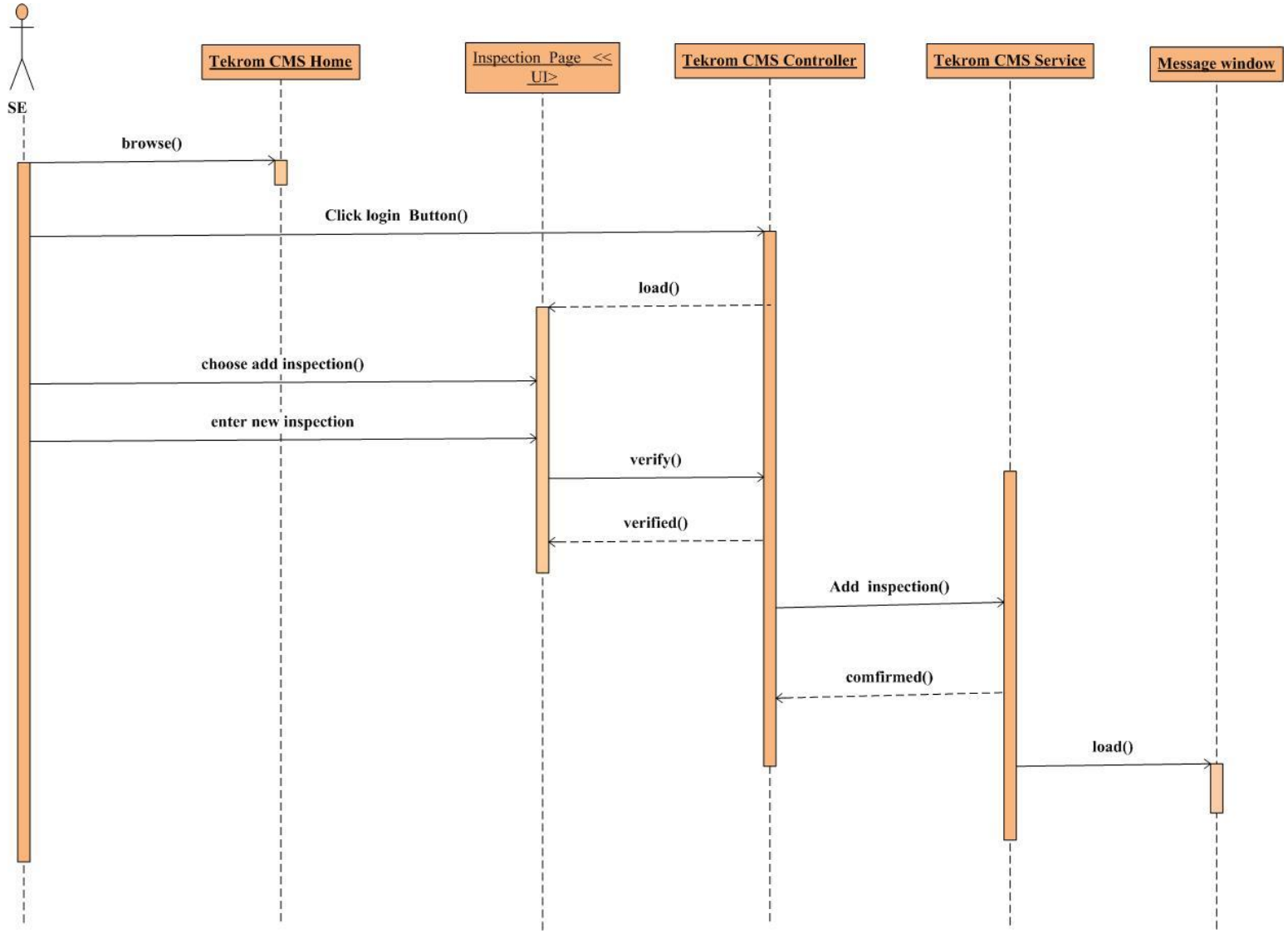


Figure 13: Sequence Diagram for adding inspection.

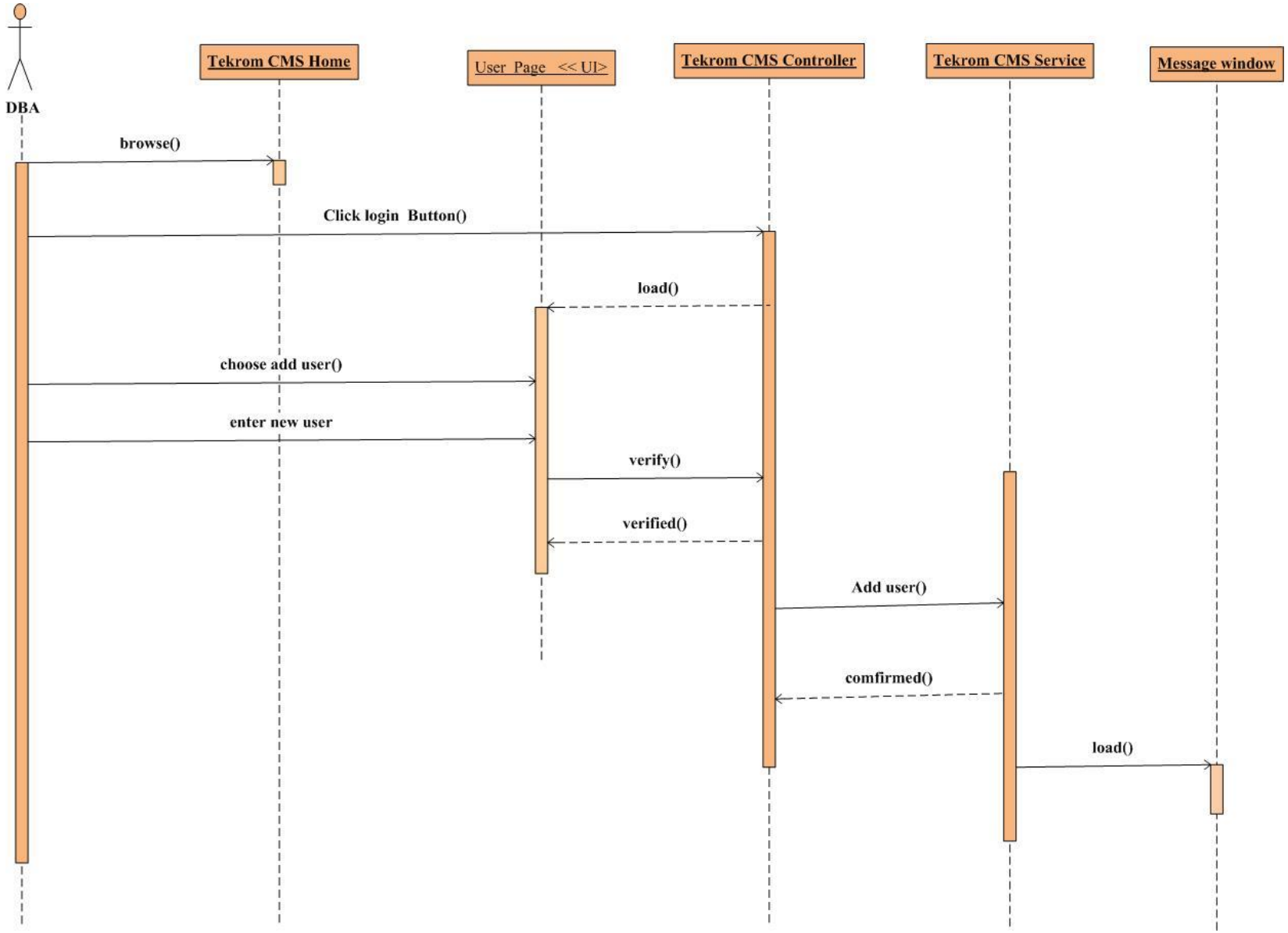


Figure 14: Sequence Diagram for adding user.

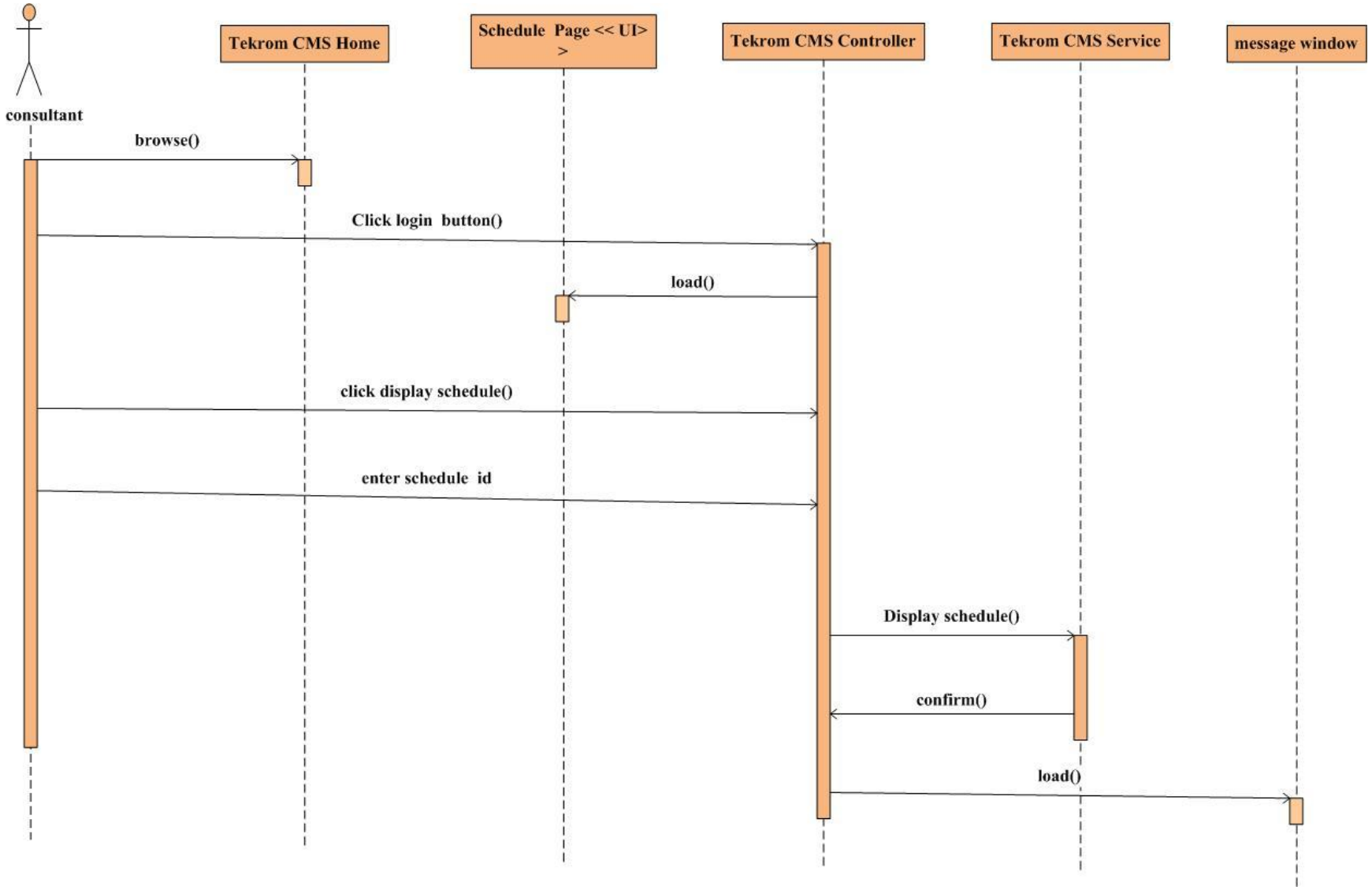


Figure 15: Sequence Diagram for viewing schedule

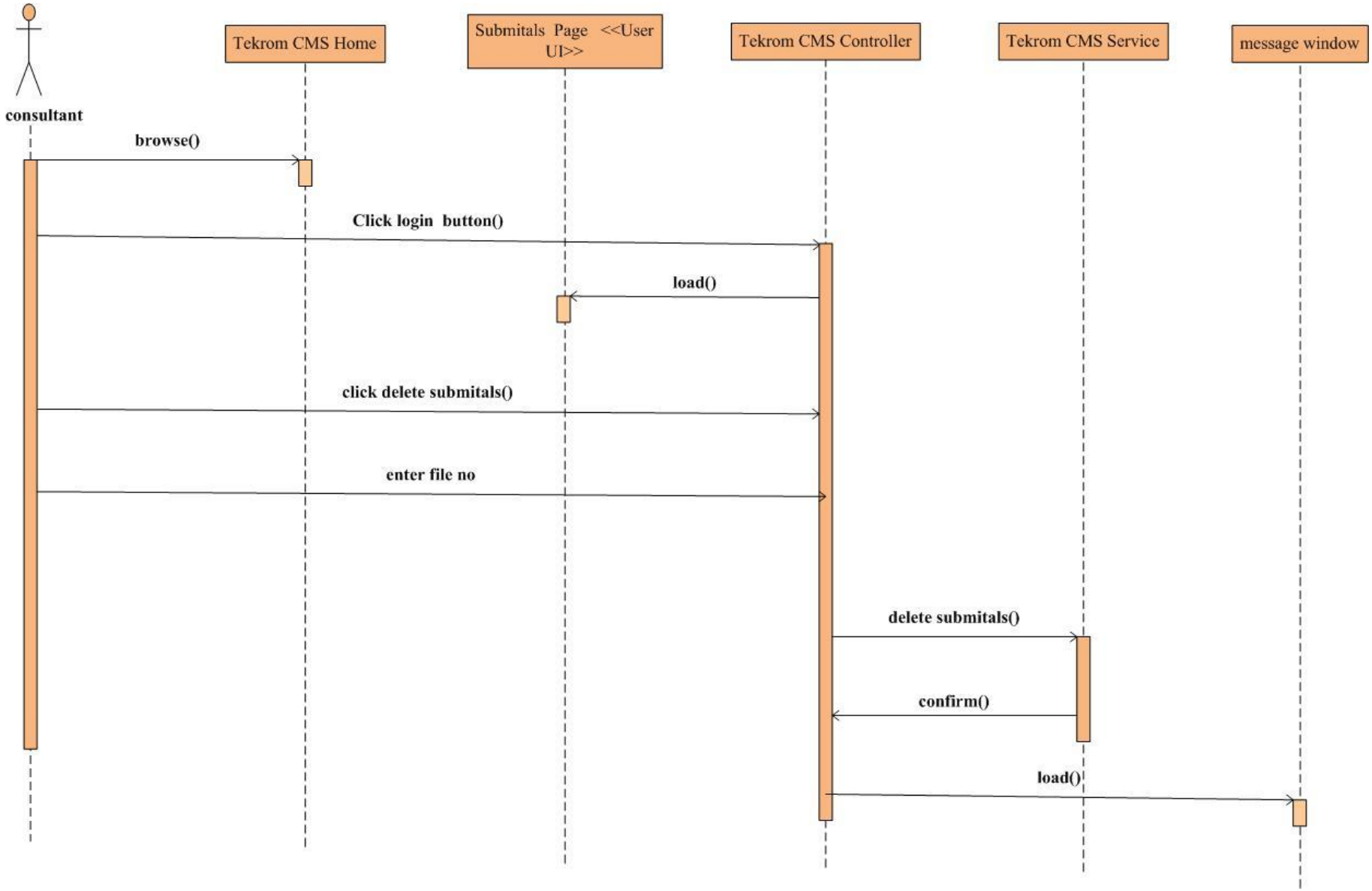


Figure 16: Sequence Diagram for removing submittals.

3.6.4 Activity diagram

Activity diagram shows the conditional logic for the sequence of system activities needed to accomplish a business process. It clearly shows parallel and alternative behaviors that can be used to show the logic of a use case. In our system, we identified some activity diagrams to clearly show the activities in the system.

Diagram :Activity for login

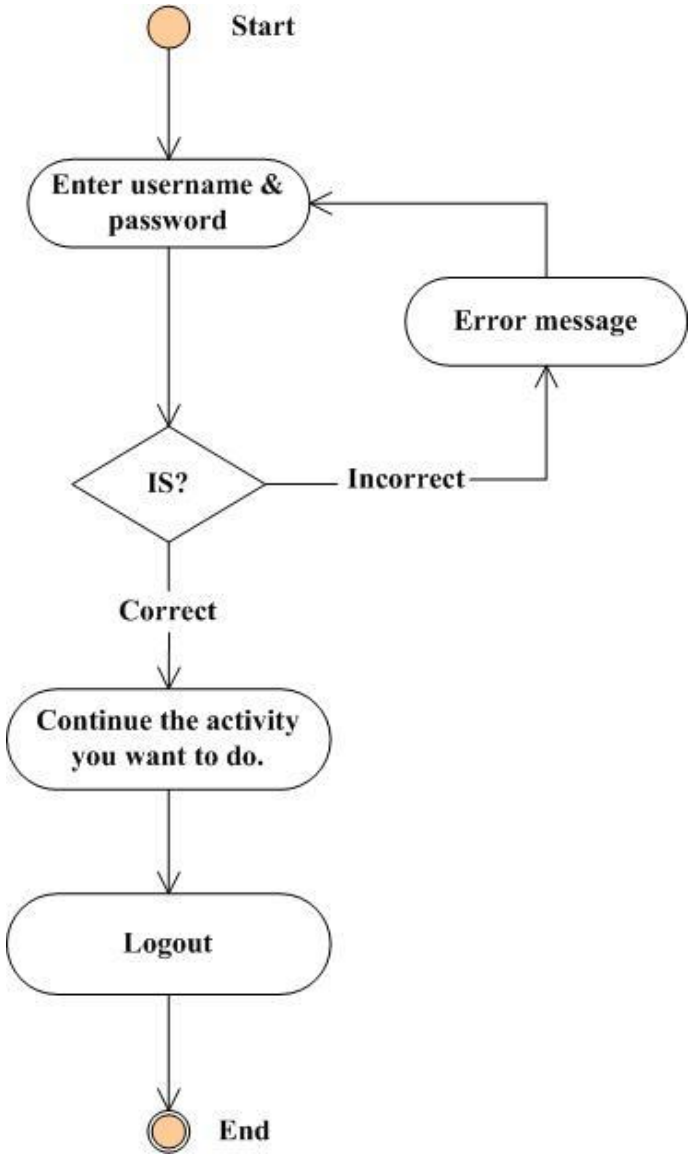


Figure 17: Activity Diagram for login.

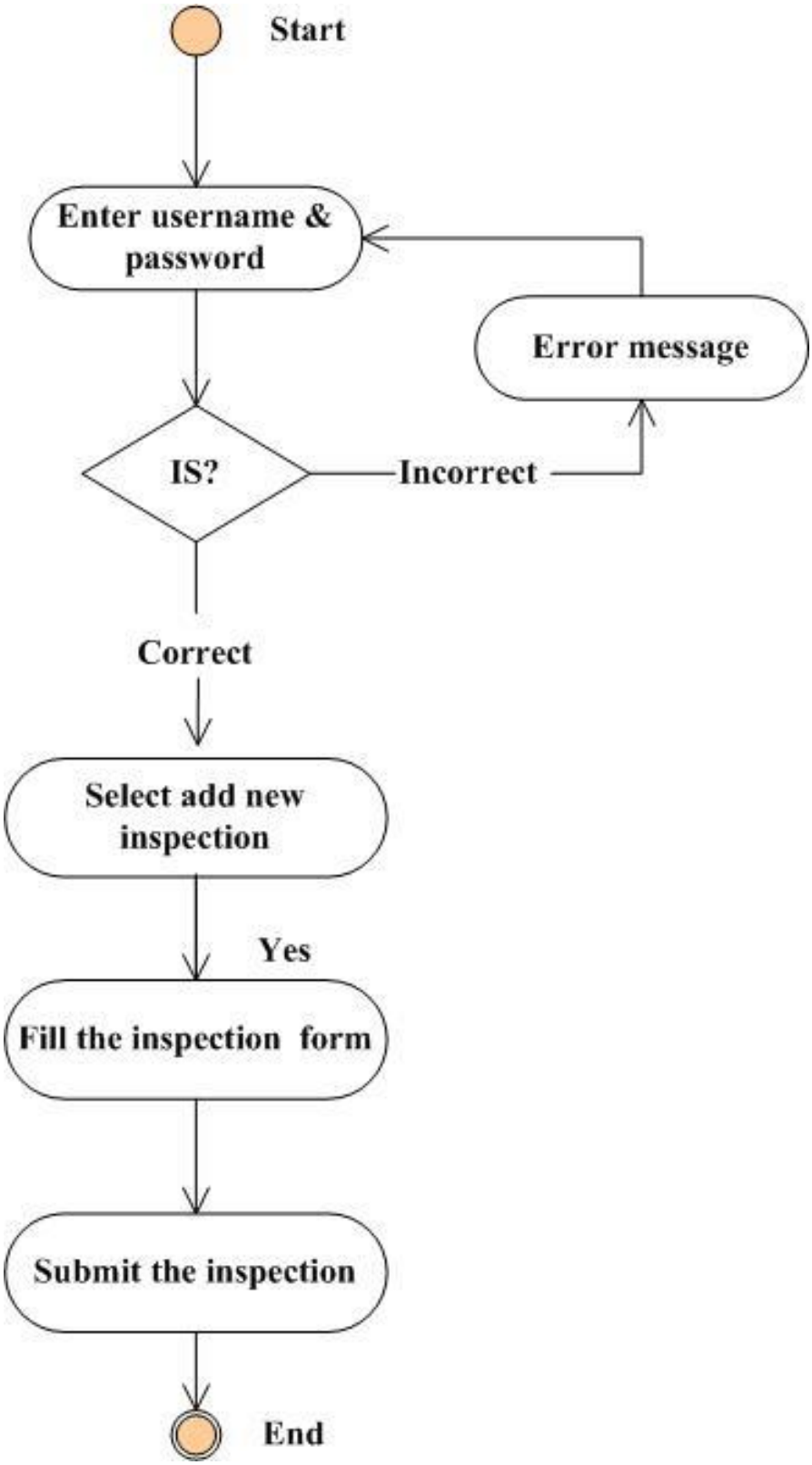


Figure 18: Activity Diagram for adding inspection.

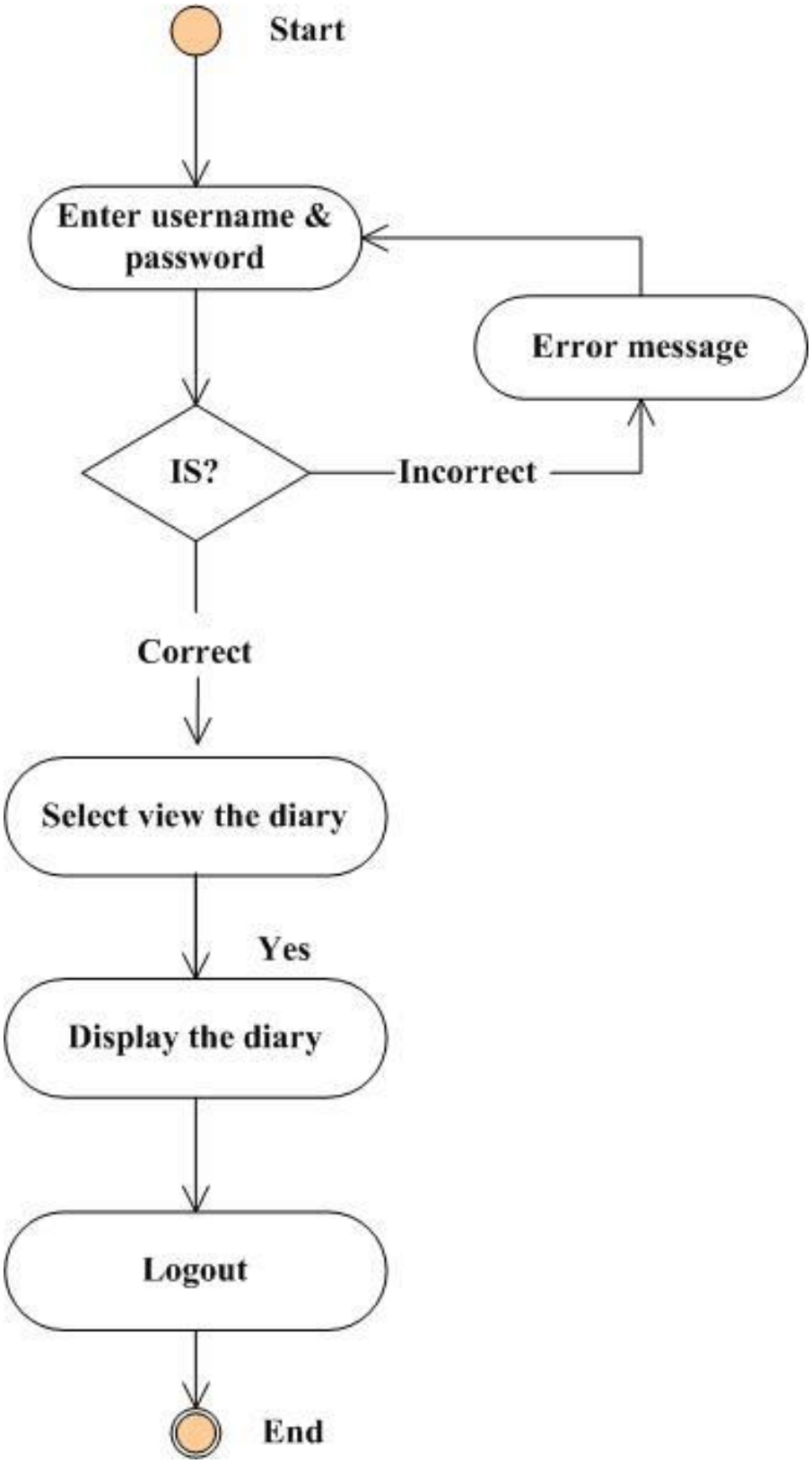


Figure 19: Activity Diagram for viewing diary.

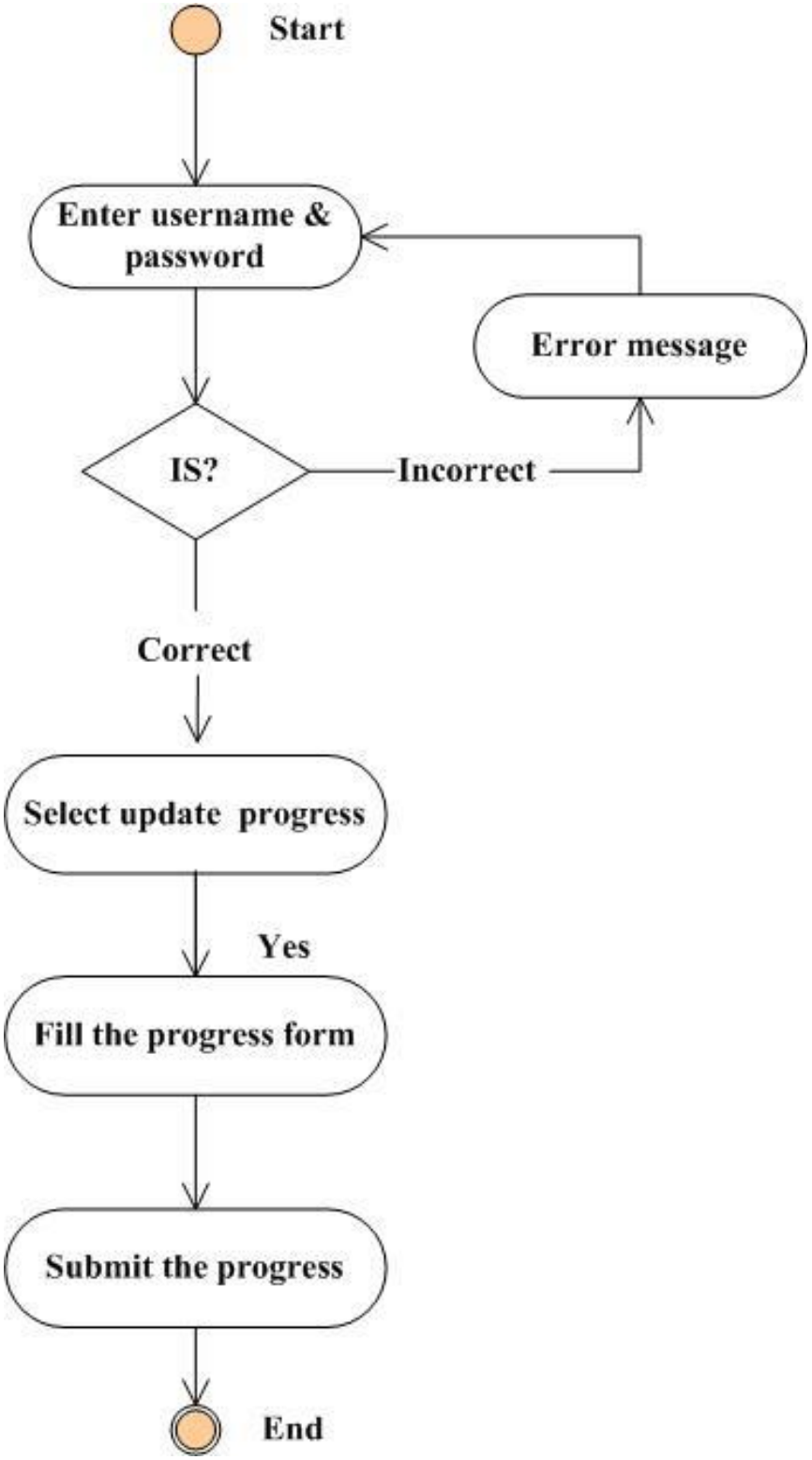


Figure 20: Activity Diagram for updating progress.

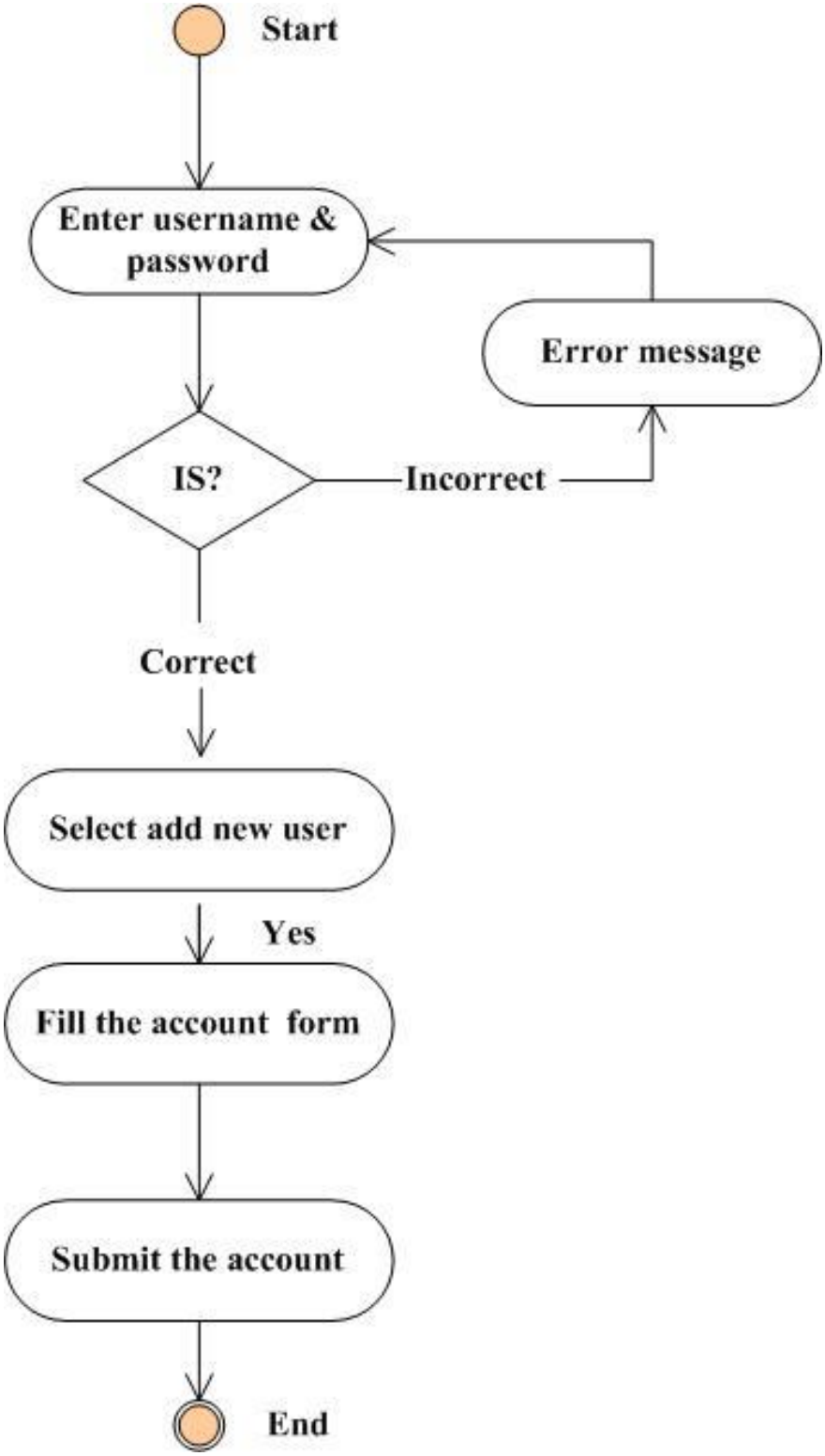


Figure 21: Activity Diagram for user creation.

3.6.5 State Diagram

In this part the team used to model the behaviors of the objects by drawing the state diagram. That shows the sequence of states that an object goes through, the events that cause the transition from one state to the other and the actions that result from a state change. The following figures show the state of the objects of the corresponding use cases.

Diagram : State diagram for viewing progress.

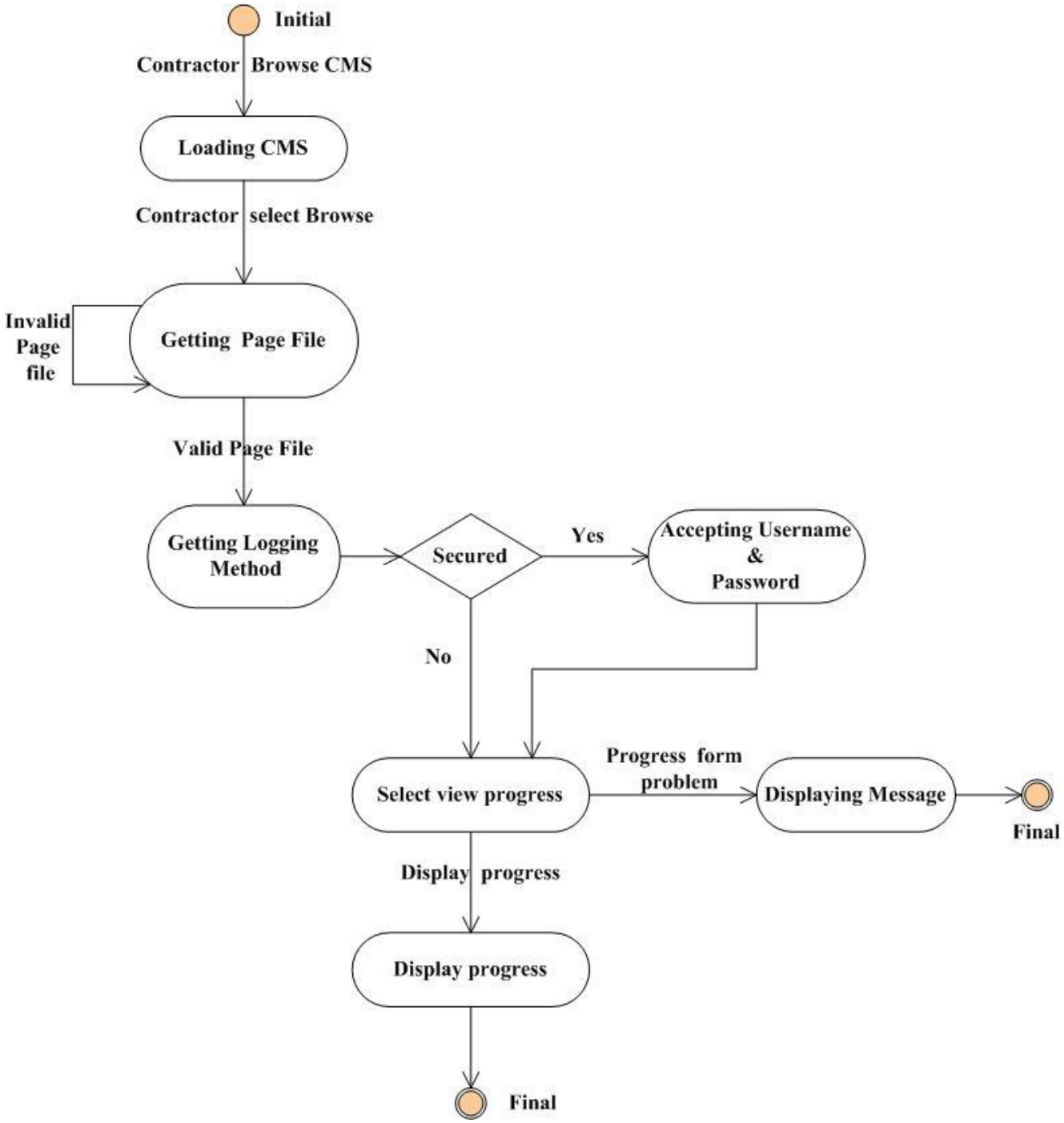


Figure 22: State Diagram for viewing progress.

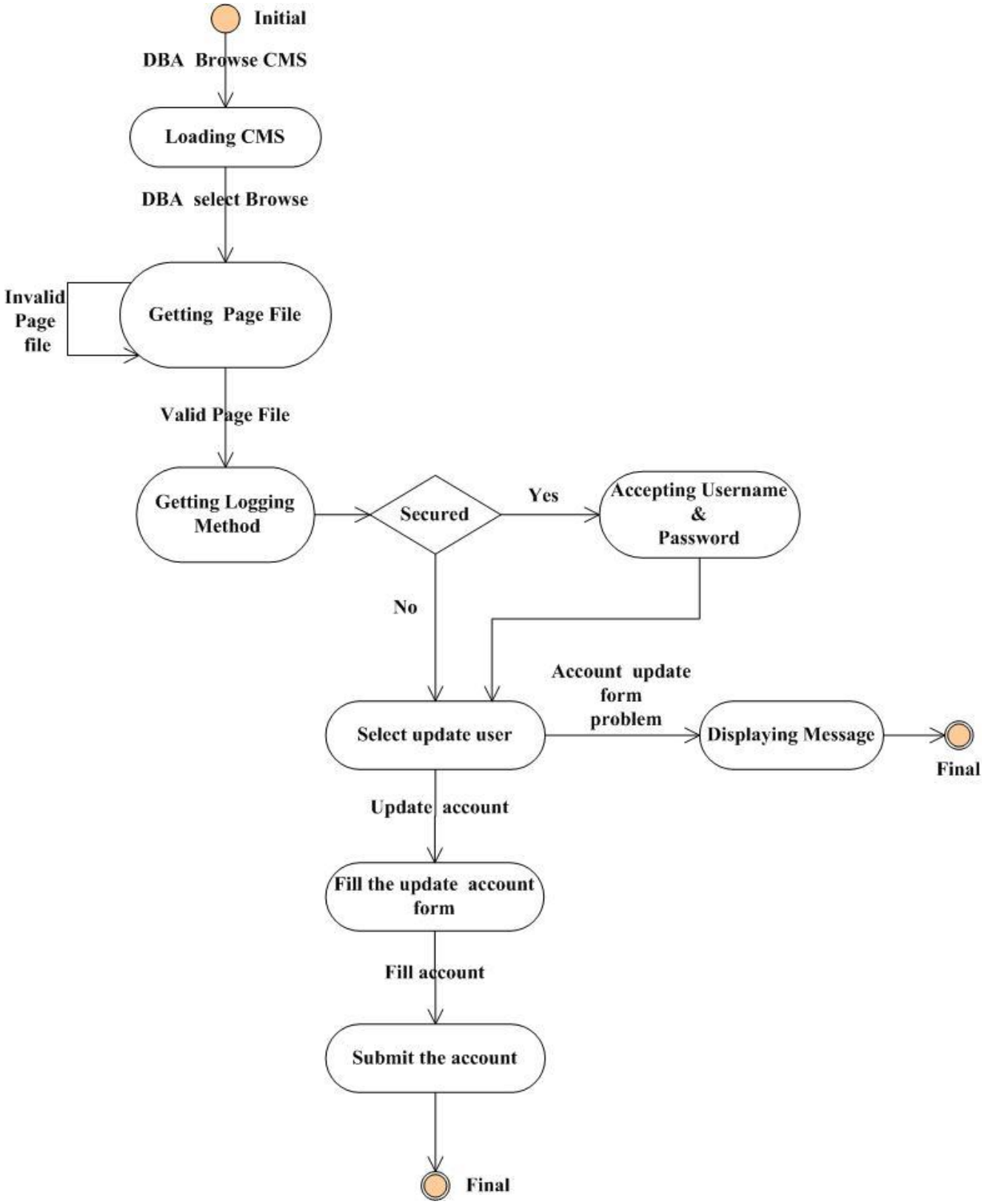


Figure 23: State Diagram for updating user.

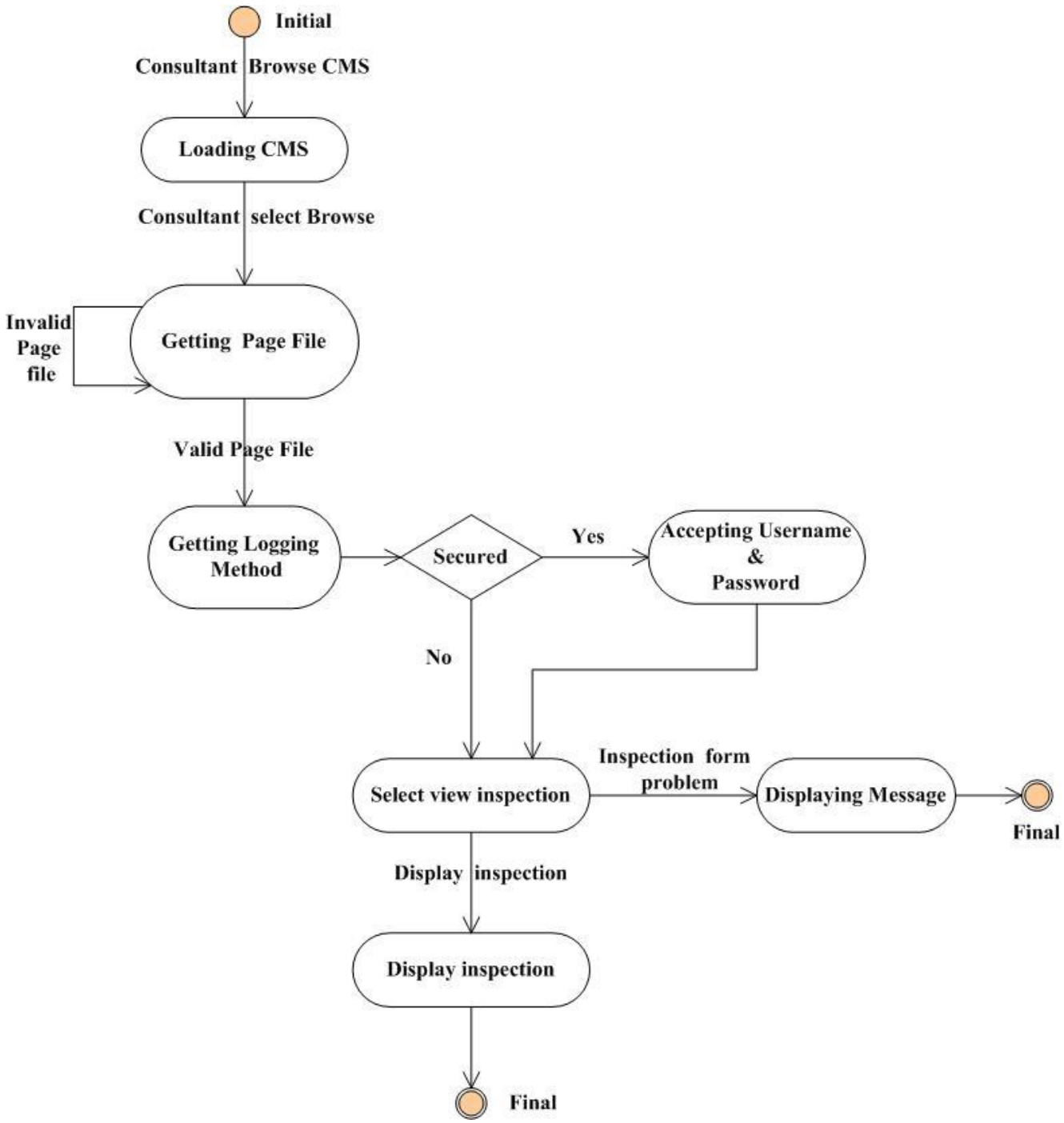


Figure 24 : State Diagram for viewing inspection.

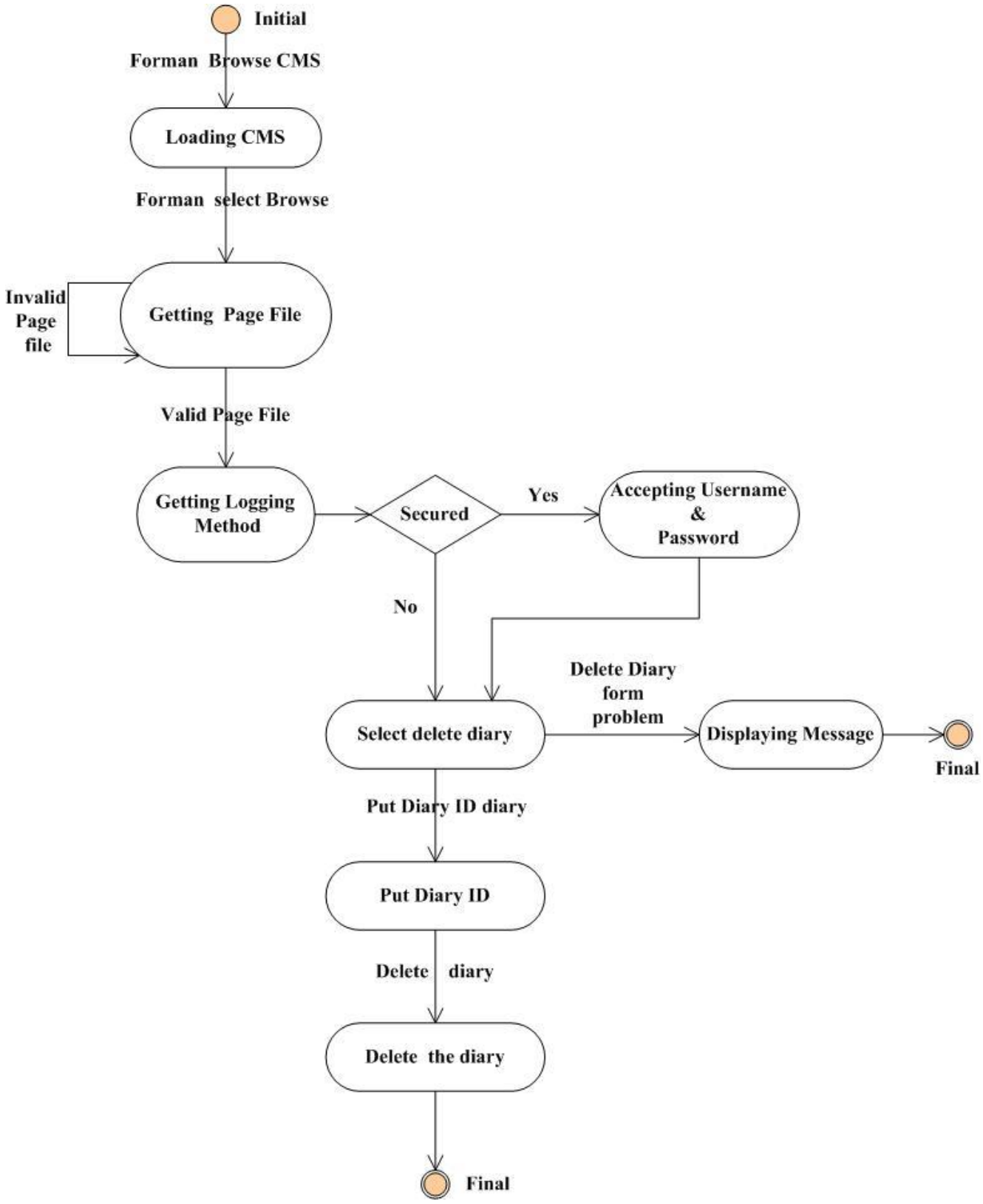


Figure 25: State Diagram for deleting diary.

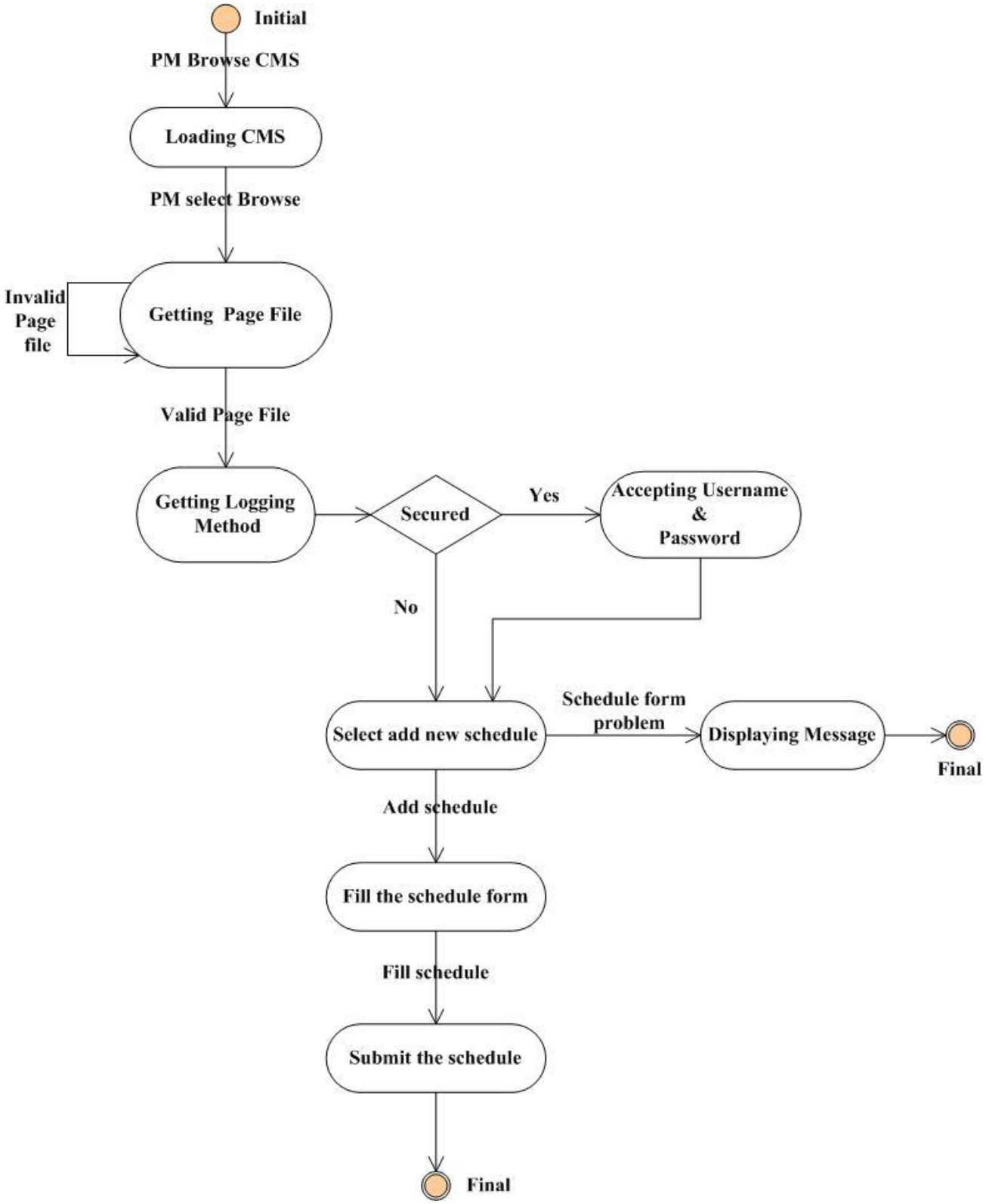


Figure 26: State Diagram for adding schedule.

Chapter Four System Design

4. Introduction

This document provides the details of architectural design and hardware software mapping of Tekrom construction management system.

4.1 Purpose of the system

Currently in Tekrom Construction Plc, procedures for gathering construction project information as well as coordinating and communicating the information amongst all the stakeholders in the process are extremely bureaucratic, confusing and awfully time-consuming. The problem has been exacerbated by the increasingly complex and large nature of construction projects with a large number of participants. There is currently a lack of a systematic approach and system that can effectively manage all information concerning construction projects to ensure a faster, more efficient and transparent process. This ultimately results in problems regarding project performance e.g. extreme delays in construction, loss of information and increasing costs. The aim of this project is to explore the viability of developing a systematic approach to the coordination of information amongst the multiple project stakeholders in the Tekrom Construction Plc and building a web based CMS for structuring and representing information for proper coordination and management in the Tekrom Construction Plc.

4.2 Design goals

The design goals represent the desired qualities of the system and provide a consistent set of criteria that must be considered when making design decisions. Based on the nonfunctional requirements and the information elicited from the users, the following design goals are identified.

Documentation

System administrator will receive properly prepared documentation about the system, and the code of the system. This will help to understand its structure and to facilitate maintenance of the system. There will also be addressed user manual to the end users. This will be in the form, where users click the help link on the system to get any information they are looking for system procedure for a particular task.

Error handling and extreme conditions

The system will face different interactions from different users and each interaction may bring an invalid input to the system. So, the system should be implemented to capture any invalid input data with error handling mechanism. If a user enters wrong inputs, the system should recognize it and guide the user by providing informative error messages to make the necessary correction.

Availability

The system should be available for any valid users as long as the service provider is available unless it is shutdown by the administrator.

Accessibility

The system should be accessible 24/7 at any place were an internet connection is available.

Security

Since the system is going to handle sensitive data concerning a construction and the personal information of an individual should be handled with a great care.

And hence the following security issues should be considered:

- **Authentication:** Unauthorized users should have no access to the system. In order to achieve this, the system should implement authentication techniques that enable only authorized users to access the system. To handle this, users with different types of privileges are required to give their user name and password at login into the system. And also the administrator to control access based on system function. The system is needed to grant one type of user access to certain system functions but not to others. For example, give privilege is available only to the system administrator.
- **Authorization:** Which resources the user can access and which operations the user is allowed to perform. The users that login the systems and performs their activities (add, view, delete, and manage) depend on their authorization of resource access. Example contractor not accessing user account creation and forman do not register employees.
- **Database security**: Security feature of MYSQL to ban the database from an unauthorized access will be implemented. The administrator through the system should only control the database.

System modifications (Extensibility)

The system should be implemented by considering addition and change of functionalities. This is achieved by carefully documenting the system and its methods. As the system is developing mainly

concerned with the object oriented approach the system will greatly support any future modification, new implementation of sub model. Besides with such great features this system also increases the ability of the system to deal with new technology or to fix defects. As the result the following mechanism used for extendable the system.

- ✓ The code should be documented well so that it will be easily understandable in time of maintenance or system modifications. This is achieved during the coding stage by having a clear description of each function (using comments),
- ✓ The code will be written in standard form. The name of class, method and attribute name write full name to make the code readable and understandable.
- ✓ The system must design for support portability feature. For example, a piece of modified system must be compatible with an older version of the system.
- ✓ New capabilities can be added to the system without major changes to the underlying architecture. The system is design by decompose the system into sub system.

The system comprises well defined, independent components. That leads to better maintainability. The components could be then implemented and tested in isolation before being integrated to form a desired system.

4.3 Current software architecture

Currently Teckrom uses a manual construction management system. This implies that the Tekrom has no software architecture. Of course there is no or we cannot find an open source construction management system architecture in the Tekrom. However, we used three tier client-server architecture for developing the proposed system.

4.4 Proposed software architecture

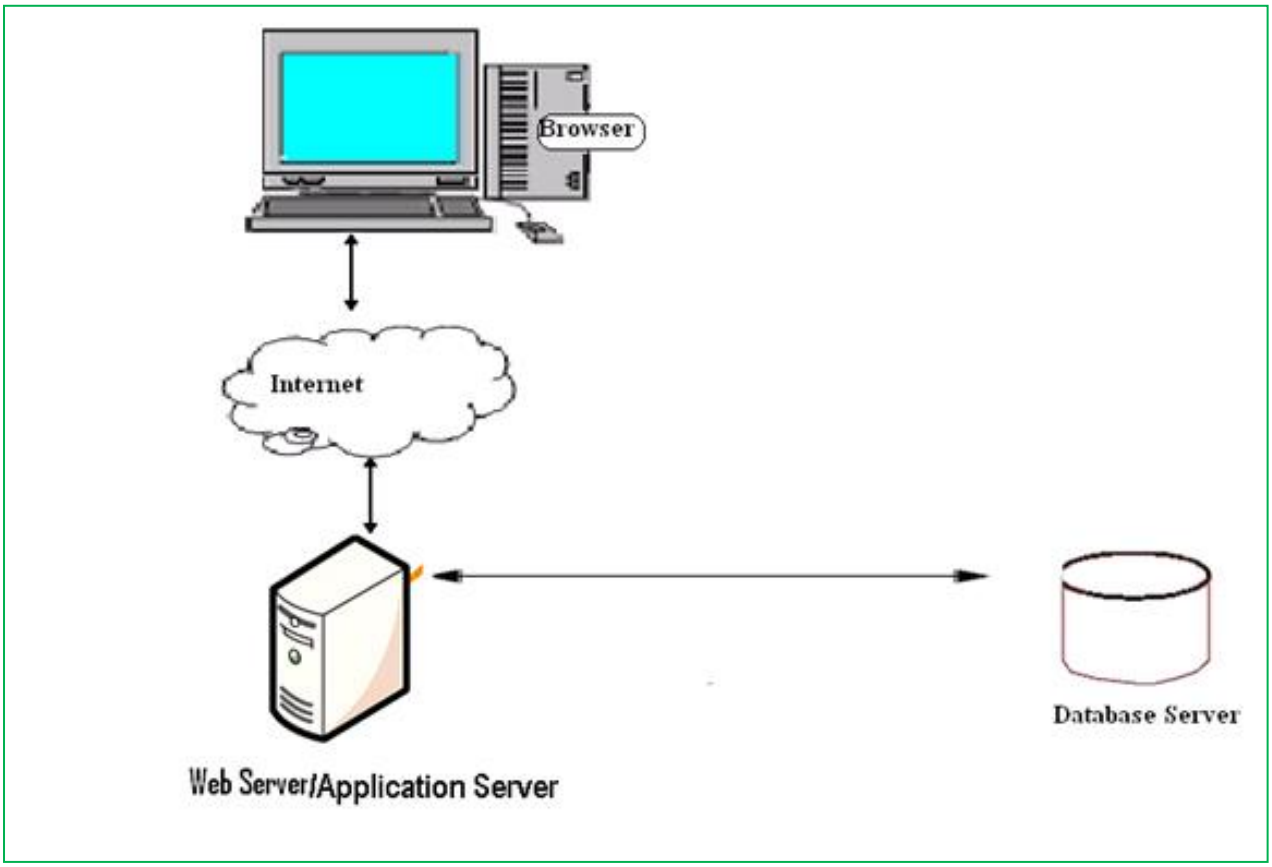
4.4.1 Overview

The proposed system is expected to replace the existing manual system by an automated system in all facts. It is mainly based on the system Analysis document in the previous chapter.

The architecture used for the system is a three-tier Client/Server Architecture where a client can use internet browsers to access the online construction management provided by the system. We select three-tier client server architecture to design the system because of the following advantage.

- ✓ All business logic can be defined once within the business layer and then shared by any number of components within the presentation layer.
- ✓ It is possible to change the contents of any one of tiers (layers) without having to make corresponding changes in any of the others.
- ✓ Enables parallel development of the different tiers of the application.
- ✓ Managing data is independent from the physical storage.
- ✓ Migration to new graphical environments is faster.
- ✓ It is possible to make changes on the presentation level without affecting the other two (business or data access layer).
- ✓ As each tier is independent it is possible to use different sets of developers.
- ✓ Since the client doesn't have direct access to the database, business logic is more secure.
- ✓ When one tier fails there is no data loss, because you are always secure by accessing the other tier.

Figure 27: The architecture of the proposed system.



- ✓ **The data tier**:-this maintains the applications data such as construction data, report data, documented data etc. It stores these data in a relational database management system (RDBMS).
- ✓ **The middle tier (web/application server**):-this implements the business logic, controller logic and presentation logic to control the interaction between the application's clients and data. The controller logic processes client requests such as requests to create and view construction data, to generate report, to record document or to retrieve data from the database. Business rules enforced by the business logic dictate how clients can and cannot access application data and how applications process data.
- ✓ **The client tier**:-the client tire is the applications user interface containing data entry forms and client side applications. It displays data to the user. Users interact directly with the application through user interface. The client tier interacts with the web/application server to make requests and to retrieve data from the database. It then displays to the user the data.

4.4.2 Subsystem decomposition

Subsystem decompositions will help reduce the complexity of the system. The subsystems can be considered as packages holding related classes/objects. During subsystem decomposition of the system we consider the following issue:-

- ✓ Divide the system into smaller subsystems with a strong cohesion.
- ✓ The instruction between subsystems should have a loose coupling.

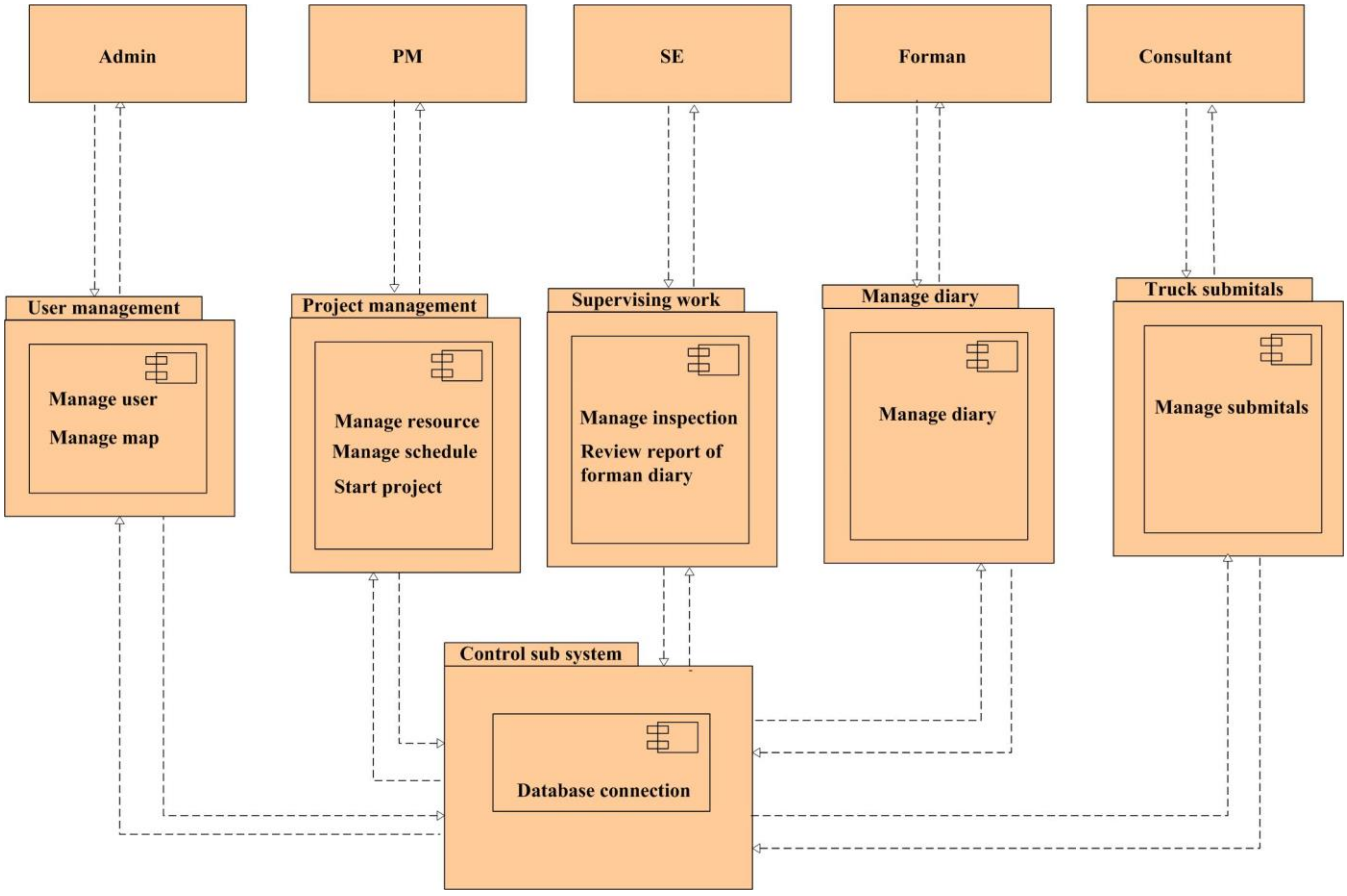


Figure 28: The construction management system under consideration is decomposed into subsystems.

Description of the subsystems is as follows:

- Manage User: The user management subsystem is responsible for handling user information.
  - ✓ Add user of the system.
  - ✓ Edit user of the system.
  - ✓ Remove user of the system.
  - ✓ View user of the system.
- Manage Resource: This subsystem handles to register resource details.

- ✓ Add employee of construction.
- ✓ Edit employee of construction.
- ✓ Remove employee of construction.
- ✓ View employee of construction.
- ✓ Add material of construction.
- ✓ Edit material of construction..
- ✓ Remove material of construction.
- ✓ View material of construction.

- Monitor schedule: This subsystem is responsible for handling construction schedule.
  - ✓ Add schedule of construction.
  - ✓ Edit schedule of construction.
  - ✓ Remove schedule of construction.
  - ✓ View schedule of construction.
- Manage progress: This subsystem is responsible for handling progress information.
  - ✓ Add current progress of construction.
  - ✓ Edit current progress of construction.
  - ✓ Remove current progress of construction.
  - ✓ View current progress of construction.
- Start the project: This subsystem is responsible for handling project information.
  - ✓ Add project of construction..
  - ✓ Edit project of construction.
  - ✓ Remove project of construction.
  - ✓ View project of construction.
- Manage Inspection: This subsystem handles to register inspection details.
  - ✓ Add inspection work of construction.
  - ✓ Edit inspection work of construction
  - ✓ Remove inspection work of construction
  - ✓ View inspection work of construction
- Manage daily diary: This subsystem is responsible for handling daily diary information.
  - ✓ Add daily diary of construction.
  - ✓ Edit daily diary of construction.

- ✓ Remove daily diary of construction.
- ✓ View daily diary of construction.

- Truck submittals: This subsystem is responsible for handling daily diary information.
  - ✓ Add submittals of construction.
  - ✓ Edit submittals of construction.
  - ✓ Remove submittals of construction.
  - ✓ View submittals of construction.
- Connection subsystem: The connection subsystem is responsible for handling connection to the database.

4.4.3 Hardware/software mapping

One of the major tasks in system design deals with hardware/software mapping which deals with which components would be part in which hardware and so on.

- ❖ User interface and processing management will be deployed on the client machine. The system will present the Graphical User Interface (GUI) which allows the user to perform different functions.
- ❖ The client/server architecture of the system enables different clients to connect to the server remotely through internet connection.
- ❖ The applications of the system will run on the application server connected to the database.

The system has two nodes such as the application server and Clients.

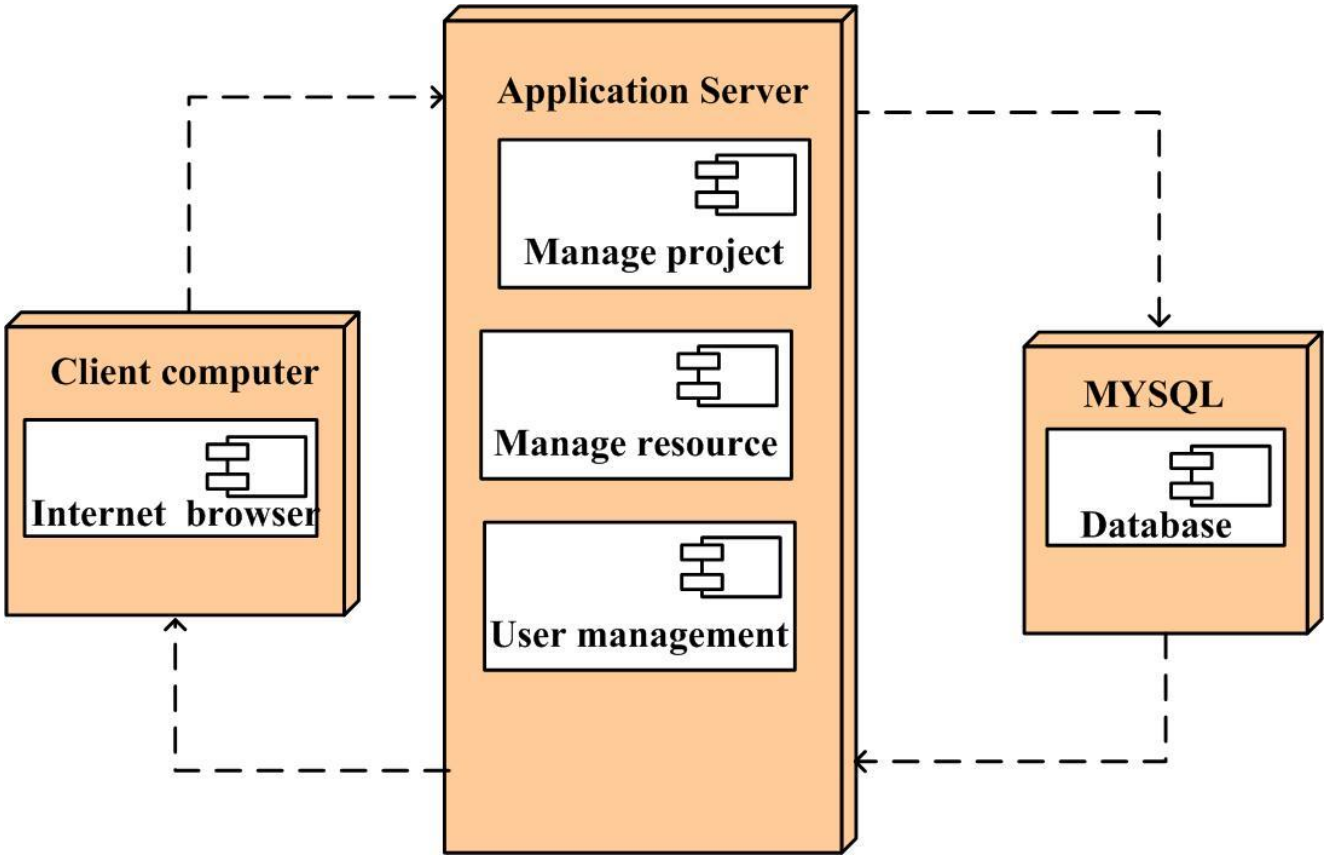


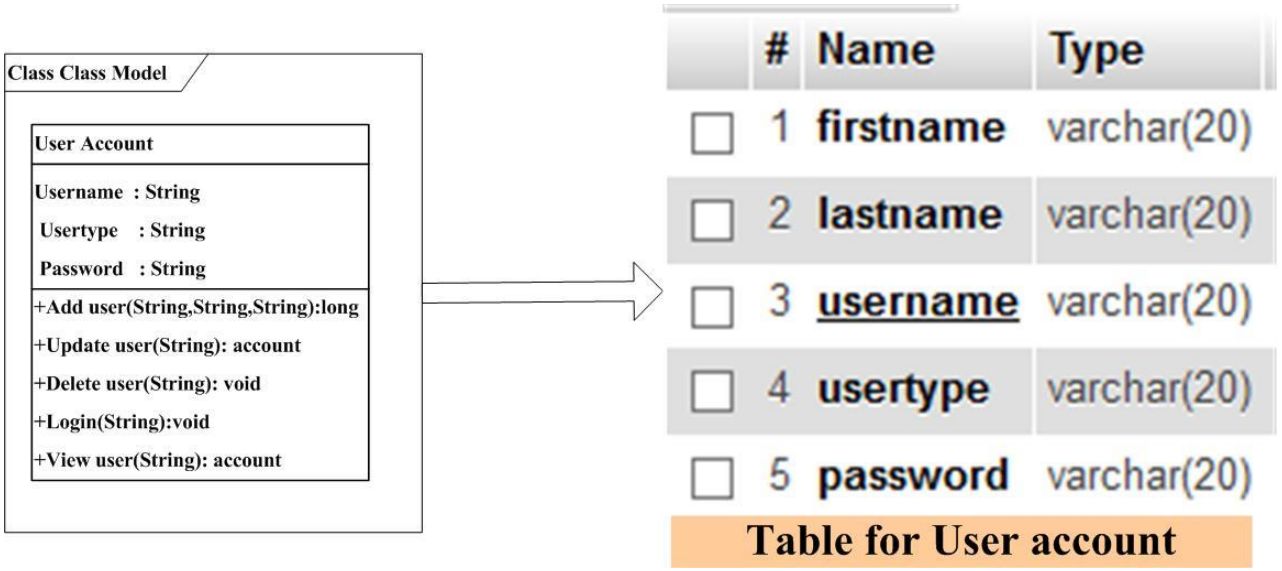
Figure 29: Hardware and software mapping.

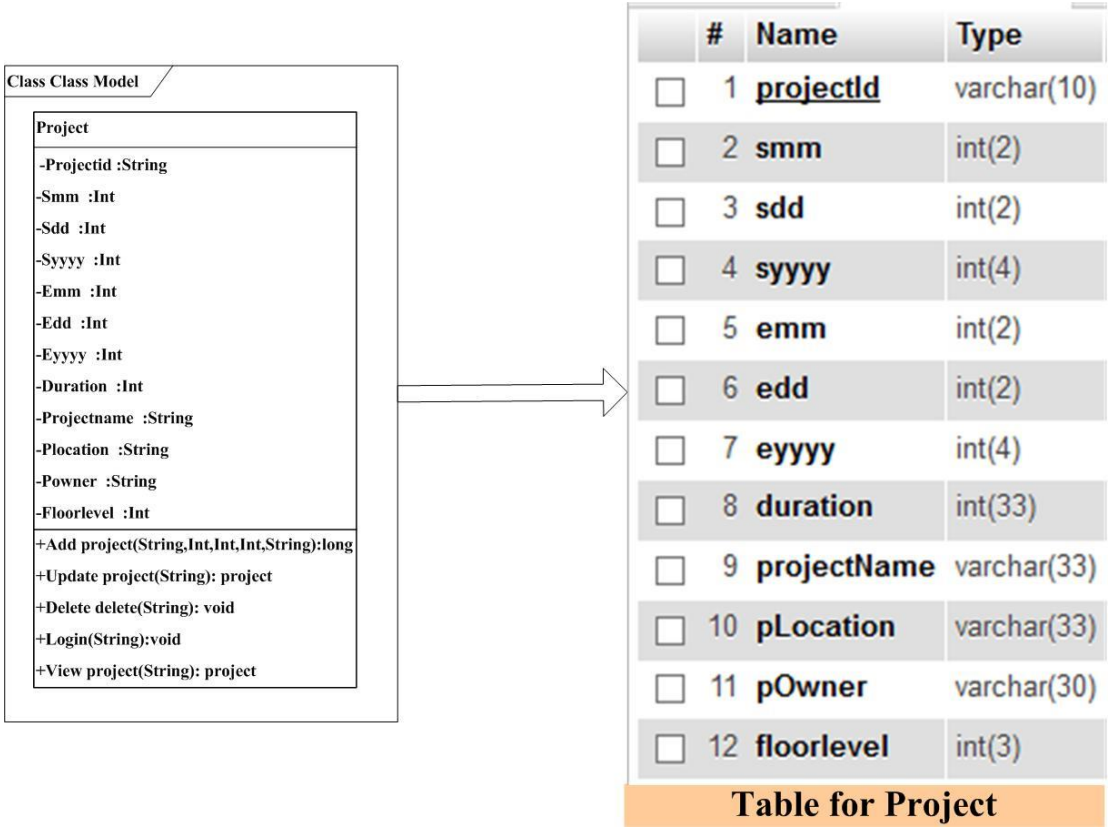
4.4.4 Persistent data management

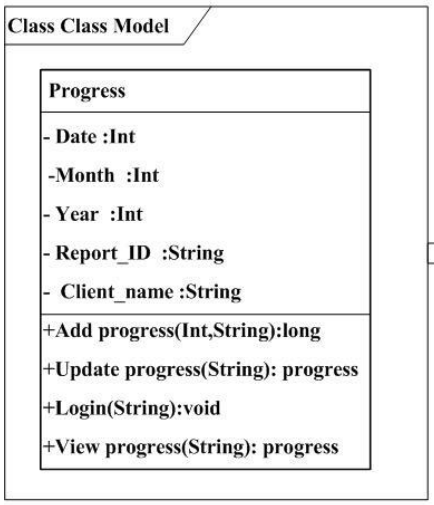
Persistent data management deals with how the persistent data (file, database, etc) are stored and managed and it outlives a single execution of the system. Information related to user, resource, diary and other related information are persistent data and hence stored on a database management system. This allows all the programs that operate on the construction management system data to do consistently.

In order to store information persistently we map objects into tables and the attributes into fields to the specific table based on the objects found on the system. Therefore, we identified the major tables that will be implemented on the selected DBMS.

Figure 30: Some of the mapping of objects to tables is displayed as in the following figures.

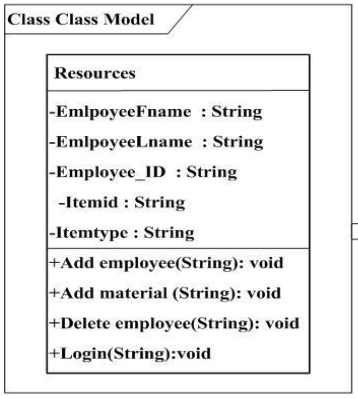






#	Name	Type
1	date	int(20)
2	month	int(20)
3	year	int(70)
4	Report_ID	varchar(77)
5	client_name	varchar(55)
6	consultant_name	varchar(55)
7	contructor_name	varchar(77)
8	project_name	varchar(20)
9	site_location	varchar(20)
10	work_type	varchar(99)
11	total_work1	int(20)
12	total_work2	int(30)

Table for Progress

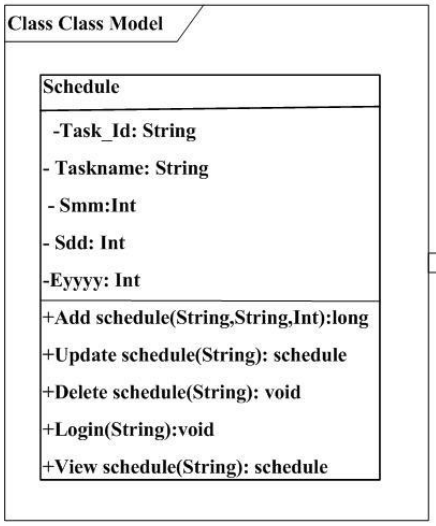


#	Name	Type
1	date	text
2	month	text
3	year	text
4	Employee_ID	varchar(7)
5	fname	varchar(20)
6	lname	varchar(20)
7	sex	varchar(6)
8	age	int(2)
9	pnumber	int(10)
10	email	varchar(40)
11	profession	varchar(40)
12	nationality	varchar(30)

Table for Employee

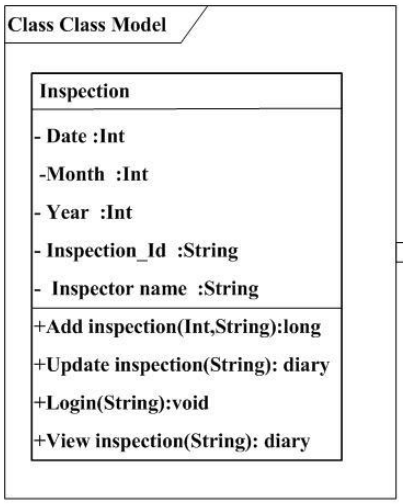
#	Name	Type
1	itemId	varchar(10)
2	itemName	varchar(30)
3	itemType	varchar(30)
4	itemAmount	int(3)

Table for Resource



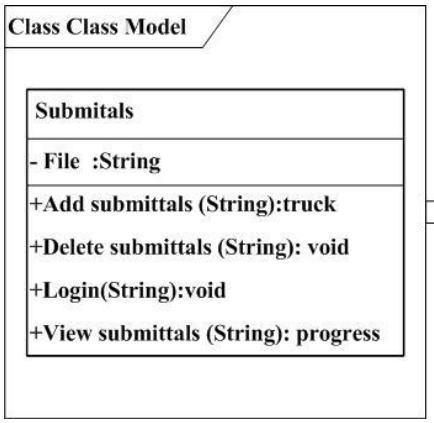
#	Name	Type
1	Task_ID	varchar(10)
2	taskName	varchar(40)
3	smm	int(10)
4	sdd	int(2)
5	syyyy	int(4)
6	emm	int(2)
7	edd	int(2)
8	eyyyy	int(4)
9	duration	int(4)
10	resource	int(3)
11	nextTask	varchar(40)

Table for Schedule



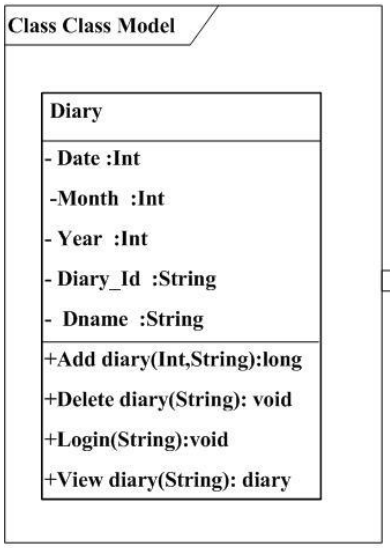
#	Name	Type
1	date	int(11)
2	month	int(11)
3	year	int(11)
4	Inspection_Id	varchar(7)
5	inspector_name	varchar(7)
6	job	varchar(77)
7	Slocation	varchar(40)
8	block	varchar(40)
9	floor	varchar(40)

Table for Inspection



#	Name	Type
1	file	varchar(110)

Table for Truck



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3	year	int(11)
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5	dname	varchar(20)
6	qualification	varchar(88)
7	plumb	varchar(120)
8	wall	varchar(88)
9	chiseling	varchar(20)
10	testing	varchar(208)
11	plaster	varchar(77)
12	quality	varchar(20)

Table for Diary

4.4.5 Access control and security

Upon start up, the system will present the user a login screen. The user will then be asked to enter user name and password. After the user entered the information, the system verifies whether the information entered is valid or not. If it is valid, the system will give access to the user based on the group to which the user belongs.

Table 2: The Access control and security of system

Sub system	Operations
Manage users	+Add user()
	+Update user()
	+Delete user()
	+Login()
	+View user()
Manage resource	+Add employee()
	+Add material ())
	+Delete employee()
	+Delete material()
	+Update material()
	+Update employee()
	+View material ()
	+View employee()
	+Login()
Start the project	+Add project()
	+Update project()
	+Delete delete()
	+Login()
	+View project()
Monitor schedule	+Add schedule()
	+Update schedule()
	+Delete schedule()
	+Login()
	+View schedule()
Manage Progress	+Add progress()
	+Update progress()
	+Delete progress()
	+Login()
	+View progress()

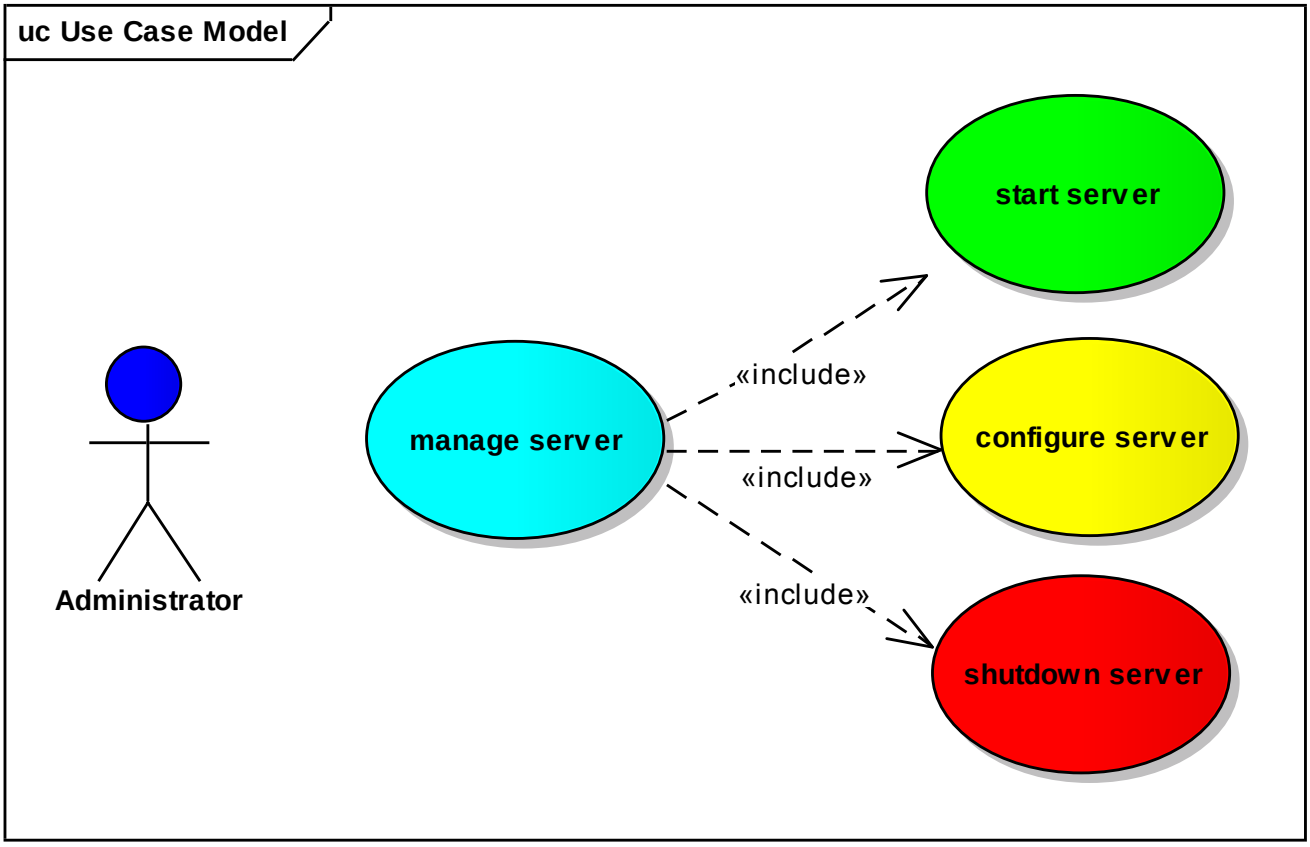
Truck submittals	+Add submittals()
	+Update submittals()
	+Delete submittals()
	+View submittals()
Manage Inspection	+Add inspection()
	+Update inspection()
	+Delete inspection()
	+View inspection()
Monitor Diary	+Add diary()
	+Update diary()
	+Delete diary()
	+View diary()
Review report of Forman	+View diary()
	+Login()
Review report of PM	+View material ()
	+View employee()
	+View project()
	+View schedule()
	+View progress()
	+View inspection()
	+View diary()
Review report of SE	+View inspection()
Truck submittals	+View submittals()

4.4.6 Boundary conditions

Decide how the system is started, initialized, and shut down, and we need to define how we deal with major failures. The startup and shutdown of the system will go through standard process. First the URL of the construction management system will be given to the browser, then the browser will connect to the application server then the application server will connect to the database. After the connection process is completed, the user of the system will be presented with a login screen. System is equipped with error handling facility as well. Invalid data entered by the user will not be accepted

by the system. When user-data-entry error happens, the system will display appropriate error message and re-prompts to enter the correct data.

Figure 31: Boundary conditions



4.5 Subsystem services

The resource management subsystem handles a number of operations listed as follows.

Operations provided by the ‘’Resource’’ class.

- Add employee operation is used to register employee.
- Update employee operation is used to update employee information.
- Delete employee operation is used to delete employee from the system.
- View employee operation is used to view detail information about employee.
- Add material operation is used to register material.
- Update material operation is used to update material information.
- Delete material operation is used to delete material from the system.

- View material operation is used to view detail information about material.

The user management subsystem handles a number of operations listed as follows.

Operations provided by the ‘’User account’’ class.

- Add user operation is used to register user.
- Update user operation is used to update user information.
- Delete user operation is used to delete user from the system.
- View user operation is used to view detail information about user.

The schedule management subsystem handles a number of operations listed as follows.

Operations provided by the ‘’Schedule’’ class.

- Add schedule operation is used to create schedule.
- Update schedule operation is used to update schedule information.
- Delete schedule operation is used to delete schedule from the system.
- View employee operation is used to view schedule.

The Submittals management subsystem handles a number of operations listed as follows.

Operations provided by the ‘’Truck submittals’’ class.

- Add submittals operation is used to create submittals.
- Update submittals operation is used to update submittals.
- Delete submittals operation is used to delete submittals from the system.
- View submittals operation is used to view detail information about submittals.

The start project management subsystem handles a number of operations listed as follows.

Operations provided by the ‘’Project’’ class.

- Add project operation is used to register project.
- Update project operation is used to update project information.
- Delete project operation is used to delete project from the system.
- View project operation is used to view detail information about project.

The progress management subsystem handles a number of operations listed as follows.

Operations provided by the ‘’Progress’’ class.

- Add progress operation is used to register progress of construction.
- Update progress operation is used to update progress of construction information.

- Delete progress operation is used to delete construction progress from the system.
- View progress operation is used to view detail information about construction progress.

The diary management subsystem handles a number of operations listed as follows.

Operations provided by the ‘’Diary’’ class.

- Add diary operation is used to create diary.
- Update diary operation is used to update diary information.
- Delete diary operation is used to delete diary from the system.
- View project operation is used to view detail information about diary.

The inspection management subsystem handles a number of operations listed as follows.

Operations provided by the ‘’Inspection’’ class.

- Add inspection operation is used to register inspection.
- Update inspection operation is used to update inspection information.
- Delete inspection operation is used to delete inspection from the system.
- View inspection operation is used to view detail information about inspection.

Chapter Five Implementation and Result

Implementation is the stage in the project where the theoretical design is turned into a working system and is giving confidence on the new system for the users that it will work efficiently and effectively. It involves careful planning, investigation of the current system and its constraints on implementation, design of methods to achieve the change over, an evaluation of change over methods. Apart from planning major task of preparing the implementation are education and training of users. The implementation process begins with preparing a plan for the implementation of the system. According to this plan, the activities are to be carried out, discussions made regarding the equipment and resources and the additional equipment has to be acquired to implement the new system. In network backup system no additional resources are needed. Implementation is the final and the most important phase. The most critical stage in achieving a successful new system is giving the users confidence that the new system will work and be effective. The system can be implemented only after thorough testing is done and if it is found to be working according to the specification. This method also offers the greatest security since the old system can take over if the errors are found or inability to handle certain type of activity while using the new system.

5.1 Implementation Methods:

There are several methods for handling the implementation and the consequent conversion from the old to the new computerized system.

The most secure method for conversion from the old system to the new system is to run the old and new system in parallel. In this approach, a person may operate in the manual older processing system as well as start operating the new computerized system. This method offers high security, because even if there is a flaw in the computerized system, we can depend upon the manual system. However, the cost for maintaining two systems in parallel is very high. This outweighs its benefits.

Another commonly method is a direct cut over from the existing manual system to the computerized system. The change may be within a week or within a day. There are no parallel activities. However, there is no remedy in case of a problem. This strategy requires careful planning.

A working version of the system can also be implemented in one part of the organization and the personnel will be piloting the system and changes can be made as and when required. But this method is less preferable due to the loss of entirety of the system.

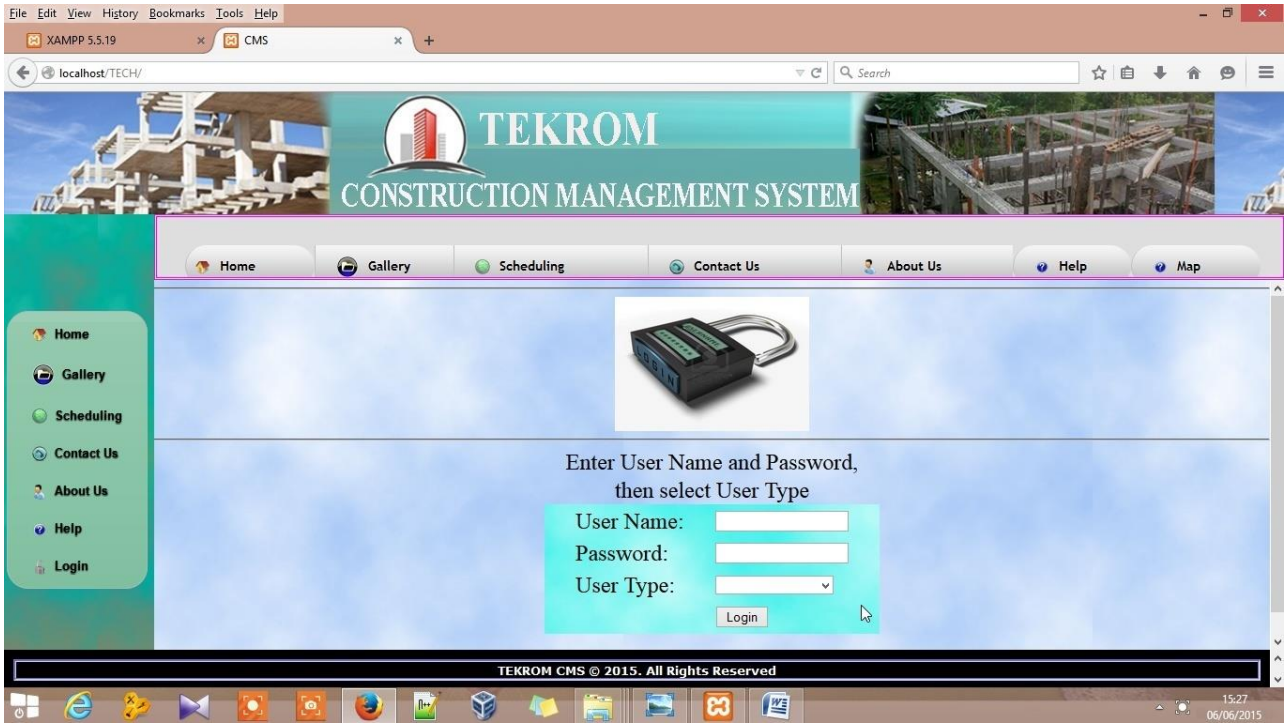
5.2 Implementation Plan:

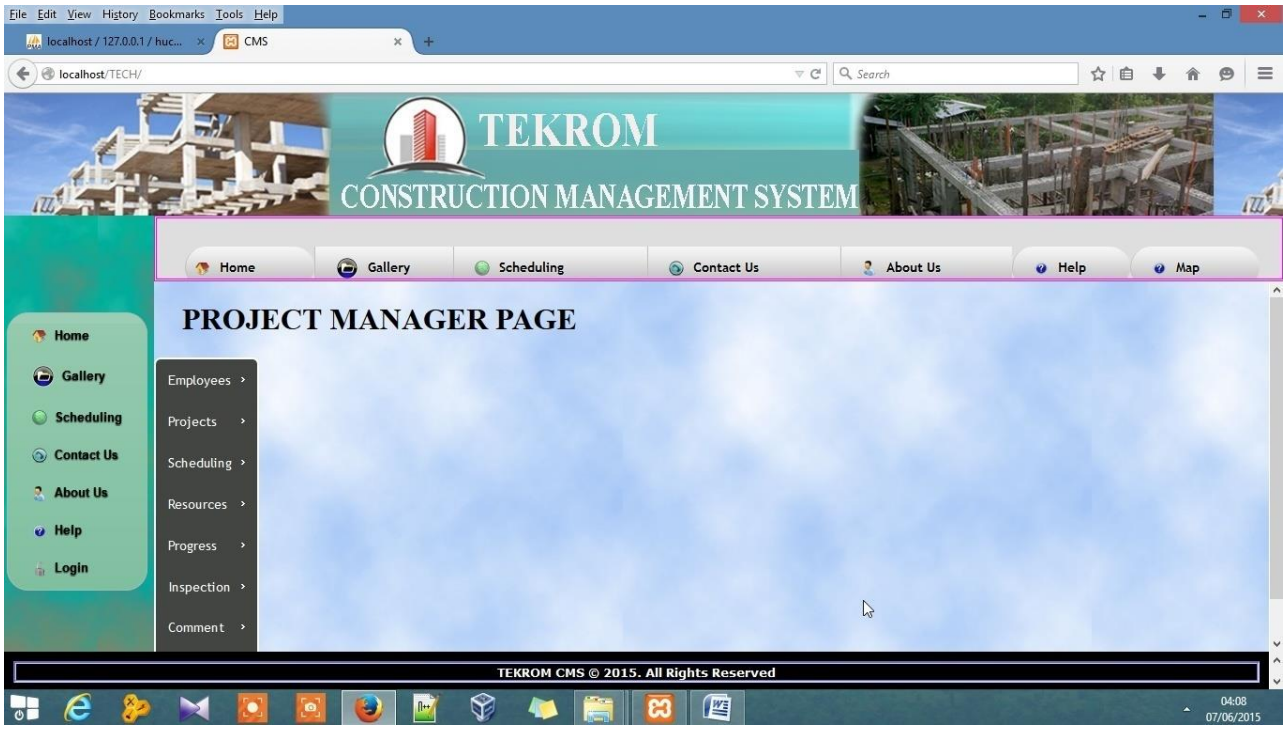
The implementation plan includes a description of all the activities that must occur to implement the new system and to put it into operation. It identifies the personnel responsible for the activities and prepares a time chart for implementing the system. The implementation plan consists of the following steps.

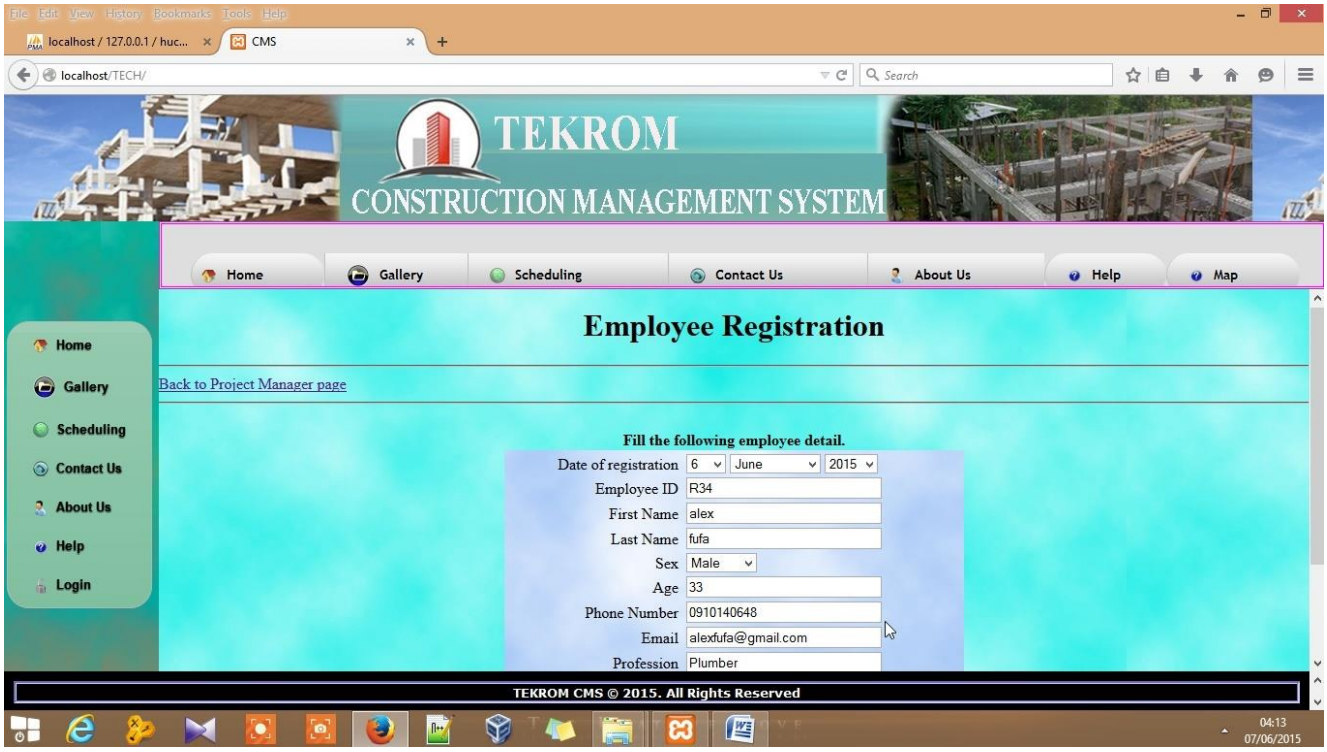
- List all files required for implementation.
- Identify all data required to build new files during the implementation.
- List all new documents and procedures that go into the new system.

The implementation plan should anticipate possible problems and must be able to deal with them. The usual problems may be missing documents, mixed data formats between current and files, errors in data translation, missing data etc.

5.3 Sample Input/output Screens



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CMS
localhost/TECH/
TEKROM
CONSTRUCTION MANAGEMENT SYSTEM
Home
Gallery
Scheduling
Contact Us
About Us
Help
Map
Login
Employee Registration
Back to Project Manager page
Fill the following employee detail.
Date of registration 6 June 2015
Employee ID R34
First Name alex
Last Name fufa
Sex Male
Age 33
Phone Number 0910140648
Email alexfufa@gmail.com
Profession Plumber
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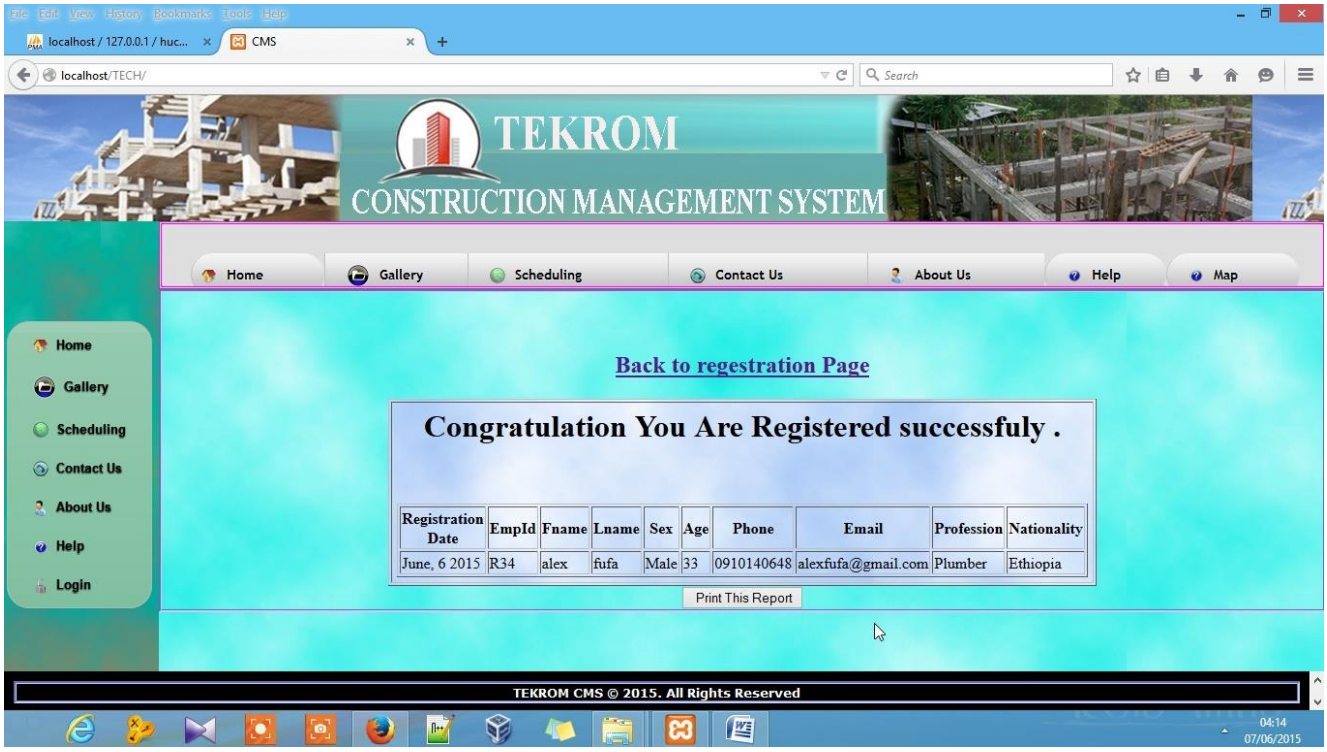
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Congratulation You Are Registered successfuly .
Registration Date | EmpId | Fname | Lname | Sex | Age | Phone | Email | Profession | Nationality
June, 6 2015 | R34 | alex | fufa | Male | 33 | 0910140648 | alexfufa@gmail.com | Plumber | Ethiopia
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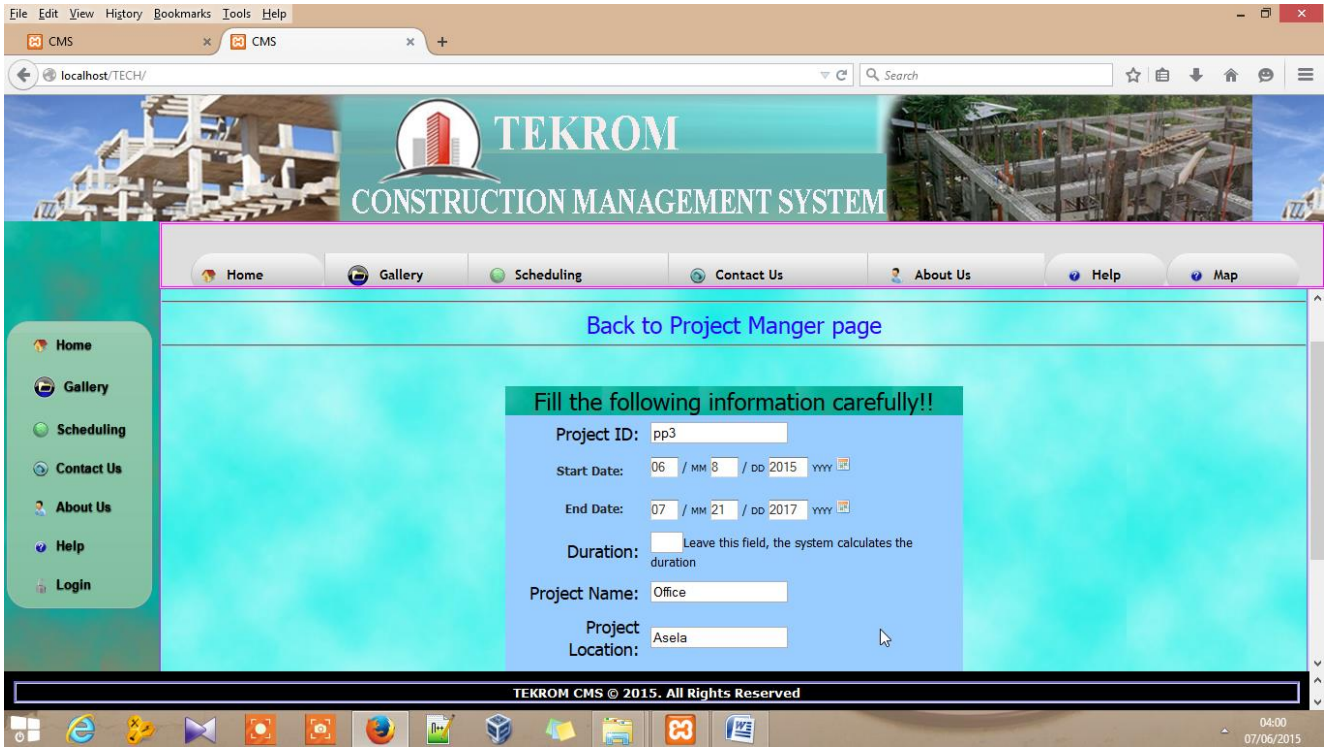
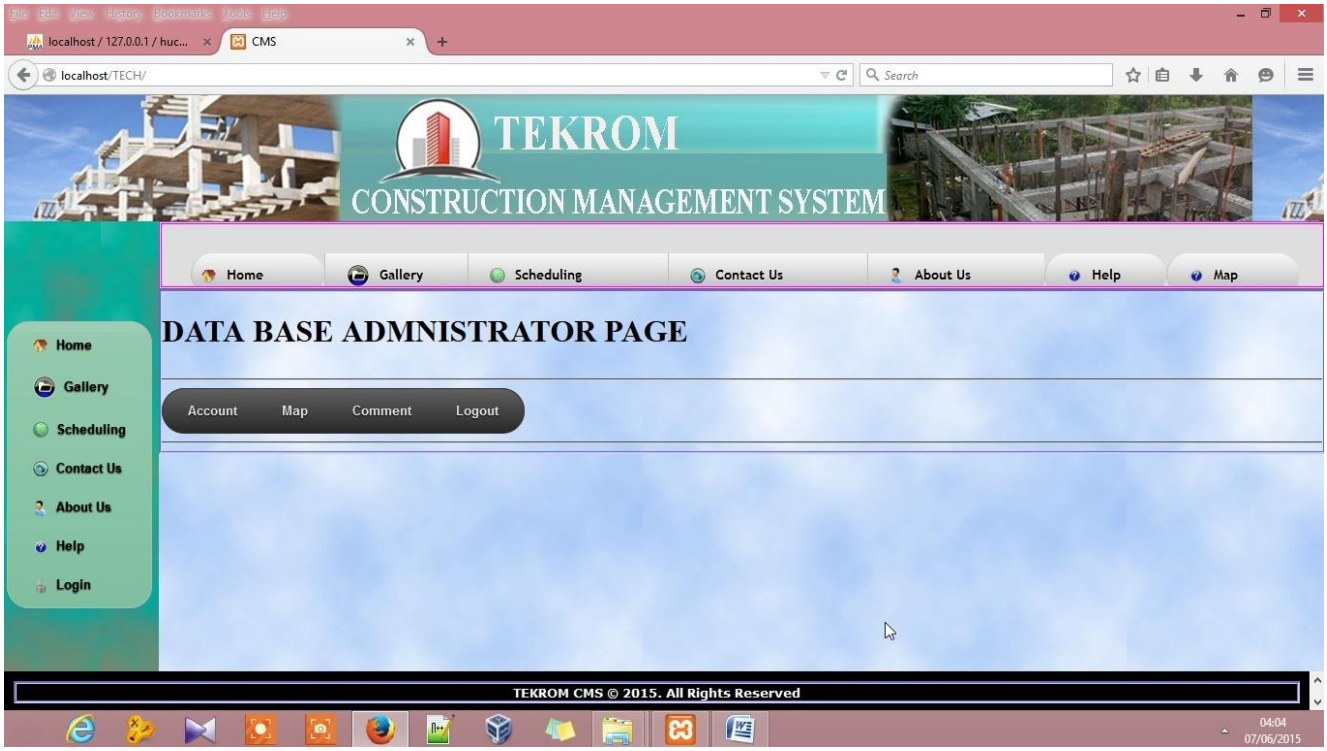

TEKROM
CONSTRUCTION MANAGEMENT SYSTEM
Home
Gallery
Scheduling
Contact Us
About Us
Help
Map
Back to Project Manger page
Fill the following information carefully!!
Project ID: pp3
Start Date: 06 / MM 8 / DD 2015 YYYY
End Date: 07 / MM 21 / DD 2017 YYYY
Duration: Leave this field, the system calculates the duration
Project Name: Office
Project Location: Asela
TEKROM CMS © 2015. All Rights Reserved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Scheduling
Contact Us
About Us
Help
Map
DATA BASE ADMNISTRATOR PAGE
Account
Map
Comment
Logout
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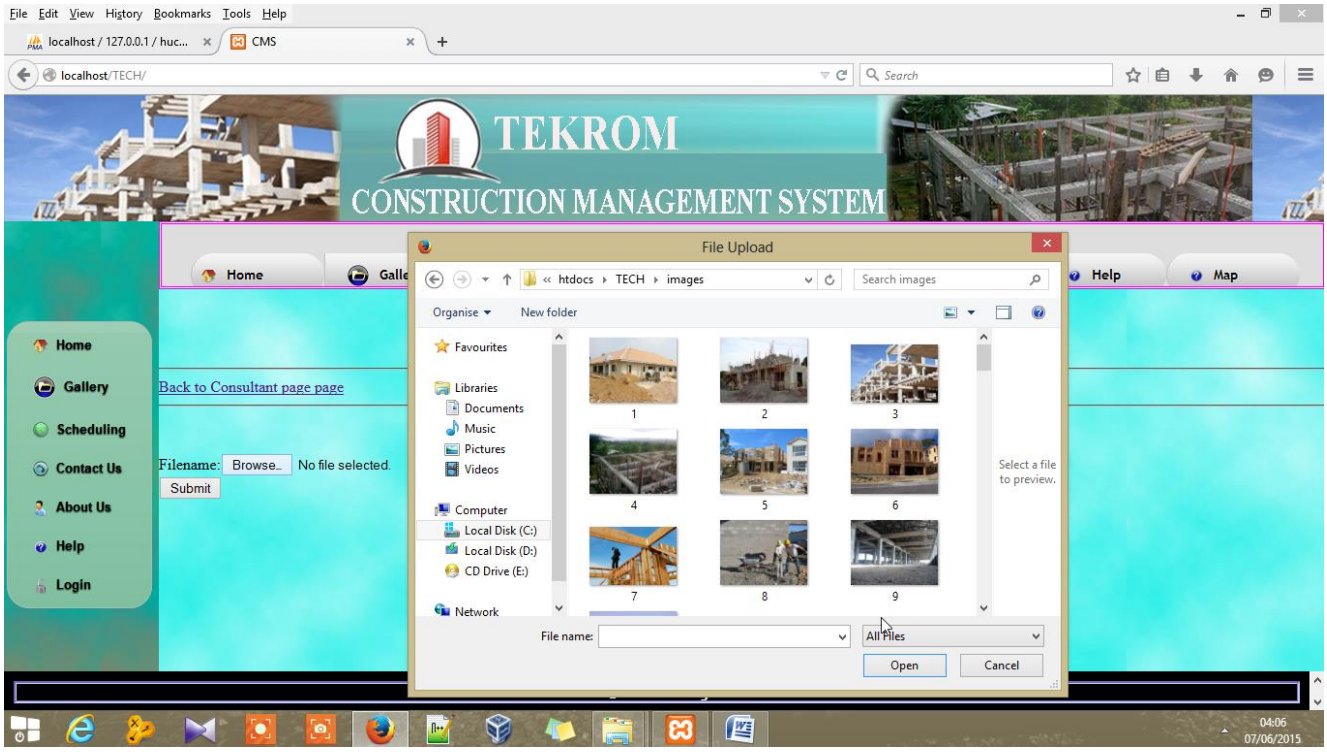
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Back to Consultant page page
Filename:
Browse..
No file selected.
Submit
File Upload
htdocs ▸ TECH ▸ images
Search images
Organise
New folder
Favourites
Libraries
Documents
Music
Pictures
Videos
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Local Disk (C:)
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Select a file to preview.
File name:
All Files
Open
Cancel
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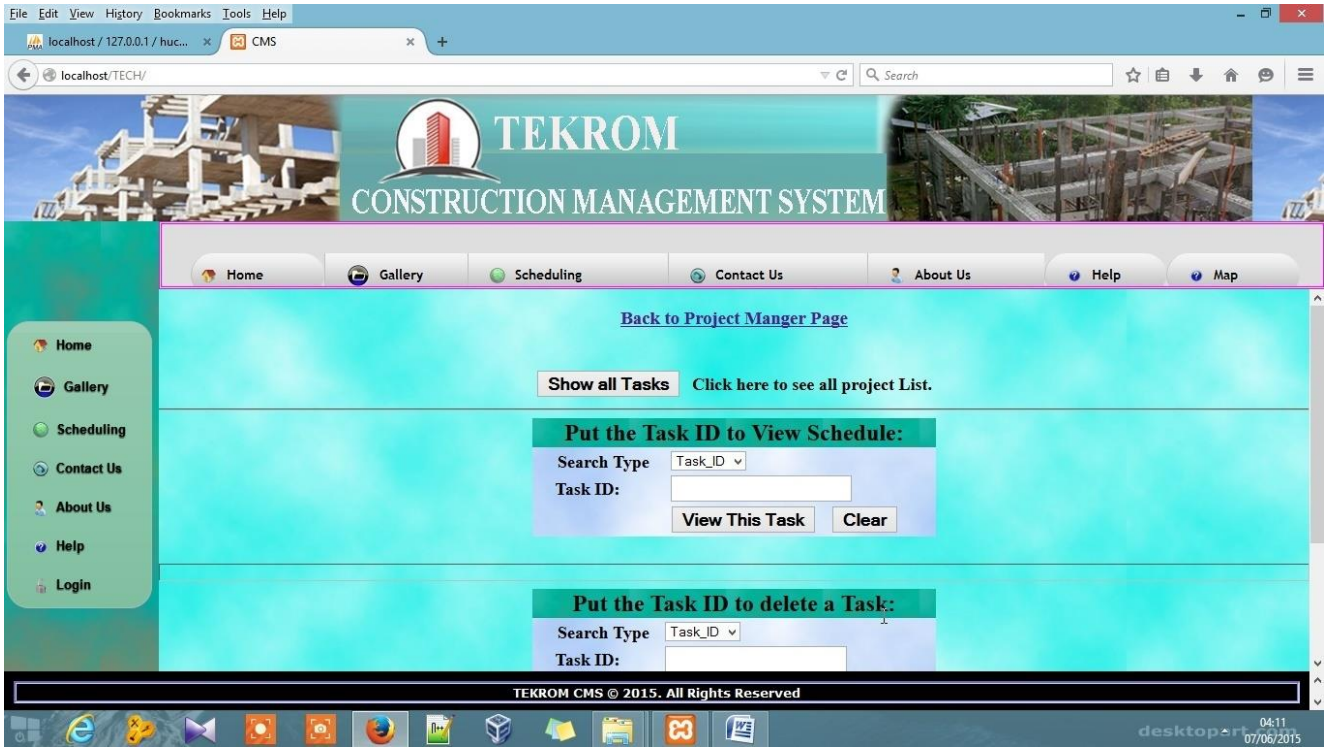
07/06/2015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Scheduling
Contact Us
About Us
Help
Login
Map
Back to Project Manger Page
Show all Tasks
Click here to see all project List.
Put the Task ID to View Schedule:
Search Type
Task_ID
Task ID:
View This Task
Clear
Put the Task ID to delete a Task:
Search Type
Task_ID
Task ID:
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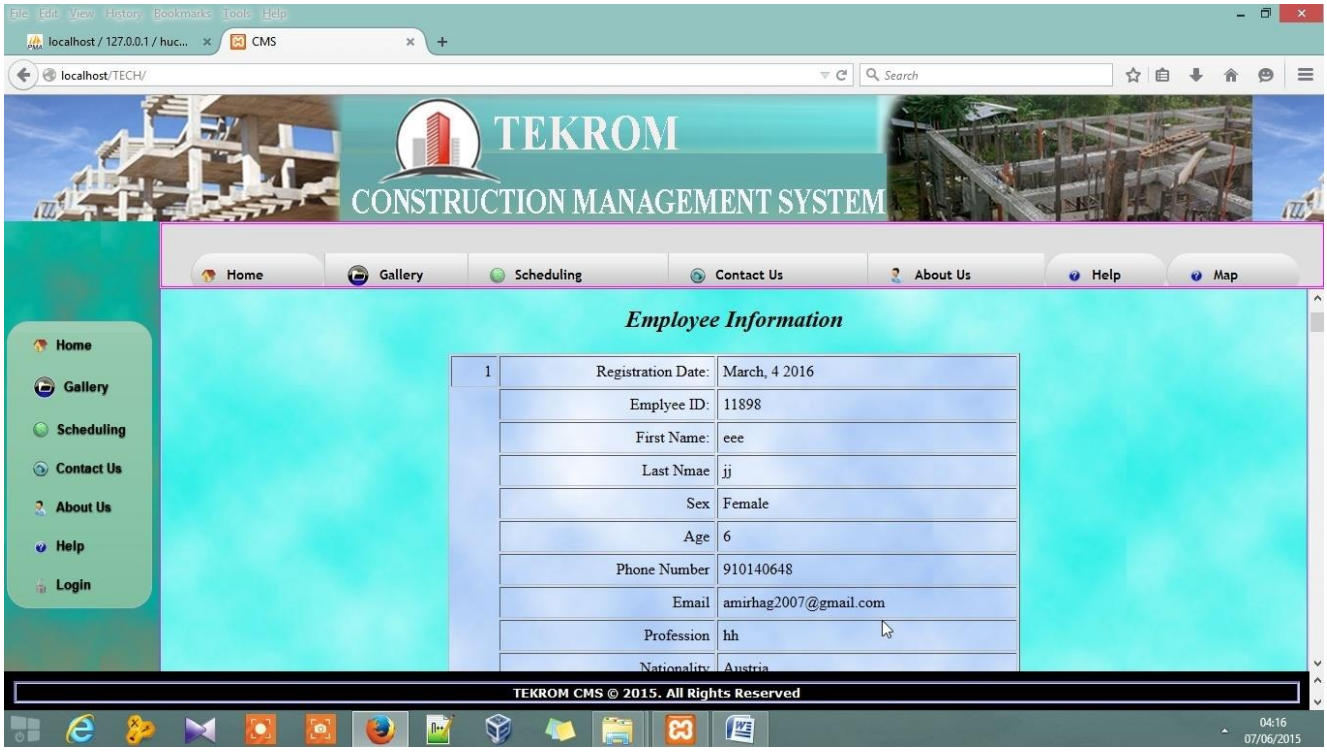
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Scheduling
Contact Us
About Us
Help
Map
Login
Employee Information
1
Registration Date: March, 4 2016
Emplyee ID: 11898
First Name: eee
Last Nmae jj
Sex Female
Age 6
Phone Number 910140648
Email amirhag2007@gmail.com
Profession hh
Nationality Austria
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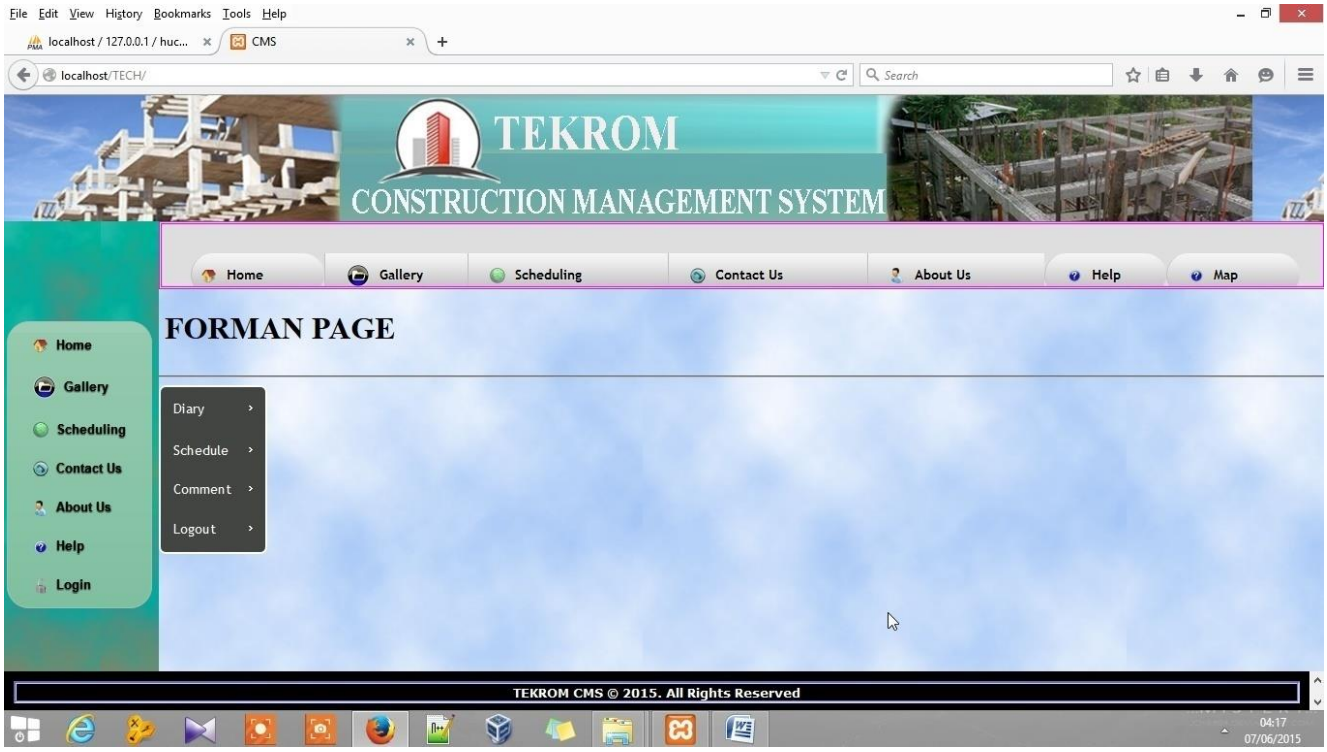
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FORMAN PAGE
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5.4 Results & Advantages

Interpretation of the Result

The system has been implemented and tested successfully. It meets the information Requirements specified to the great extent. Although the system has been designed keeping the Present and future requirements in mind and made very flexible. There are limitations of the

System. Proper consideration has been given for a wide range of new enhancements in The future, throughout the development of system. The system is developed user friendly. In future, if it is required to generate reports other than provided by the system, it can be simply Achieved by a separate module to the main menu without affecting the design of the system.

ADVANTAGES

- It simplifies the operation.
- It avoids a lot of manual work.
- Avoids errors by avoiding the manual work.
- User friendly screen to enter the data and Enquire the database tables.
- User can easily access the system without much experience.
- Provide Hardware and software securities.
- It provides security to the data.
- Portable and flexible for further extension.
- The access to the Server information is more secured by using the Authentication process of manager.

Chapter Six TESTING:

6.1.1 Introduction

Testing is a process to show the correctness of the program. Testing is needed to show completeness, t improve the quality of the software and to provide the maintenance aid. Some testing standards are therefore necessary reduce the testing costs and operation time.

Testing software extends throughout the coding phase and it represents the ultimate review of configurations, design and coding. Based on the way the software reacts to these testing, we can decide whether the configuration that has been built is study or not. All components of an application are tested, as the failure to do so many results in a series of bugs after the software is put to use.

6.1.2 Test Plan Overview

Test Plan is defined as a strategic document which describes the procedure how to perform various testing on the total application in the most efficient way.

- This document involves the scope of testing,
- Objective of testing,
- Areas that need to be tested,
- Areas to be automated, various testing tools used

Test Development:

1. Test case Development (check list)
2. Test Procedure preparation. (Description of the test cases)

Test Execution:

1. Implementation of test cases. Observing the result.

Result Analysis:

1. Expected value: is nothing but expected behavior of application.
2. Actual value: is nothing but actual behavior of application.

Bug Tracing: Collect all the failed cases, prepare documents.

Reporting: Prepare document (status of the application)

6.1.3 Features to be tested

I. Black box testing

Black box testing also called behavioral testing, focuses on the functional requirements of software. This testing approach enables the software engineer to derive the input conditions that will fully exercise all requirements for a program. Black box testing attempts to find the errors like

- Incorrect or missing functions
- Interface errors
- Errors in data structures or external database access
- Behavior or performance errors
- Initialization and termination errors

In Black box testing software is exercised over a full range of inputs and outputs are observed for correctness.

II. White Box Testing

White box testing is also called Glass box testing is a test case design control; structure of the procedural design to derive test cases using White box testing method, the software engineer can derive the test cases that guarantee that all independent paths within the module have been exercised at least once. Exercise all logic decisions on their true or false sides. Execute all loops at their boundaries and within their operational bounds. Exercise internal data structure to ensure their validity.

6.1.4 Test Approach

Testing can be done in two ways:

- Bottom up approach
- Top down approach

Bottom up approach: Testing can be performed starting from smallest and lowest level modules and proceeding one at a time. For each module in bottom up testing a short program executes the module and provides the needed data so that the module is asked to perform the way it will when embedded within the larger system. When bottom level modules are tested attention turns to those on the next level that use the lower level ones they are tested individually and then linked with the previously examined lower level modules.

Top down approach: This type of testing starts from upper level modules, since the detailed activities usually performed in the lower level routines are not provided stubs are written. A stub is a module shell called by upper level module and that when reached properly will return a message to the calling module indicating that proper interaction occurred. No attempt is made to verify the correctness of the lower level module.

6.1.5 Software testing strategies

Testing involves

- Unit testing
- Integration testing
- System testing
- Acceptance testing

The first level of test is unit testing. The purpose of unit testing is to ensure that each program is fully tested.

The second step is integration testing. In this individual program units or programs are integrated and tested as a complete system to ensure that the software requirements are met.

The third step System testing is actually a series of different tests whose primary purpose is to fully exercise the computer-based system.

Acceptance Testing involves planning and the execution of various types of tests in order to demonstrate that the implemented software system satisfies the requirements. Finally our project meets the requirements after going through all the levels of testing.

6.2 Test Case Specification

Test scope:

1. Test coverage is provided for the screen “Contraction project Management status entry” form of a project, employee, Material, Scheduling, modules of CMS application.

2. Areas of the application to be tested

A. Unit testing

- **Login Module:**

Sr. No	Test Case Description	Input	Expected Behavior	Observed behavior	Test Result
1	Can ID field be Null?	Null ID	ID cannot be NULL	Warning msg "ID can't be NULL"	Success
2	Can password be Null?	Null password	Password Can't be NULL	Warning msg "password can't be Null"	Success
3	Login button is working or not?	Button pressed	Perform login processing	Call proxy Inbox frame	Success
4.	Is Login Frame displaying properly?	Invoke Login Frame	All text fields are displayed and are properly aligned	Little alignment problem	Success

Table 3: **Login Module**

- **Server side Login Module**

Sr. No	Test Case Description	Input	Expected Behavior	Observed behavior	Test Result
1	Is Database Connection establishing?	Connection object is created	Connection establishes	No error during connection was found	Success
2	Is able to retrieve Login ID and password from database?	Login ID+ Pass-Word	Able to fetch data from Database	No error found during data fetching	Success
3	Is able to match Login ID & Password	Login Id +Pass-word	Proper matching	Matching done	Success

Table 4: Server side Login Module

- **Client- Server Login Module combined Testing**

  Add Record Module:

Sr. No	Test Case Description	Input	Expected Behavior	Observed behavior	Test Result
1.	Is Database Connection establishing?	Connection object is created	Connection establishes	No error during connection was found	Success
2	Addition of Employee	Reg.date/Emp.ID/Fname/Lname/Sex/Age/Pno/ Email/Proffesio	Addition Completed.	Addition Completed.	Success
2	Addition of Project	Project ID/Name/Sdate/ EDate/Duration/ ProjectLocation/	Addition Completed.	Addition completed	Success
3	Adding a Project which already exits.	Project ID/Name/Sdate/ Edate/Duration/ ProjectLocation/	Addition should not complete	Addition is not completed, because record already exists.	Success
4	Addition of a schedule	Task ID/TaskName/sdate/edate/duration/resource/next task	Addition Completed	Addition completed	Success
5	Addition of an overlapping schedule with the master schedule.	Task ID/TaskName/sdate/edate/duration/resource/next task			

Table 5: Add Record Module.

- **View Record Module:**

Sr. No	Test Case Description	Input	Expected Behavior	Observed behavior	Test Result
1.	Is Database Connection establishing?	Connection object is created	Connection establishes	No error during connection was found	Success
2	On search Criteria of EmployeeID view emp record .	Employee ID	Records found and displayed on the view page.	Records found and displayed on the view page.	Success
3	On search Criteria of ProjectID view project record	Project ID	Records found and displayed on the view page	Records found and displayed on the view page	Success
4	On search Criteria of TaskID view Task record	Task ID	Records found and displayed on the view page	Records found and displayed on the view page	Success

Table 6: View Record Module.

B/ Integration Testing

- **Register Module, Login Module and Logout Module is Integrated**

Sr No	Test Case Description	Input	Expected Behavior	Observed behavior	Test Result
1	Is new User created?	Login ID +personal information	User should be created and personal information should be stored in Database	User named ID is created.	Success
2	Is Database Connection establishing?	Connection object is created	Connection establishes	No error during connection was found	Success
3	Is able to match Login ID & Password	Login Id +Pass-word	Proper matching	Matching done	Success
4	Does status of user changes to 'Logout status'?	Logout cmd	Status should change.	No change in status	Success

Table 7: Register Module, Login Module and Logout Module is Integrated

- **Add Record Module, Delete Record Module, Update Record Module, Search Record Module is Integrated**

Sr No	Test Case Description	Input	Expected Behavior	Observed behavior	Test Result
1	Is new Record Added in database?	Project ID/ProjName/Sdate /EDate/Duration/Pr ojectLocation/Proje ct owner etc	Records should be added and displayed on the view page	Record is added and displayed on the view page.	Success
2	Is existing Record deleted from database?	Project ID/ProjName/Sdate /EDate/Duration/Pr ojectLocation/Proje	Records should be deleted and should not be displayed on the	Record is deleted and not displayed on the view page.	Success
3	Is existing Record updated into database?	Project ID/ProjName/Sdate /EDate/Duration/Pr ojectLocation/Proje ct owner etc	Records should be updated and should be displayed on the view page	Record is updated and displayed on the view page.	Success
4	On search Criteria names should be correct.	Project ID/ProjName/Sdate /EDate/Duration/Pr ojectLocation/Proje ct owner etc	Records should be displayed on the view page	Records found and displayed on the view page.	Success

Table 8: Add Record Module, Delete Record Module, Update Record Module, Search Record Module is Integrated.

C/ System Testing

- **Functional Requirements**

Sr. No	Test Case Description	Input	Expected Behavior	Observed behavior	Test Result
1	Can New User Register?	Personal Info of User	User should Be registered on the server	User is Registered only If desired Id does Not collide with Existing Ids	Success
2	Can User Login?	Loginld + password	User should Be login	User is login only When Login Id & password is valid	Success
3	Can User Add Records	Project ID/ProjName/ Sdate/EDate/ Duration/Proj ectLocation/P roject owner etc	User should be able to Add records	Added records will be displayed	Success
4.	Can User Delete Records	Project ID/ProjName/ Sdate/EDate/ Duration/Proj ectLocation/P roject owner etc	User should be able to delete records	Deleted records will not be displayed	Success

5	Can User Update Records	Project ID/ProjName/ Sdate/EDate/ Duration/Proj ectLocation/P roject owner etc	User should be able to update records	Updated records will be displayed	Success
6.	Can User Search Records	Project ID/ProjName/ Sdate/EDate/ Duration/Proj ectLocation/P roject owner etc	User should be able to search records	Result of search will be displayed.	Success
7.	Can User Read information available on the site.	Click the link	User should be able to Read information	Information will be displayed.	Success
8	Can User Logout	Click On Logout	User should be able to Logout	Logout Message	Success

Table 9: Functional requirements

Chapter Seven

7.1 Conclusion

The entire project has been developed and deployed as per the requirements stated by the user, it is found to be bug free as per the testing standards that are implemented. The project deals with various operations and activates that are carried out in the different levels of construction management System. Object oriented model is adopted for the development of the project.

As we come to the end of our project development, So far in our effort to complete all phases of the project, this document consists of seven chapters including this chapter.

In the introduction part the organization, for which this project is carried out, the project is dealt with within detail. It consists of the project goal, duration of project, scope, limitation and others are discussed thoroughly.

In the second chapter the related literature review, theoretical background, related studies and experiences on the construction management systems through the world are discussed in details.

In the third chapter requirement analysis, functional and non functional of the system is discussed, in detail for the purpose of modeling efficient new systems.

In the fourth chapter the new system modeled using the system diagram such as the system use case model, sequence diagrams, class diagrams, activity diagrams and system user interface prototyping. The project team so far has seen the basic functionality of the new system identified and documented. The output of this phase of the project will be the base of the next phase between the states.

In the fifth chapter the implementation and the result, algorithm they used, method used, sample input/output screens and sample codes are mentioned in details.

The coding is done in a simplified and easy to understandable manner so that other team trying to enhance the project can do so without facing much difficulty. The documentation will also assist in the process as it has also been carried out in a simplified and concise way.

In the six chapters testing plan is the exposure of the system to trial input to see whether it produces correct output or not are evaluated. Testing software extends throughout the coding phase and it represents the ultimate review of configurations, design and coding. Based on the way the software reacts to these testing, we can decide whether the configuration that has been built is study or not. All

components of an application are tested, as the failure to do so many results in a series of bugs after the software is put to use.

In persistence modeling the classes that permanently store information in the database and relationship between them are shown. The user interface design is very helpful because it considers the end user of the system. Therefore a lot of work and time is spent on this part to make the user interface user friendly. The designed components were converted in to the actual and databases are created at this phase of the project. Furthermore the team project has discussed the general architecture of the system with the installation. Software and hardware requirement.

The main advantage of the system over the existing system is the increase in the speed of information retrieval since that data is maintained systematically and any type of information required for the end user of the system can be generated easily. Any specification untraced errors will be concentrated in the coming versions, which are planned to be developed in near future. User friendliness is the unique feature of this system. The system generates the reports as and when required. Data entry into the application can be done through various screens designed for various levels of users. Once the authorized personnel feed the relevant data into the system, several reports could be generated as per the requirements.

This system offers information relevant to the user accessing the application thus avoiding unnecessary overloading and at the same time maintaining the security.

Generally, project team would like to remark that the project has given us a great deal of experience not only in the technical aspects but also in writing together as a team to accomplish a certain goal, which is a much desired quality. The project team also would like to point that our project team set out to accomplish at the beginning of the project.

7.2 Results achieved

Main Achievement of the System

After entering into the project, user is left with several options via –

a) The user can take new connections.
b) The user can view the existing lists of project, which already have system connections.
c) The user can of course see schedule & take scheduling statements.
d) The user can also do several administrative works like managing resource, addition or modification of employee & material entries.
e) The user can View the map and can also modify it if and only if he/she is an authorized person.
f) The user can of course truck submittals, and inspection works. Also can work with Diaries.

User friendliness is another unique feature of this system. The system generates the reports as and when required. Data entry into the application can be done through various screens designed for various levels of users. Once the authorized personnel feed the relevant data into the system, several reports could be generated as per the requirements.

This system offers information relevant to the user accessing the application thus avoiding unnecessary overloading and at the same time maintaining the security.

7.3 Limitation of the project

Limitation:

1 The size of the database increases day-by-day, increasing the load on the database back up and data maintenance activity.
2 Training for simple computer operations is necessary for the users working on the system.

7.4 Future works

Every application has its own merits and demerits. The project has covered almost all the requirements. Further requirements and improvements can easily be done since the coding is mainly structured or modular in nature. Changing the existing modules or adding new modules can append improvements. Further enhancements can be made to the application, so that the web site functions very attractive and useful manner than the present one.

8. The project has been brought within a short period of time, thereby were not able to reach all the options, as we found new during our project work.
9. As the new requirements arise, options can be added to the system by defining the functionality for the element.
10. Construction managers can even view live happenings at the site location without physically being at the site, in its city, or even country.
11. Portability is maintained in this software.
12. Modification can be made to implement the software so that it can be well applicable to worldwide organization.
13. The software is not applicable for any other applications.
14. At this time the software is not act as a fully user friendly. Because valid user is not able to change its details itself and these permissions are allowed to Administrator only.
15. Database may be available in future for long times and information may be use anytime.
16. This System being web-based and an undertaking of Cyber Security Division, needs to be thoroughly tested to find out any security gaps.
17. A console for the data centre may be made available to allow the personnel to monitor on the sites which were cleared for hosting during a particular period.

7.5 References

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- Apache Tomcat http://tomcat.apache.org
- MySQL http://www.mysql.com
- UML official website http://www.uml.org/
- StarUML - The Open Source UML/MDA Platform http://staruml.sourceforge.net/
- http://www.php.net
- http://www.w3schools.com

Appendix A:

Interview guide

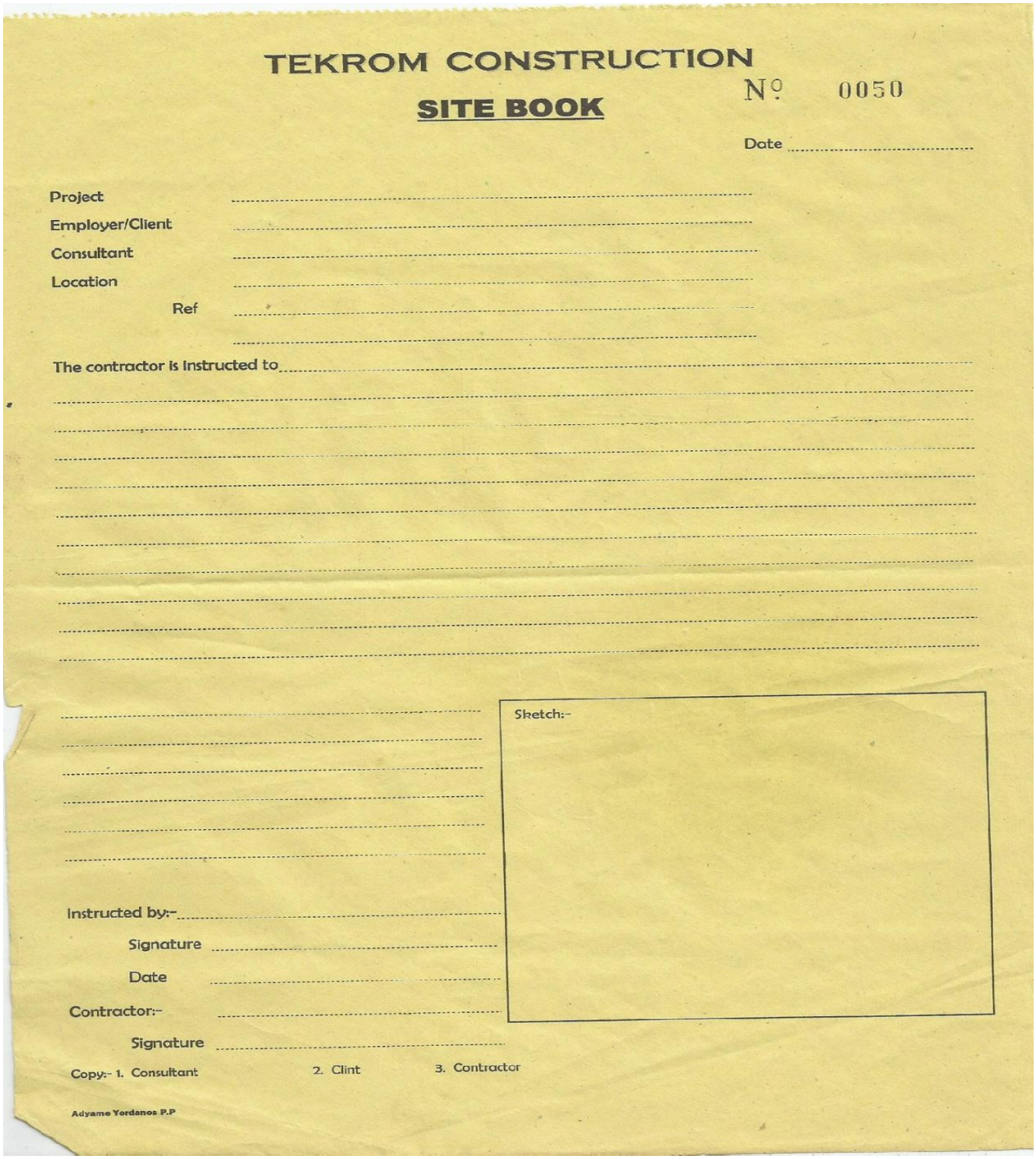
The interviewer gave an explanation to the respondents about the intention of the interview before proceeding to the questions bellow:

Some of the questions that we have already asked are:

1. How construction management system is going on?
2. During construction time, are there any problems? If there, what are they?
3. What requirements are needed for the process?
4. Who is responsible for what?
5. Are there documented records of external communications with Clients, suppliers, other parties?
6. How the Contractor identified and determined the impact of legislative and statutory obligations on the safety, health, environment and quality of their processes and services?

Appendix B

Document analysis diagram 1.



TEKROM CONSTRUCTION

SITE BOOK

Nº 0050

Date .....

Project .....

Employer/Client .....

Consultant .....

Location .....

Ref .....

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The contractor is instructed to .....

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Sketch:-

Instructed by:- .....

Signature .....

Date .....

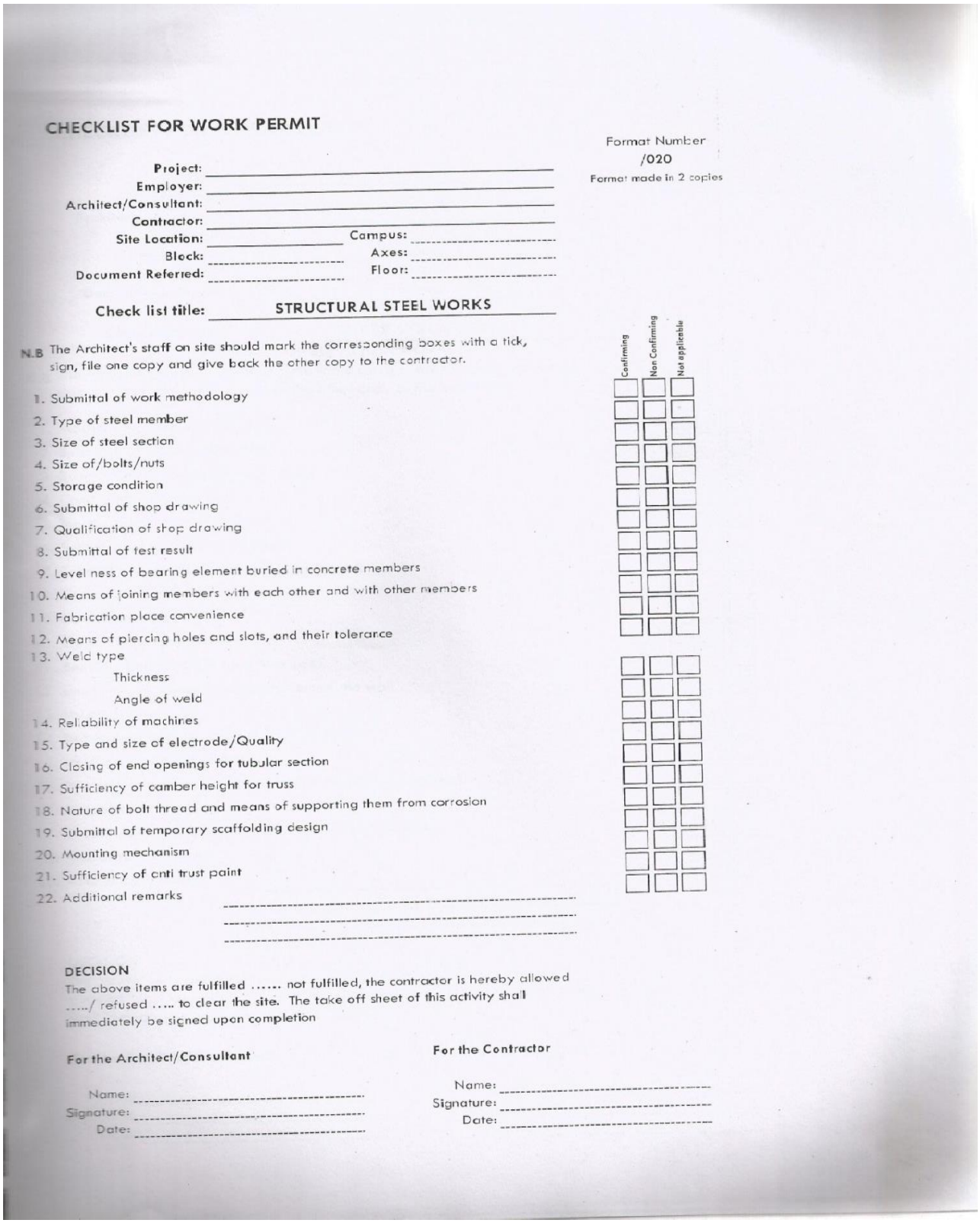
Contractor:- .....

Signature .....

Copy:- 1. Consultant 2. Clint 3. Contractor

Adyame Yordanos P.P

Document analysis diagram 2.



CHECKLIST FOR WORK PERMIT

Format Number
/020
Format made in 2 copies

Project: _____
Employer: _____
Architect/Consultant: _____
Contractor: _____
Site Location: _____ Campus: _____
Block: _____ Axes: _____
Document Referred: _____ Floor: _____

Check list title: STRUCTURAL STEEL WORKS

N.B The Architect's staff on site should mark the corresponding boxes with a tick, sign, file one copy and give back the other copy to the contractor.

	Confirming	Non Confirming	Not applicable
1. Submittal of work methodology	☐	☐	☐
2. Type of steel member	☐	☐	☐
3. Size of steel section	☐	☐	☐
4. Size of/bolts/nuts	☐	☐	☐
5. Storage condition	☐	☐	☐
6. Submittal of shop drawing	☐	☐	☐
7. Qualification of shop drawing	☐	☐	☐
8. Submittal of test result	☐	☐	☐
9. Level ness of bearing element buried in concrete members	☐	☐	☐
10. Means of joining members with each other and with other members	☐	☐	☐
11. Fabrication place convenience	☐	☐	☐
12. Means of piercing holes and slots, and their tolerance	☐	☐	☐
13. Weld type	☐	☐	☐
Thickness	☐	☐	☐
Angle of weld	☐	☐	☐
14. Reliability of machines	☐	☐	☐
15. Type and size of electrode/Quality	☐	☐	☐
16. Closing of end openings for tubular section	☐	☐	☐
17. Sufficiency of camber height for truss	☐	☐	☐
18. Nature of bolt thread and means of supporting them from corrosion	☐	☐	☐
19. Submittal of temporary scaffolding design	☐	☐	☐
20. Mounting mechanism	☐	☐	☐
21. Sufficiency of anti trust paint	☐	☐	☐
22. Additional remarks	☐	☐	☐

_____
_____
_____

DECISION

The above items are fulfilled ..... not fulfilled, the contractor is hereby allowed ...../ refused ..... to clear the site. The take off sheet of this activity shall immediately be signed upon completion

For the Architect/Consultant

Name: _____
Signature: _____
Date: _____

For the Contractor

Name: _____
Signature: _____
Date: _____