



Examination Management System for British Council

**A dissertation submitted for the Degree of Master of
Information Technology**

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DECLARATION

Declaration

The thesis is my original work and has not been submitted previously for a degree at this or any other university/institute.

To the best of my knowledge it does not contain any material published or written by another person, except as acknowledged in the text.

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ABSTRACT

BC Srilanka is one of the well-known Organization for conducting UK exams in Srilanka and Maldives. BC was established 69 years ago in Colombo – Srilanka. Presently plays a vital role with UK exams operations, English Courses, Direct for professional exams and supportive to other English activities for teachers and student in Srilanka. British Council Srilanka coordinates lot of examinations through examination boards (Cambridge, Pearson, BCS and ACCA) of UK such as School exams, IELTS, BCS, ACCA and Cambridge English in many BC branches operates through a high quality rates, standards and regulations according to network within BC staff.

At present, BC website operate daily exam registration using an automated system but this process is inefficient, unavailability and very slow for real-time transactions in web due to increase in large no of data volume with new exams and venues among these countries. Therefore, suggested Web-based Exam Management System for BC will ease up standard key-value functions internally and externally in business process as Administration, Candidate, Exam, Venue, Staff, Resource Management, Report and Backup modules within critical data protection through confidentiality and authentication security.

This system recover features are Email, SMS, verification code, Scanning ID documents upload, captcha and chat forum for professional exam candidates and also works which will be updated by examination branch by authorized examination staff. Further, it enables the candidate to make their preliminary exam registration process online and to track down the status of their payment online through Payment cards or PayPal.

The System has tailored Model View Controller (MVC) Architecture and Object Oriented Analysis and Design (OOAD) techniques. The system will be develop based on the Iterative and Incremental Development Methodology of Rational Unified Process (RUP) hence each increment can be providing a working milestone to the customer. The HTML5 is core markup language, Bootstrap, CSS3 for styling, and MEAN technology as **M** – MongoDB (Database), **E** – Express.js (Node.js framework), **A** – Angular2 for client-side scripting (front end), **N** - Node.js use for server-side (backend), and IDE is IntelliJ IDEA. EMBC would improve the efficiency and productivity of the daily functions of the business, and also would strengthen the Exams – Business – Candidates relationship which leads to adding competitive advantage to the business in for future progress. The online distributed nature of the system will be very helpful to expand their business in the future as well.

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And also thanks go to my staff to observe this processes, transactions and functionalities of the system, also provide me to their necessary some exams information to improve my exam domain for regarding project to bring a reality of the System.

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LIST OF ACRONYMS

EMSBC – Examination Management of System British Council
UK –United Kingdom
BC - British Council
BCS – British Computer Society
ACCA - Association of Chartered Certified Accountants
IELTS – International English Language Testing System
Q & A – Questions and Answers
VSP – Venue Staff Portal
HR – Human Resources
BOSS - Back Office Schedule System
DCI – Deputy Center Invigilator
SMS – Short message senders
GUI – Graphical User Interface
ID – Identify Documents
MVC - Model-View-Controller
HTML - Hyper Text Markup Language
CSS - Cascading Style Sheet
DB - Data Base
DBMS - Data Base Management System
OS – Operating System
SQL - Structured Query Language
TCP/IP – Transmission Control Protocol. / Internet protocol
FTP – File Transfer Protocol
RUP - Rational Unified Process
IDE – Integrated Development Environment
CRUD - Create, Read, Update and Delete
OOD - Object Oriented Designing
OOP - Object Oriented Programming
PDF - Portable Document Format
RAM - Random Access Memory
UML - Unified Modeling Language
URL - Uniform Resource Locator
WWW – World Wide Web

Chapter 1 | Introduction

1.1 Introduction

British Council Srilanka conducts UK exams in Srilanka and Maldives within highest standard level and objective of serving the education sector which handling exams for Srilankan students. BC have been offering a wide range of service provider for UK exams across the island wide through our BC branches in Colombo, Kandy, Jaffna, Matara, Galle and Negombo. BC handles the English language centers and process UK exams through the BC network and over 100 BC branches in worldwide.

BC mainly focus in English, Education, Society, and Arts among group of young people through their community leaders. BC provides UK School, Professional, IELTS and Cambridge English exams. BC serve more loyal candidates and consist of well experience exam operation team. BC communicates with candidates, parents, partners, clients and each other's is essential to keep reputation, ensuring the effectiveness of the examination process.

Therefore, BC have effectively, diversity and promoting equality of opportunities among BC work, BC creates International opportunities for the people of UK with other countries build trust between worldwide. BC has acquired a good reputation for providing a best venture, perfect service to customers – friendly environment shown a high progress and expect to expand their service further more in south Asian region.

1.2 Problem Statement

BC conducts various exams such as school exams, professional exams and Cambridge English. So these exam products data are duplicate in several places and notifications and updates are not prompt at the correct time to users. British Council Srilanka conducts exams in Srilanka and Maldives. The large no of data volume processed among BC and BC branches (Kandy, Matara, Jaffna and Maldives) very slowly. The existing system transactions are not performing properly to address some of the concerns in the entire system of modules such as exam time tables, exam venue allocations, exam admin issues, staff allocations, keep candidate's registration information, exam date exchanges and report generations are inaccurate, inconsistency, delay and non- reliability of existing computer system due to increased rate of large no of candidates,

introducing new examinations, expand facilities among BC branches and newly registered institution and exam staff for examinations with BC. These problems occurred during last few years due to increase of data volume in existing system.

Exam Module runs all the BC exam products among BC branches. BC needs to follow all Examination Boards (Cambridge, Pearson, BCS and ACCA) rules and regulations according to quality and standards of UK. Therefore, every time needs to consider examination with exam updates relate to new syllabus, subjects, assignments, modules, exam fees and also need to update candidates at a time but this operation are not operating with proper way. Candidates can't communicate as chats, face to face, Q&A and assist with specializing people should not prompt, courteous in order to give the negative impression of BC for each exam product. Registered candidates can't use exam resources, inquire regard their exam product issues, exam reserve dates can't interchange with locations according to terms and conditions. Candidates to not supports full-time, poor updates with candidates regard their exams details and also protect their personal information in a highly secure manner by data protection team. Annually not collect feedback records of candidates in each exam types. Ensure to candidates to follow the agreed exam procedures regarding the location and security of theirs belong and special access arrangements are not provided as required. Exam staff module connects with for payments, check annual staff performance records and new recruitments but not handle in suitable manner. Venue Module is to mark their availability for exam sessions and check which exam product to they have been assigned by BC administration staff so sometimes not send location alerts to their emails. Admin module can't handle candidate, venue, staff, system admin issues occur while going on exam session periods. Each exam staff accounts can't customize within exam products.

1.3 Objectives

The main objective of this project is to improve the efficiency of the exams, manage the details of Exams, Candidates, Venues and Staff to reduce the overall workload. This project is totally built at administrative end and thus only the administrator is guaranteed the access. This can be achieved through the automation. It tracks all the details about the Exams, Staff and Venues.

- Provide the searching facilities based on various factors such as Exams, Venues, Dates and Sessions.

- Allow each exam manager to focus their exam schedules and proceedings on achieving objectives. They are aligned with organizational vision, mission and with each examination boards.
- Automated the business solution such as candidates, exam venues, results, resource management, Backup, staff and report modules in the web based system.
- Encourage candidate, Institutions and staffs to accomplish their business need centralized global solution development with a highly secured, reliable, user-friendly and performance web based examination management system.
- Allow easy monitoring of activities for top management can communicate with candidates, exam staff for their activities. Obtain exam staff and candidate information easily and effectively for better decisions.
- Improve efficiency of the Examinations and to reduce the overall workload of the Exam Manager and other staff. And also track meeting activities with the forum. Provide a communicational framework for each staff member with their identity. Create a repository of candidate and staff master file data. Track meeting activities by listening to them with forum and display meeting outcomes to be viewed by the staff.
- Afford a communicational framework for each staff members for their identity, easy- fast examination process to monitor the candidates and the staff, make available a good service to the candidate with consistently updated information and generate various reports such as candidates, staff allocation and analysis staff participation utilization of the resources and venue reservations.
- Improve the candidates' motivation toward the examinations and also arrange for a facility to log in the system through the candidate's portal of the system.
- Keep candidate related data in the secure manner and the quickly retrieved environment by introducing an overall administration system for the staff members. Those staff members will be in different exam product groups which have been categorized into different privilege groups.

The System should provide

- Accurate transaction report such as Daily, Monthly & Annually for the management decision making power.
- Generate alerts and notification facilities. Online candidates profile facility to update new examinations.

1.4 Scope

The New System determining specific goals, boundaries, deadlines and features to be achieved in easily, simple and vividly. It also provides in current all works relative to Examination Management System activities will go through on smoothly.

- **User Management Module(Admin)**
Register profiles, user login, user logout, user privileges. The System should have a Super User Login method such as Super Admin (create Admin Accounts), Admin (BC exam venue staff), Manager (BC exam department staff) and candidates which can be used in secure privilege and implement the entire System in New Technologies.
- **Examination Module**
Exam scheduler allocates examination products(categories), exam venues, an arrangement of venue staff members, scheduled exam timetables. Sending exam results through email and SMS, updates exam venues to candidates and to the venue staff. Search examination updates.
- **Candidate Module**
Registered candidates allocate to exam venues, collect feedbacks, scheduling for the exam, send exam notifications and timetable. Provide online technical assistance to candidates. Manage and update information to candidates and also send exam-related news. (Candidate portal)
- **Exam Staff Module**
Staff scheduler allocate exams, venues and exam updates. Provide preparation sessions and workshops for each exam products, collect feedback from higher staff, annually update performance. Manage information of exam staffs (Supervisors, DCI - Deputy Center Invigilators, Invigilators).
- **Venue Module**
Assign exams dates, exam staff and according to each exam products among branch locations closest to exam venues, before one month to exam date for the examinations. Check facilities of each branch allocate exam venues suitable or not according to

examination board rules relate to exam venues such as quality and condition of exam room.

- Resource Management Module

Distribute documents, stationary, tools and soft copies according to each exam product requirement for their exam dates.

- Report Generation Module

Various types of Reports and charts for management decision making purpose.

- Backup and Restore Module

The system should be able to provide alerts (SMS/email) and notification to the user.

Moreover, the proposed System will include record monitoring in different user perspectives and provide a Secure System.

1.5 Project Purpose

The project is about to handle all the information of the candidate /students regard exam product, subjects/modules, registration, staff, new candidate and venues. Also it manages resources which were achieved and handled by semi-automated system previously.

The main purpose of the project is to integrate distinct section of the organization into consistent manner so that complex function can be operated smoothly by any technical or non-technical person.

The project aims at the following

- To manage information of students, subjects and venues.
- Consistently update information of all the candidates
- Reach the examination related news to candidates and exam staff
- Provide easy way to complete the Admin and Examination operations
- Keep the candidate related data secure and quick retrievals
- Customize system according to client requirements
- Online discuss with examination staff.

1.6 Structure of the Dissertation

The dissertation consists of six main chapters. A number of appendices have been attached at the end in order to provide some additional information as well. A brief description of the contents of the main chapters has been given below.

The ***Background*** phase explains about the detail overview of background information relevant to the system, critical review of similar systems currently available and alternative technology options and relevant implementation tools.

The ***Analysis and Design*** phase explains about the detail overview of the analysis, requirements gathering techniques, software requirement specification and high level analysis diagrams are discussed under Analysis. Design includes overview of the design methodologies to the design of solutions based on alternative and selected based approach. complete detailed design of the tools and techniques Software Architecture and Database Designs are discussed under this chapter. This chapter also includes detailed use-case diagrams, class diagrams, sequence diagram, activity diagram and deploy diagrams. The chapter gives the features of the Graphical User Interfaces (GUI), which help the users to interact with the System using the screen shots.

The ***Implementation*** phase describes the implementation technologies, design patterns, of the system. Further implementation environment, existing software tools reuse and technologies used in the implementation, application structure and important code segments of the system.

This ***Testing and Evaluation*** phase defines how the system was tested using various sample data analysis methods, evaluation scenarios, test plans, test tools, frameworks and the outcomes of the assessment. This includes testing procedures and test cases.

The ***Conclusion*** is the final chapter of the dissertation, which includes the critical evaluation of the project, review the entire development process carried out and gives details about the recommended future improvements and lessons learnt throughout the project have been discussed under this chapter.

Chapter 2 | Background

2.1 Critical Review of available Similar System

British Council current system was the classification to understand the background which we have to work and to understand the concepts and procedures of an examination system. I refer TOEFL, SAT, Deskara, UniTime, examination sites for a detailed study.

- TOEFL

The TOEFL test measures the ability of allocations to venues. Registration is available five to six months before the test date. Early can reserve your test seat as exam Registration. Candidate can see closest test dates. Registering online is the easiest way to students. Register for the exam, test date, ID checks, results in release dates and workshop dates. TOEFL test provides Free resources and official pre materials to practice for test success with tools from the creator. TOEFL make available free unlimited access to past question paper of the test that you can download and to practice for a candidate. It includes interactive reading and listening proficiency questions, as well as sample responses to speaking and writing questions. A free planner helps you set weekly practice goals and stay on track with tips and tasks for the weeks leading up to test day. The planner helps you understand how to prepare for the test effectively and to build the English-language and grammar skills needed for success on the TOEFL test. [7]

- SAT

The candidate is looking, how to get admission to a particular exam, s/he can take the subject/modules tests and understanding of that particular exam. Exam tests are offered in areas. SAT exam has been developed to evaluate the written, verbal skills of the candidates. For the overall preparation, SAT is similar to other exams in the sense that you can either take the route of self-studying or attend coaching classes. SAT is a standardized test administered is based reading and writing sections, which consists of a reading test, writing test and language test so it similar to IELTS. It keeps pace with the latest changes and our resource material is continuously updated. The batches are small ensuring each candidate personalized attention. Regular assessments help to identify problem areas and they assist candidate accordingly. Frequent review sessions with staff help to candidate improve their overall exam. Various candidates sat for exam in a session with hundreds of candidate every year for the SAT. [8]

- Deskera

Deskera is exam planning and execution which can be used for examination. It has features to create examination venues, manage book recourse, invigilators assignments and plagiarism detection with misconduct management, take disciplinary actions and create examination time table. The advantage of this is user-friendly interfaces, product test well done. Exam Management system can effectively automate and streamline exam planning and execution, and it has been designed to make the examination processes easier. Exam Management portal helps you to automate the entire examination process from creation of exams and grading criteria to handling allocating invigilators. Examination automation is designed to manage access permissions for different users to prevent misuse and mismanagement of legal and official data by any unauthorized user. Our online Exam Management also takes into account of registration details. eTraining will help to get training and development functions and how the needs assessment fits into this process, followed by an in-depth look at the core functions involved in conducting a training needs assessment. [9]

- UniTime

UniTime is a comprehensive educational scheduling system that supports developing exams and managing exam timetables, changes to these timetables, sharing rooms with other exam venues. It is a distributed system that allows multiple exam schedule managers to coordinate efforts to build and modify a schedule that meets their diverse organizational needs while allowing for minimization of candidate course conflicts. Capture, analyses and respond to prospective candidate inquiries. Candidate's data quickly and work smarter to target prospects and increase new candidate enrollment. Connect with prospects from anywhere, and improve the visibility of candidate's progress. Customize multiple stages in the admission process workflow to meet different needs. Set admission eligibility criteria and seats for different exams, grades and institutions. Generate powerful reports with charts that provide insights on the number of the prospective candidate applying for programs, seat allocation and utilization to make informed decisions. There are also easy-to-use and modify candidate admission forms and letters to share with applicants across the website. Send admission offers of courses to any number of applicants from a single location to save time and reduce staff workload. Track the full status of candidate applications throughout the admission process, from inquiry through application, admission and enrollment. Access candidate data from anywhere and streamline the evaluation process, which allows you to automatically approve or reject applications for specific exams, or assign it to staff. [10]

The following table 2.1 shows summarizes of the facilities provided by the above systems.

Modules	TOEFL	SAT	Deskera	UniTime
Administration				
Exam	√		√	√
Candidates	√	√	√	√
Venue	√	√	√	√
Staff				
Report				
Home - profile		√	√	

Table 2.1 Summarizes of Similar Systems

2.2 Alternative Technology Options

EMBC (Examination Management System for BC) is a web-based system, development based on the client and server layout and MVC architecture. EMBC would improve the efficiency and productivity of the daily operations of the business, and also would strengthen the business-customer's relationship which leads to add competitive advantage to the business in future progress.

Alternative technology as can be use PHP, ASP, .Net and JAVA with SQL, MY SQL, Sybase, Oracle database with Apache/Tomcat server to this system because all free, non-proprietary tools and presently more web sites creators use these technologies for web development. These languages are most popular and use is faster than to any other languages according to search engine popularity. These languages are suited to development of ecommerce sites and wide range of database connectivity and run on independent platforms among Windows, Linux and Mac OS.

So I selected MEAN technology is a set of Open Source components that together, provide an end-to-end framework for building dynamic web applications; starting from the top (code running in the browser) to the bottom (database) development in Examination Management System has been built on Framework. Design Pattern and Approaches which separates the

application into three segments: database, Views, and roots. The System can be structured in order to promote the reuse of program code, which is an important feature of Object Orientation. [18]

The development process methodology was based on the Rational Unified Process(RUP), CSS3, Bootstrap was used for consistent styling of the entire application. Node.js was used for the server side and Angular2, for the client side scripting. Mongo DB was used as the DBMS of NOSQL to the system. (Jason) [17]

2.3 Recommended Hardware and Software Requirements

- Hardware Requirements

The recommended minimal server hardware specifications in order to obtain the best application performance.

Hardware	Recommended requirement
Processor	Intel core i3 processor 2.8GHz
RAM	4 GB RAM
Hard Disk Space	250GB Hard Disk
Memory	10 GB Memory per Server
Display	1366 x 768 resolution
Printer	Inkjet or Laser Printer
Internet	Unlimited Monthly bandwidth with Internet

Table 2.2 Hardware Requirements

- Software Requirements

The required and recommended software application in order to implement the examination management system.

Software	Recommended requirement
Operating System	Windows 7, Windows 8, Linux
Software bundle	<ul style="list-style-type: none"> – HTML5, Bootstrap, CSS3 – Express.js – Angular2 – Node.js
Database	Mongo DB – No SQL booster
Browser	Firefox, Chrome
Code Editor	Notepad++ 6.9
IDE	IntelliJ IDEA
Reports	Stimulsoft.JS
Testing Tools	Selenium

Table 2.3 Software Requirements

Recommended Operating System (OS)

Operating System(OS) is consisting of programs and data. That runs on computers and manage computer hardware resources and provide communication services for efficient execution of various application software's.

For hardware functions such as inputs and outputs, memory utilization, the operating system act as an intermediary between application program and the computer. Hardware although the application code is executed directly by the hardware and will frequently call the OS to be interrupted to OS are found on almost any devices utilize the computers and mobile phones.

Eg: Windows, LINUX, Mac OS and UNIX

Recommended Data Base

RDBMS have used this project using MYSQL / SQL database for all the transactions as an open source RDBMS System. RDBMS is a database management system is based on the relational model and also many popular databases currently use in RDBSM have a choice for the storage information in used records of Financial and personnel data. Relational databases have been replaced legacy hierarchical and network databases because they are easy to understand and use. However relational databases challenge to object databases were introduced to address the object relational impedance mismatch in relational database. [19]

We can use SQL, Mongo DB for databases to this system.

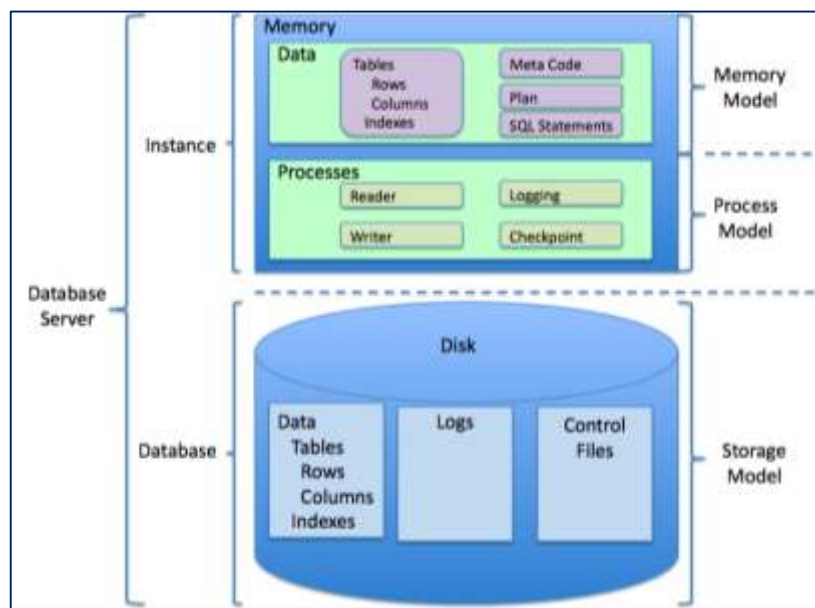


Figure 2.1 General Structure of a Database.

This chapter focuses on the literature review of similar systems. The aim of a literature review is to identify, read, studying the existing similar systems relate to their functions, features, advantages and disadvantages would be helpful as well and have a good grasp of main published work concerning a particular topic or question into Examination Management System. current BC system was the classification to understand the background which we have to work with online and offline.

Chapter 3 | Software Analysis and Design

3.1 Fact Finding Techniques

I used fact finding techniques as Interviewing, Questionnaires, Observation and Examined the existing documents. Several interviews were conducted with Exam products wise exam product managers, exam officers, exam operate staff and with candidate's combination of close and open-ended questions. Because of interviewing requirement gathering is clarify the facts and more information of exams. **Questionnaires** are used often especially in the situation where the number of candidates are very high and give more ideas to improve about exam conducting. [6]

Observation is different from venue to venue and exam to exam so staff is hard to observe exams and get a clear picture of it but separate exam wise observe in real time practical operations such as IELTS. **Examining the existing documentations** enables to discover some exams background information which have not been revealed yet by exam managers.

Interviewing, on site observation and examining the existing documents were used to discover requirements for the EMSBC. The daily business processes such as Exams, Candidates are observed in couple of sessions. The captured facts were represented as scenarios to give a clear picture on basic requirements and interaction sessions of the existing system documents were examined in order to extract the business details needed to store in the system and the format of the documents. [6]

The staff members in different management levels were selected to discover requirements related to the Management and Administrative procedures. It can be a beneficial to us, when we intend to acquire more knowledge and understanding about the domain.

3.2 Drawbacks of the Existing System

The following major drawbacks have been identified in the existing BC system.

- The historical data of the business such as the detail of the past exams and candidates, are not preserved in the system. Removing historical data produces some inconsistency to other existing data as well.

- Details of the entire exam and the candidate details are not kept in the system which reduces the benefit of the data in business analyzing processes. Only the summary of the daily transactions is stored in the system as well.
- Most of the data is entered into the system twice, firstly recorded in one module later another module. This consumes time, produces unnecessary workload and causes the unavailability of the updated data during the business hours – more time consuming.
- There is no clearly defined way in preparing registration, which occurs bottlenecks in examination registration process.
- Sensitive business data is exposed for anyone and there is no backup routine procedure which increases the vulnerability of the security of the data.
- Complex monitoring of business progress. Consume large volume of pair work.

The existing system of the EMBC is an automated computer system. The existing system was divided subsystems as follows in order to study the system more efficiently.

- Exam Module
- Venue Module
- Exam time table
- Candidate Module
- Staff Module

Exam Module

This module handles all exams together so difficult to identify statics of each exam products data for decision making. Specially school exams some subjects are clashes in time tables and exam branches interchange student details also not clear. Some exam information is missed due to all exam records together in db tables. Exam time table and exam date exchange wise two separate module carry on this system but procedures are different so same record repeat in different transactions. Exam updates not popup at correct time to candidates and exam staff.

Venue Module

Venue module connect with each branches but some new branches can't operate with new venues due to current transaction records are very poor. Some venues facilities are not suitable for exam conditions as lights, heat and others so these details not update in to managers. Not

added new venues to system so candidates make comments for that. Venue interchange transaction is poor.

Candidate Module

This module is so important module in this system but less efficiency in process. Because candidate's updates are not performing highly due to large amount of candidate information in existing system without backup. Some candidates applying exams for several times then difficult to search validity period and there some records add as a new candidate like again. Results, updates and notifications not send at a time. Some exam fee either transfer or refund not operate in properly.

Staff Module

All the current staff members are handled in the Staff through the manager. Details of the past staff members are not removed from the database periodically as well. The bank deposit list is also prepared in order to transfer the salaries to the bank accounts of each employee is very slow. Employee trainings and performance statics difficult to monitor in this system so some employee trainings missed and difficult to check employee documents handover or not.

3.3 Analyzing the Existing British Council Examination System

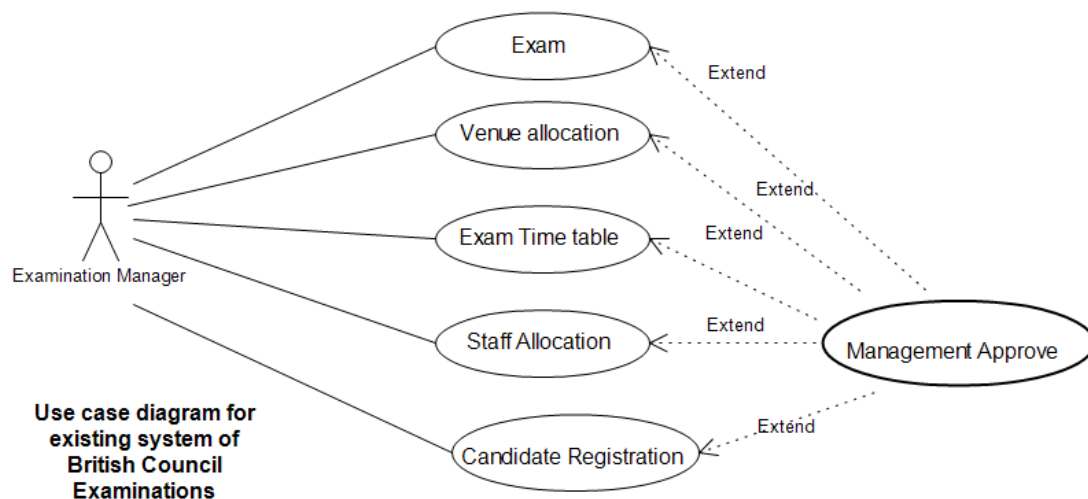


Figure 3.1 Existing Examination System of BC

This figure shows existing procedure of BC examination system need to take management approve for every exam transaction.

3.4 Functional Requirements

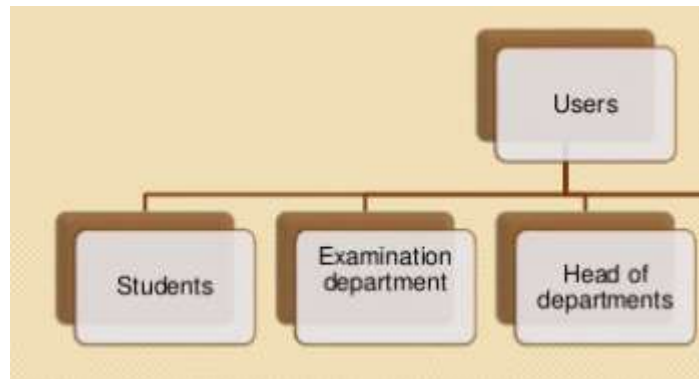
Following are a list of functional requirements that are identified EMBC during the analysis stage: [4]

- User Management (System Administration)

The administrator should be able to deactivate or re-activate the users if needed. The administrator should be able to reset the passwords of the users if needed. The system should generate data backup on the demand of the administrator. This module handles user profiles, logins, user logout and user privileges. The System should have a Super User Login method such as create Admin accounts for EMBC, Admin operate logins of higher administration staff in BC, Managers login handle each exam product managers to their exam information and exam staff can be login for mark exam availabilities with in secure privilege and implement the entire System. Assign user permission to view and manage user details. You can easily assign permissions related to managing modules, moderating messages, customize settings and rules.

- Exam Management

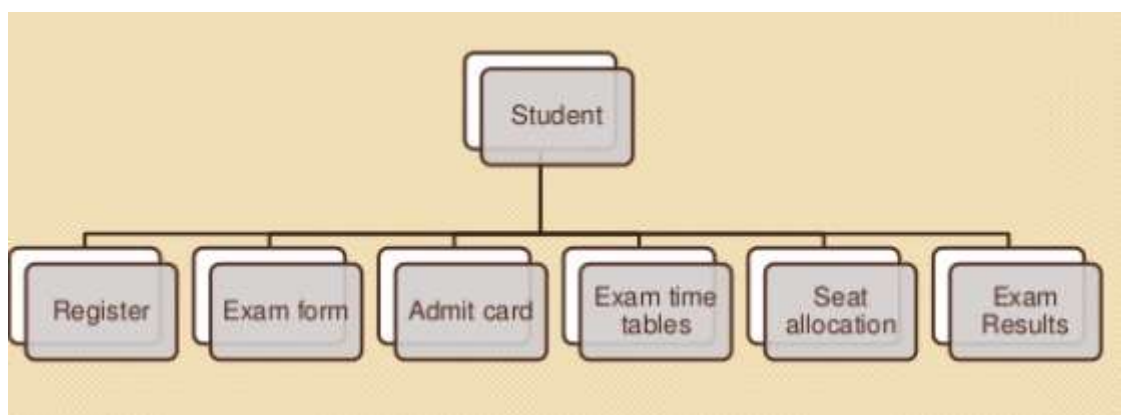
Each exam products can be easily identifying through exam product catalogue. Exam updates are quickly pass to exam staffs and candidates. (email and sms) Exam venue fee information's can be easily interchange among branches or venue with permission of exam manager. Any exam product board facts can be view, search vastly within in any location by BC staff. You can define exam-specific criteria for automating application approval such as verification code validity for exam payment session and rejection of submission documents for exam registration by inform with alerts and notifications can be sent to concerned authorities as per defined workflow routing processes as special candidate. Record malpractice (unacceptable candidate behavior in exams), special candidates(disease) and other learning activities. (Exam Scheduler)



- Candidates Management (Students)

Candidates can process exam registration entering their details and submitting ID document through online and also can pay exam fee in online. After registered candidates can use facilities (Candidate Forum) relate to their exam products. Provide online technical assistance to candidates. Manage and update information to candidates and also send exam related news such as venues, exam dates, exam results and time table. The entire application enter data into registration-to-admission statement cycle can be managed within the system.

The candidate activity tracker, and behavior reporting tools allow to manage discipline incidents and take corrective action. All registrations for a particular exam are recorded and collated automatically (candidate portal). Also manage candidate enrollment and registration for exam by configuring rules and conditions. Automatically capture candidate data and register all types of candidate, including new, transfer, continuing, credit and non-credit students. Capture applications from various sources across the web, including each examination boards' websites.



- Staff Management

This module uses for allocations for exams and venues each exam product. Staff Scheduler provide training sessions, workshops and briefings for each exam products for

update performance. Manage information of exam staff (Supervisors, DCI and Invigilators), manage staff personal details, send exam related particulars. Define exam-specific criteria for automating application approval and rejection. Configure rules and conditions for exam registration. Create future plan academic terms and include exams to be offered, and candidates' intake. Make announcements to the selected staff for the staff training schedule, plan changes, permissions and training assigned to them and exam-related communication. Provide an immediate solution to the Administration staff as well as exam staff requirements. (Staff Scheduler)

- Venue Management

Each branch has exam venues to assign exams, staff and locations details send to each exam date one month prior to the examinations. This process operates by VSP in this way, they can get ready by given schedule of the examination dates, times and also inform venue locations and new venues.

Allocate exam products, time sessions, staff roles and locations according to each exam product requirement for their exam dates one month before to the examinations through VSP then exam staff mark availability of exam dates.

- Financial Management

This module manages the candidate's exam payment credits regard of each exam sessions. System should manage the payment history of the exam fees because of refunded and exchange within next exam sessions. System should be able to process the payments returns also.

- Reports Module

This module allows each exam product managers to generate and view their exam product statics create timely wise reports and notifications to dash boards, as information of no of candidates sit for coming exams and past, no of Venues conduct exam on exam dates and no of staff allocate each exam products. The system should allow the managers to search data and print the reports. Various types of Reports and charts generate can create for management decision making purpose in monthly, session wise and annually. Capture feedback about every former exam effectiveness and also track feedback suggestions of candidate regarding exam infrastructure and various other resources relate to exam conducting path.

3.5 Non-Functional Requirements (Performance Requirements)

Non-functional requirements describe the characteristics or constraints the system should have, which affect the whole system rather than a specific part. The non-functional requirements of the EMBC have been described below. [4]

- The system should be user-friendly which means the web application is easy to operate even having poor knowledge of computer. System should have both its functionality and appearance. The staffs of the BC are very familiar with windows environment. Therefore, the system should be close to windows GUI environment as possible. The system should also be easy-to-learning of interfaces to users can work with any web browser.
- The system should be consistent and secure. The system will handle sensitive business critical data. Hence enough security should be imposed. User authentication and access controls should be provided in the system.
- The system should be reliable and robust. The system should provide data validation procedures in order to ensure the accuracy of the data. System should also be available at any given time and should work with minimum failure rate.
- The system should be portable. The system will be accessed by the customers and suppliers using their own systems which can have different platforms. Therefore, EMBC should run perfectly on any popular platforms.
- Efficiency of the System, including response time and processing time should be less, when customer online exam registration or searching an exam since most of the users expect this feature from a System.

3.6 System Architecture of EMBC



Figure 3.2 System Architecture of EMBC

3.7 Proposed Process Model for EMBC.

EMBC to select RUP methodology because it is an iterative and use case-driven software development methodology which consists of principles, best practices, and tools. It describes two perspectives called static view and dynamic view. Static view describes a set of work flows while dynamic view describes four phases each of which has own objectives and milestones. The RUP lifecycle comprises four main phases namely: Inception, Elaboration, Construction and Transition. [5]

Rational unified process model (RUP) was chosen for the EMBC system. RUP is an adaptable process framework, where the elements of the processes can be changed according to the EMBC needs. This mainly concentrates on risk reduction due to past failures of exiting system.

Reasons of selecting RUP are it is an iterative software development process framework and it supports object oriented development. Therefore, RUP is the most appropriate with SDLC (Software Development Life Cycle) methodology. [4] RUP was selected as the methodology of the EMBC. Since of this features are well suited with the development nature to the EMBC.

3.8 Design of the EMBC

EMBC is divided in to eight modules as follows in order to be efficient the design process and further implementation.

- User Management
- Exam Management
- Candidate Management
- Staff Management
- Venue Management
- Reports Management
- Resource Management
- Web Management

The top-level use case diagram of each module is represented in the following sub sections. Some use case narratives and additional diagrams are also provided when needed.

Please refer the appendix B – design documentation for other important use case narratives and the additional diagrams.

3.8.1 Use Case Diagrams for Examination Management System of BC - *EMBC* Design

- **User Management (Admin)**

This module intends for administering the EMBC itself. This includes managing system users, controlling access levels, manage system log and generating data backup. The administrator is able to deactivate or re-activate the users if needed. The administrator is also able to reset the passwords of the users if needed. Super admin is a virtual admin with full access for all modules. However only recommend to create new admin. Admin creates operators and managers. Super admin account cannot be edited, reactivated, deactivated, reset its password, edit profile itself through the application. Direct database editing is needed for those. [18]

The following figure 3.3 use case diagram shows the main activities in Admin module.

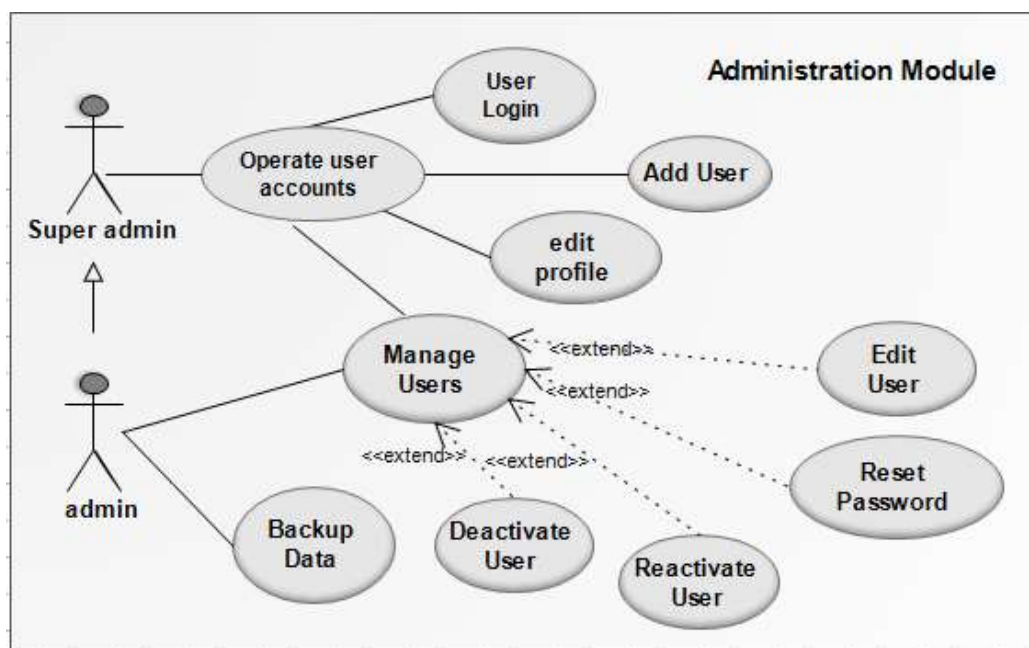


Figure 3.3 Use case diagram for the Administration Module

Use case Name	Manage Users
Actors	Admin
Description	Admin updates users.
Pre-conditions	Admin must logs in to the system
Main Flow	
<ol style="list-style-type: none"> 1. Admin navigates to the user administration section of the system. 2. System displays the user's details. 3. System allows admin to edit, reset password, deactivate or reactivate the user based on the user's current status. 4. System updates the user and confirms. 	
Alternate Flows	
<p>3.1 Admin selects the option to edit the user.</p> <p>3.1.1. 'Edit User' use case is executed.</p> <p>3.2. Admin selects the option to reset the password of the user.</p> <p>3.2.1. 'Reset Password' use case is executed.</p> <p>3.3. Admin selects the option to deactivate the user.</p> <p>3.3.1. 'Deactivate User' use case is executed.</p> <p>3.4. Admin selects the option to reactivate the user.</p> <p>3.4.1. 'Reactivate User' use case is executed.</p>	
Post-conditions	none

Table 3.1 Use case narrative for Manage Users use case

The following table 3.2 shows summary of each module for Login privileges.

Module	Super Admin	Admin	Higher Managers	Exam Product Managers	Exam Officers	Exam Staff	Candidates
User (Admin)	√	√					
Exams			√	√	√		
Candidates			√	√	√		√

Venues	√	√	√	√		
Staff	√	√	√	√		
Report	√	√				
Financial	√	√				
Home- Profile	√	√	√	√	√	√

Table 3.2 Access control for Admin Modules

• Exam Module

This module can operate higher management and exam managers because all exam products setup through this module is most important module in EMBC. This section handle exam scheduler for load exam time tables and exam results to candidates then easy to balance exam across registration process in heavy school exam session time periods. Exam Scheduler provides for multiple candidates, venue interchanges, exam code validity period and multiple exam sessions in one database. This module manage exam inquires through Exam Scheduler can take a special candidate's needs into account and allocate candidates to special reading or writing time, papers or assistants. (Special requirement students) Exam boards rules and regulations update monitor by each exam product managers. Each exam managers can generate exam reports, notification and full audit trail is provided for module.

The following figure 3.4 use case diagram shows the main activities in Exam module.

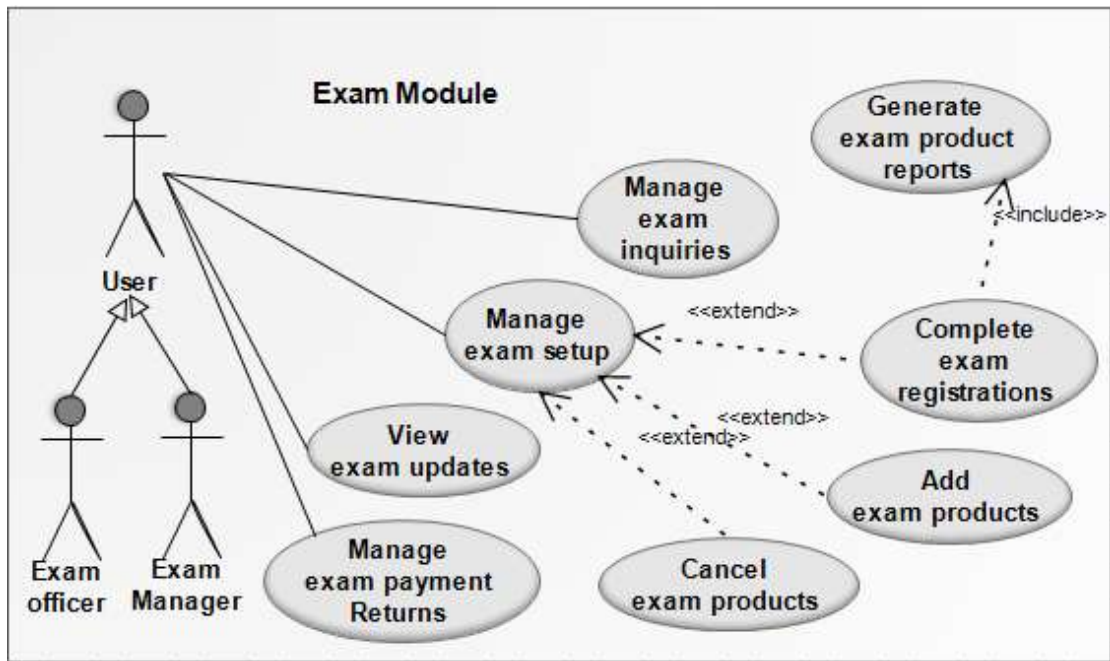


Figure 3.4 Use case diagram for the Exam Module

Use case Name	Add Exam product
Actors	none
Description	Actor places an exam registration.
Pre-conditions	The use case “Manage exam registration” must have been executed.
Main Flow	
<ol style="list-style-type: none"> 1. Actor navigates “New Exam product” sub suction. 2. System displays the form to fill. 3. Actor selects the Exam board. 4. System updates the screen with country. 5. Actor selects the country to sit exam, fills the other relevant data. 6. System validates the inputs 7. System adds the exam information and confirms. 	
Alternate Flows	
1.1 One or more field is invalid. <ol style="list-style-type: none"> 1.1.1 System informs the error(s) and prompts to correct. 	
Post-conditions	Exam registration has been added successfully.

Table 3.3 Use case narrative for Add Exam Products use case

- **Candidate(Customer) Module**

This module involves add candidate, register candidate, edit candidate, view candidate and delete candidate functions. In add candidates operate in separately with different exam products such as school exams – School candidates and private candidates, IELTS exam – Institution candidates and BC candidates. Candidates exam fee can be refund or transfer for next exam sessions. The system should facilitate the candidate exam inquiries to the BC if needed and the staff should be able to reply them as well. candidate allocator integrates with email system, enabling you to send confirmation to optimized exam timetables with prompt change notification. Candidates need to submit color copies of ID documents when registering to system then managers approve as a Registered candidate then provide all exam materials send to email. Each exam products monitor malpractice candidates because some exam products band them for a time period. Allow search exams and exam fee refund only the quantity not handle finance side, because exam fee different in exam session to session.

The following figure 3.5 use case diagram shows the main activities in candidate module.

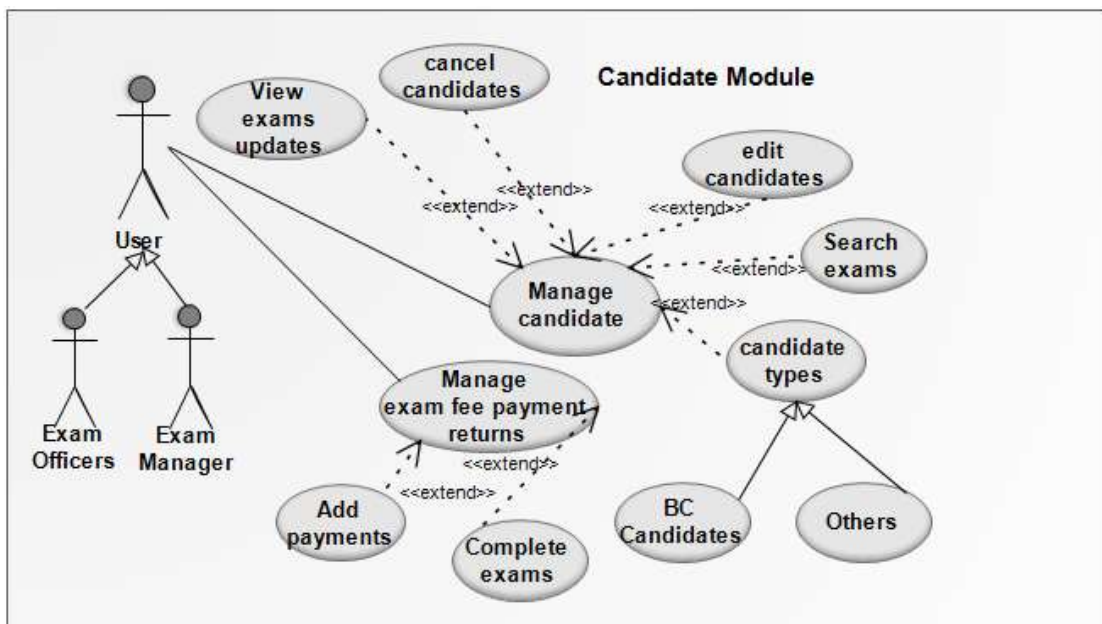


Figure 3.5 Use case diagram for the Candidate Module

Use case name	Manage Candidates / Customer
Actors	Exam Staff
Description	Exam Staff manage the customer's details
Pre-conditions	Exam staff log into the systems
Main Flow	
<ol style="list-style-type: none"> 1. Staff navigates to the section where the customer management allowed. 2. System displays the section with the customer's details. 3. System provide options to the staff to view, edit, cancel and search customers. 	
Alternate Flows	
<p>3.1 Staff selects the option to view the details of existing customers.</p> <p>3.1.1 The use case 'View profile' is executed.</p> <p>3.2 Staff select option to edit the details of an existing customers.</p> <p>3.2.1 The use case 'Edit profile' is executed.</p> <p>3.3 Staff select option to cancel an existing customer.</p> <p>3.3.1 The use case 'Cancel profile' is executed.</p> <p>3.4 Staff select to search customer.</p> <p>3.4.1 The use case 'Search Customers' is executed.</p>	
Post-conditions	none

Table 3.4 Use case narrative for the Manage Candidate use case

• Staff Module

This module operates by BC staff for each exam products so exam staff to inform exam dates early then they mark their available test dates according to require amount of staff select each branch exam venues. The manager should be able to add, edit and cancel staff details. The staff members should be able to edit their profile themselves. Exam staffs can be allocated to sessions based on their availabilities and the roles to be carried out. Up to date timetables can be made available to all exam staff via their mobile devices or accessible through the web.

The following use case diagram of Staff module is in the figure 3.6

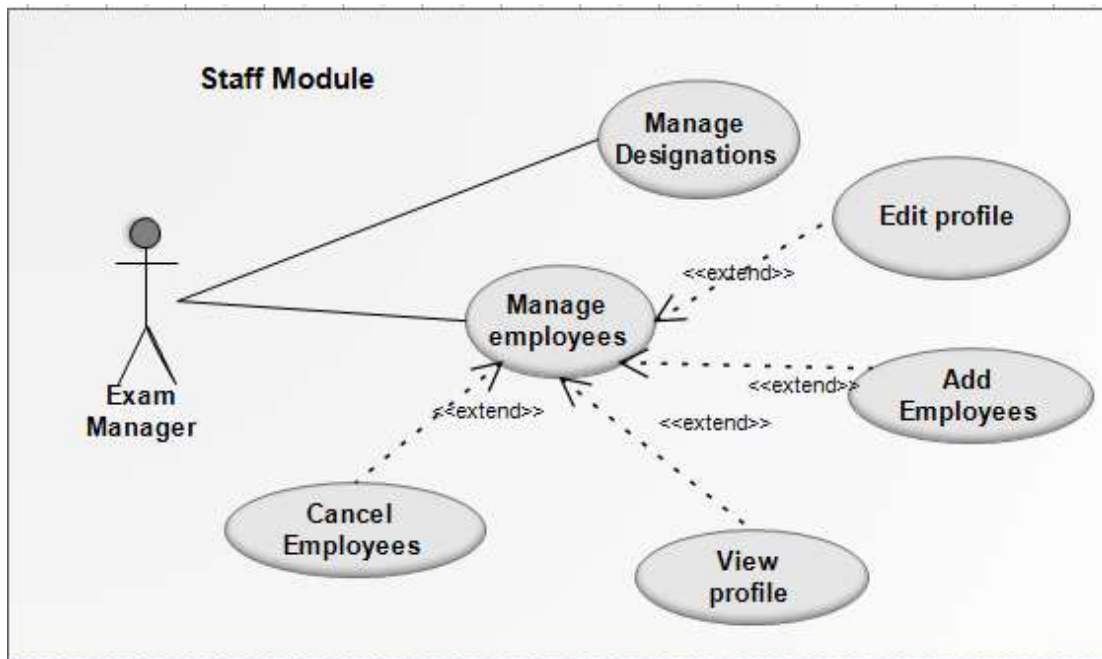


Figure 3.6 Use case diagram for the Staff Module

Use case name	Send Email and SMS
Actors	Exam Staff
Description	Send an email to make an inquiry
Pre-conditions	Exam staff must have been logged into the systems
Main Flow	
<ol style="list-style-type: none"> 1. Staff navigates to the section where the sending an email is allowed. 2. System displays a form to fill. 3. Staff fills the form and send. 4. System validate the inputs entered by the staff. 5. System send the emails to recipient. 6. System displays the confirmation message. 	
Alternate Flows	
<p>4. one or more field is invalid.</p> <p>4.1 The system informs the actor about the validity and prompt to make corrections.</p> <p>5. Message Couldn't be send.</p> <p>5.1 System informs the staff about the errors occurred.</p>	
Post-conditions	none

Table 3.5 Use case narrative for send email to staff use case

3.8.2 Sequence Diagrams for EMBC

- Add users to EMBC

The following sequence diagram shows add new user process in the Admin(user) module in the figure 3.7

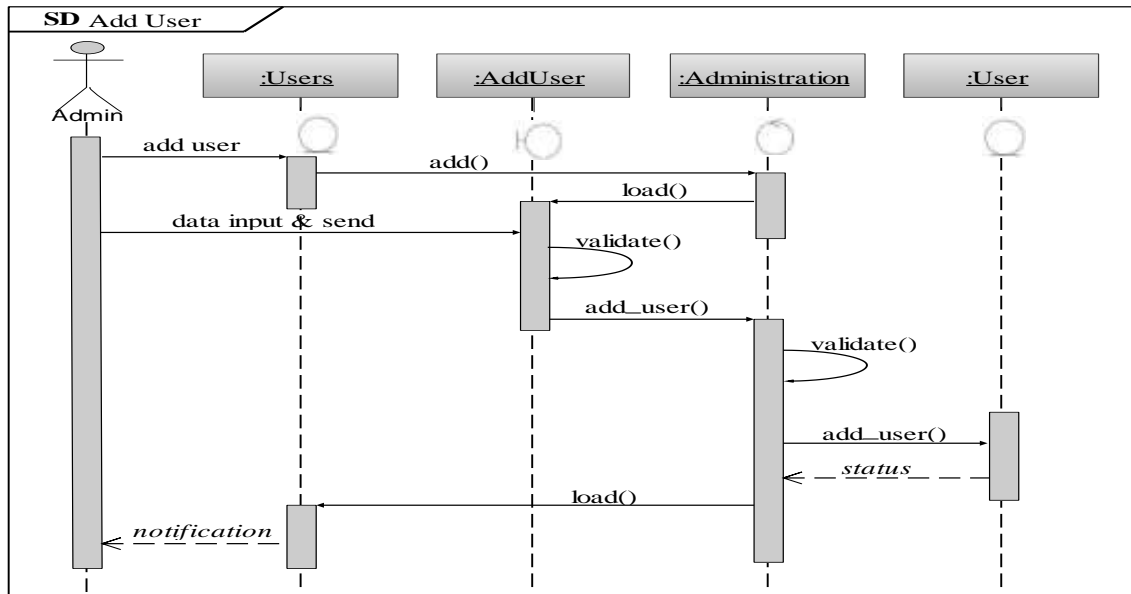


Figure 3.7 Sequence diagram of Add users for EMBC

3.8.3 Class Diagram for EMBC

The static view of the application is represented by the class diagram which is very useful to get an overall idea of the system. [2] The overall class diagram of the EMBC with multiplicity and the associations is given in figure 3.8.

Please refer the Appendix B - Design Documentation for attributes and methods of each class.

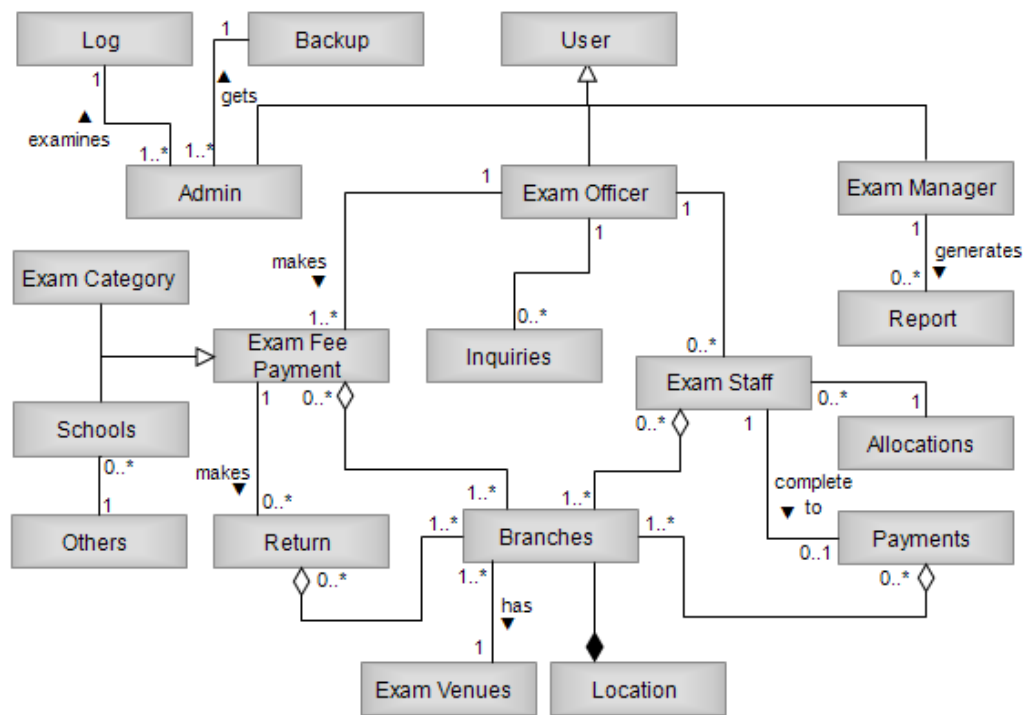


Figure 3.8 Class Diagram for EMBC

3.9 Database Design for EMBC

Database is one of the most critical parts of any data-driven application such as EMBC. Hence appropriate techniques are used in order to ensure the integrity of the database. Normalization is carried out to eliminate possible database anomalies. [19]

The Data base design diagram of the EMBC is given below in the figure 3.9

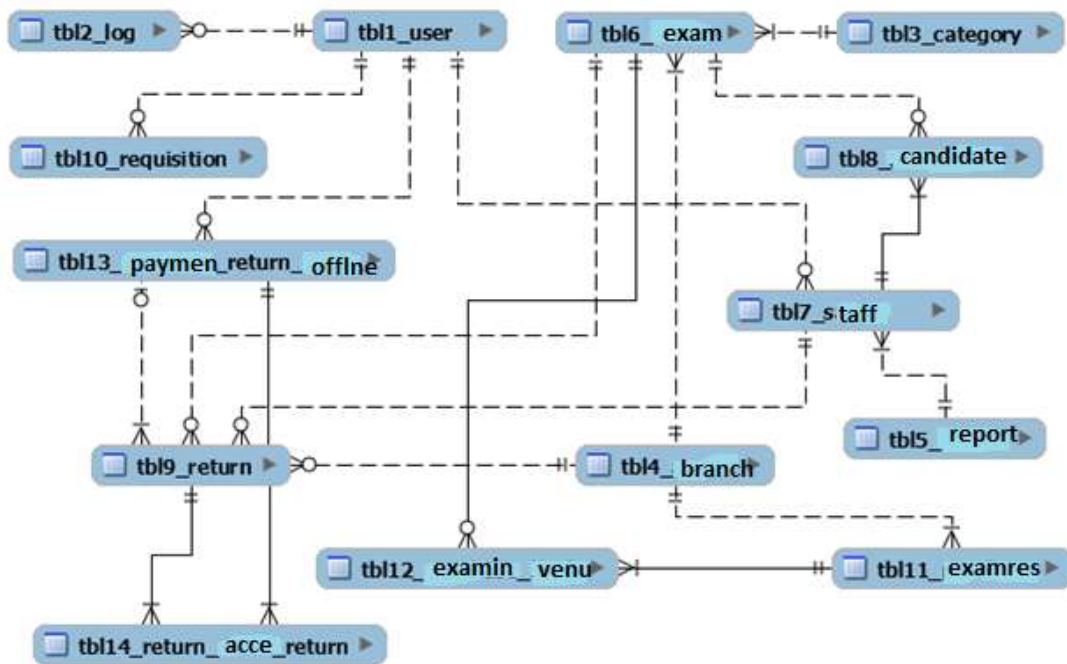


Figure 3.9 Database Design for EMBC

3.10 Development Architecture

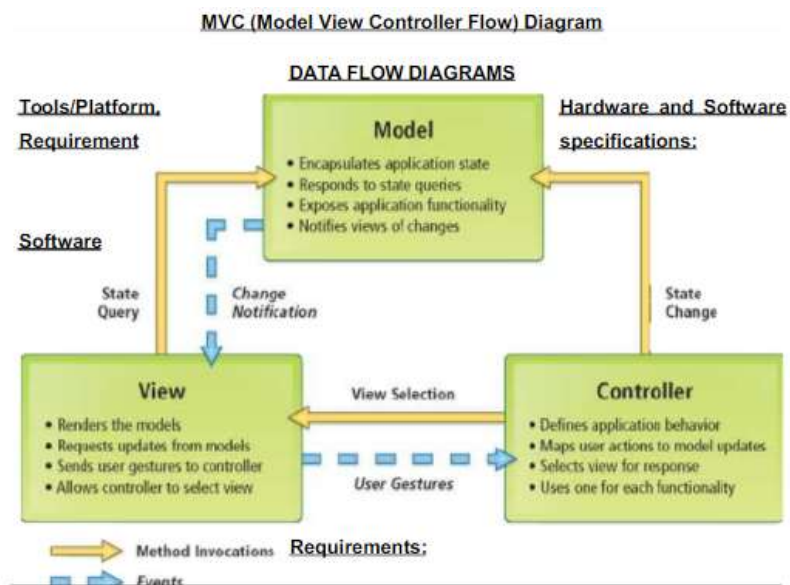


Figure 3.10 MVC Architecture

As shown above in figure 3.10, the entire application is separated into three main components called Model, View and Controller in the MVC architecture. The Controller process the user

request. Model is responsible for data manipulation process connected with the database. Views are responsible for representing the output.

EMBC is based on the client-server architecture because of its web based nature. The MVC architecture was selected for the EMBC further which is a software development design pattern and approach which separates the application into three segments: Models, Views, and Controllers. Using this, the system can be structured in order to promote the reuse of program code, which increases the maintainability and flexibility of the system. [20]

3.11 User Interface Design for EMBC

User interfaces are one of the critical factors in evaluating the user friendliness of the application. Because it is the component the user sees and interacts with. Some of the guidelines followed have been summarized below. [6]

The following sections represent some of the main interfaces and components of the EMBC in order to provide a perception of the overall interfaces of the EMBC.

Please refer the appendix C - User Documentation for more interfaces.

3.11.1 Home page and Login Interface

The system login page which belongs to the developed system is represents the main interface provided for login to system. In any computerized system the first interface encountered by the user is the login page. Therefore, by designing and handling errors properly a pleasant feeling about the rest of the system can be created within the user.

This facilitates to access the main management areas and provides links for some frequently used functionalities as well. The following figure 3.11 shows EMBC main home page and login interface.



Figure 3.11 Home Interface for the EMBC

Figure 3.12 Interface of students Registering for the EMBC

Figure 3.13 Interface of Parents Registering for School Exam in EMBC

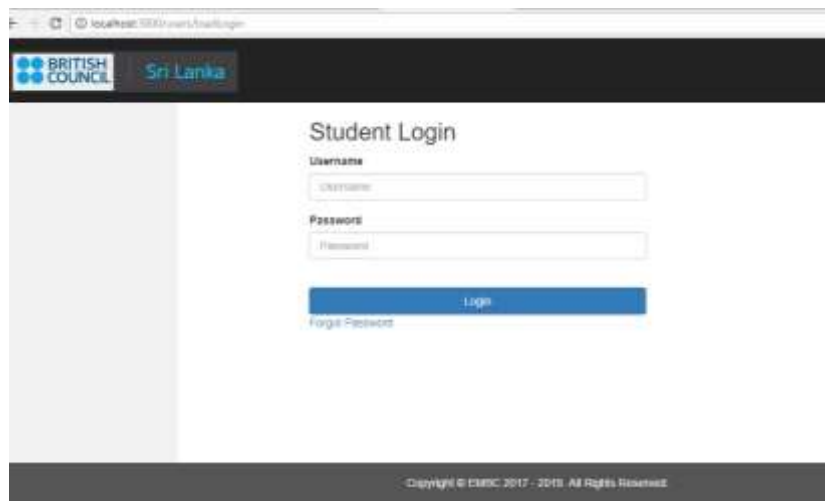


Figure 3.14 Login Interface of Student (Candidates) for the EMBC



Figure 3.15 Login Interface of Exam Managers for the EMBC

3.11.2 Administration Page

The home page of the administrator's account is displayed by figure 3.16. According to the candidate's requirements as well as by studying other similar web-based system interfaces, the final output had been created. The basic information of the user, login time, last login date, and login history is displayed by it.

The following figure 3.16 shows Admin Explorer page of EMBC.

RollNo	ExamType	Venue	Status	Reg Date/Time	Exam
1810208008	School Exam - External	Colombo-BN/Ch	OFFLINE	Tue Feb 27 2018 16:12:58+05:00 (Sri Lanka Standard Time)	Exam
18102081002	School Exam - External	Colombo-BN/Ch	OFFLINE	Tue Feb 27 2018 14:15:27:58+05:00 (Sri Lanka Standard Time)	Exam
18102740440	School Exam - External	Regmota-RCE	OFFLINE	Sun Mar 11 2018 15:23:08:58+05:00 (Sri Lanka Standard Time)	Exam
18102740818	School Exam - External	Regmota-RCE	OFFLINE	Sun Mar 11 2018 15:23:08:58+05:00 (Sri Lanka Standard Time)	Exam

Figure 3.16 Administrator Explorer - School Exams of EMBC

3.11.3 Forms

The below figure 3.17 represents the form used to add new candidate in to the system. Various form elements have been selected based on the nature of the data to be entered. Error messages are also used to avoid mistakes in the data entering process.

Figure 3.17 Form for Exam Registering of EMBC

3.11.4 View

The below figure 3.18 shows the view of Candidate - new Exam Registration the system

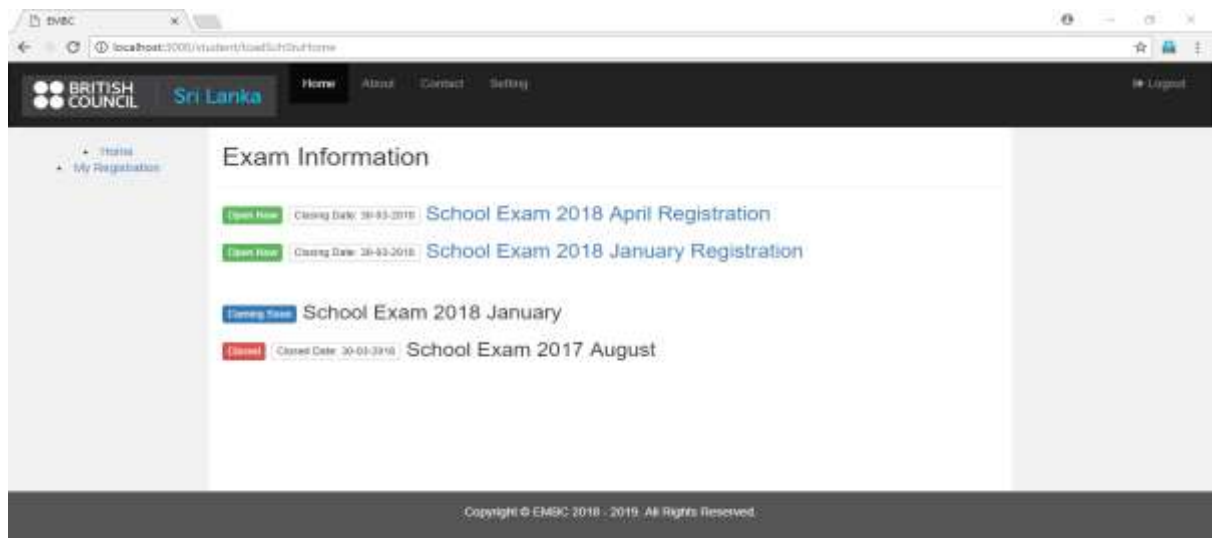


Figure 3.18 View of Exam Manager to Registered Exams in EMBC

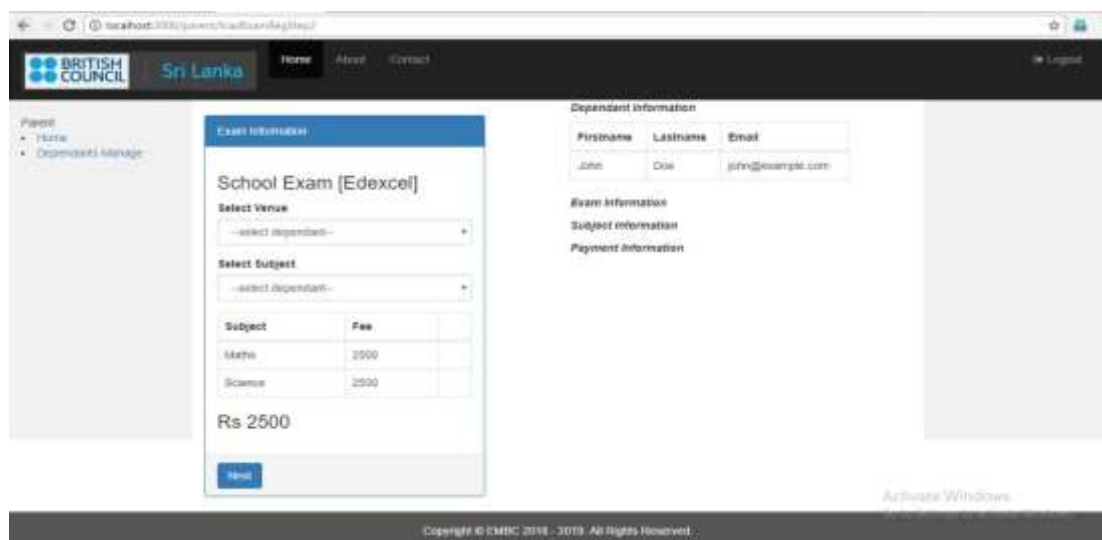


Figure 3.19 View of Student select Subjects in EMBC

System Analysis stage gathering and interpreting facts, diagnose problem and the information about the Examination Management System to recommend improvements on the system. The existing system studied and analyzed. It is concerned with becoming aware of the problem, identify the relevant and decision variables, analysis and synthesizing the various factor and determine a satisfactory solution of action. System Design stage gathered information design according to user requirements using diagrams, interfaces, database and create architecture of EMBC. This stage use wireframe feature to capture user requirements in an interfaces.

Chapter 4 | Implementation

The development of the executable application based on the design which made in the design phase, is brought into action in the implementation phase. Some of the main activities done in this phase are, selecting programming languages, selecting other tools and technologies such as framework, selecting hardware platform and coding the system.

4.1 Development Tools

Following tools were used in the development of the EMBC.

- IntelliJ IDEA 3.3 as the IDE
- Node.js, Express.js and Angular2 for system development.
- Mongo DB and NoSQL Booster 3.5.1 for database manipulation.

4.2 Development Technologies

Following technologies were used in the development of the EMBC.

- **CSS3** was used to style the pages. It enables to make consistent design for the whole application in easy-to-manage manner. [3]
- **Bootstrap** – Bootstrap is a free collection of tools for creating a websites and web applications. It contains HTML and CSS-based design templates. Bootstrap easily and efficiently scales the application with a single code base. Bootstrap makes front-end web development faster and easier. It's made for folks of all skill levels, devices. [3]
- **Node.js** was used as the server sides java script runtime environment – lets you implement web application back-end in JavaScript. Node.js is a platform built on Chrome's JavaScript runtime for easily building fast, scalable and concurrent web applications. Node.js help to develop backend development of system with NPM (Node Package Manager) Node.js uses an event-driven, non-blocking I/O model that makes it lightweight and efficient, perfect for data-intensive real-time applications that run across distributed devices. [12]
- **Angular** (formerly Angular.js, now also known as Angular 2): Front-end web app framework; runs your JavaScript code in the user's browser to implement a *reactive* user interface (UI). A reactive UI gives the user immediate feedback as they give their input,

allowing your application UI to be dynamic. It is client and server side java scripting. It provides some awesome features like the two-way data binding. It's a complete solution for rapid and awesome front end development. We use as HTML Template language with core html syntaxes. [15]

- **Mongo DB** was used to implement the database of the web application. Mongo is a schema less NoSQL database saves data in binary JSON format which make it easier to pass data between client and server in web application. According to that time periods can change data structure and enter real time data to development. Data can be stored and recall anytime is an important feature of MongoDB. MongoDB was also designed to be used asynchronously and document oriented database – used by your back-end application to store its data as JSON (JavaScript Object Notation) documents. [13]

4.3 Implementation of Express.js

Express.js is a lightweight framework used to build web applications in Node.js. It is a very Back-end web application framework running on top of Node.js, which allows developing full featured web applications in efficient manner. It provides a number of robust features for building single and multi-page web application. It is very simple, easy to use and very flexible. Because of these features, Express.js has been valuable framework in the implementation of a web applications. [16]

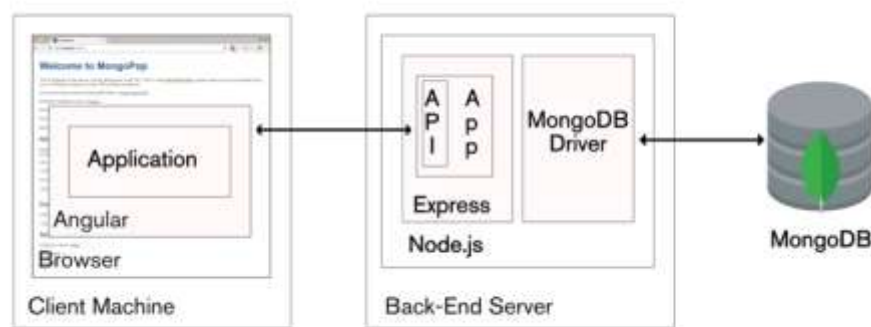


Figure 4.1 Implementation of Express.js

The router, method and the set of parameters and then the particular router is called. Router processes the request with the assistance of database which provide database manipulation and set of extended functionalities categorized into helpers, libraries and more. Finally, the router loads the particular view with the data which is sent back to the browser.

4.4 Module Structure

There were some rearrangements made into the design structure of the EMBC when implementing on the IntelliJ IDEA. Some are splitting some classes into database, views and router merging the classes and introducing some additional components such as Helpers and Libraries.

As shown below in figure 4.2, the EMBC consists of main folders are **db**, **routes**, **view** and **application** which consist of the application specific files and the core IntelliJ IDEA framework files respectively.

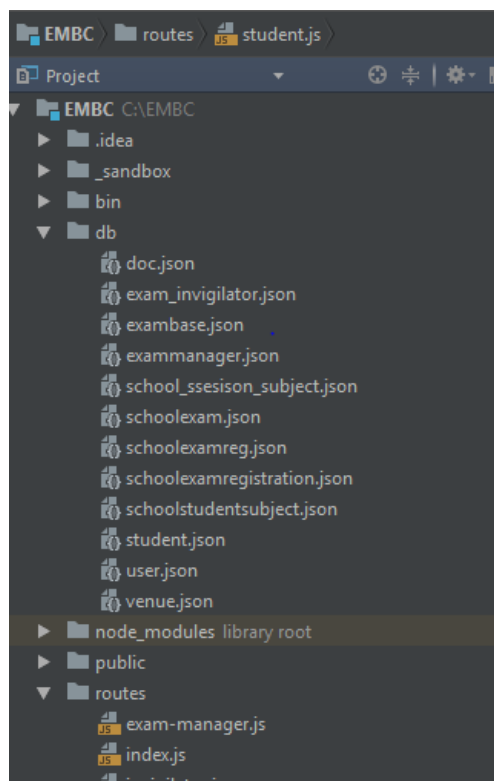


Figure 4.2 Structure of the Application

The files in the **db** and **views** folders have been categorized according to the module structure of the EMBC design. The files in the **routes** are not categorized in this manner to make clean URLs.

Public folder consists of the files which are allowed to access publically. It has folders for images, fonts, style sheets and so on.

4.5 Major Code Descriptions

Selected code segments have been described in this section in order to provide the clear picture about the execution of the EMBC.

4.5.1 Router

As mentioned earlier, Router is the main component of the MVC framework. Each request invokes a specific function of a specific router.

Following code segment shows the overall structure of the *User* section of the *Administration* router which related to the *user module*.

```
var express = require('express');
var router = express.Router();
var util_model = require('../util-model');
var ObjectId = require('mongodb').ObjectId;
var studentmodel = require('../student-model');
var mongo = require('mongodb');
var user_model = require('../user-model');
var exam_model = require('../exam-model');

var ssn;

/* GET users listing. */
router.get('/', function(req, res, next) {
  res.send('logout successfully');
});
router.get('/loadLogin',function (req,res,next) {
  console.log('>loadLogin');
  res.render('login',{msg:''});
});

router.post('/login', function(req, res, next) {
  console.log('>login');
  var dbconfig = req.app.locals.dbconfig;

  var loginobj = {
    nic_ppt : req.body.nic_ppt,
```

The above functions of the router have been categorized further according to their purpose as commented in the code in order to improve the maintainability of the router.

4.5.2 DataBase(db)

Model is responsible for enabling database interaction. Each db of the EMBC provides a set of operations(CRUD), which means creating, reading, updating and deleting entries in a Database. The db were developed for each object in the database in json format. They have consistent structure and operations as well.

The following code segment shows the structure of the *user_db* of the EMBC with some important functions.

```
"_id" : ObjectId("5a91fc86406ca92ab0f0933b"),
"nic_ppt" : "8",
"password" : "a",
"status" : "ACTIVE",
"user_type" : "student"
},
{
  "_id" : ObjectId("5a9e559ff56303356075c4a5"),
  "country" : "srilanka",
  "email" : "prent@gmail.co",
  "exam" : "School Exam",
  "exam_type" : "Edexcel",
  "first_name" : "Janaka",
  "id_type" : "NIC",
  "last_name" : "Vidanage",
  "nic_ppt" : "2222222222",
  "password" : "a",
  "title" : "Mr",
  "user_type" : "parent"
},
{
  "_id" : ObjectId("5aa24c75cf108010506b1423"),
  "country" : "srilanka",
  "email" : "staff@gmail.co",
```

4.5.3 View

Views are the web pages display on the user's browser, which are the combination of HTML and CSS. HTML defines the static contents while Node express for generating dynamic contents on the data submitted by the router. HTML5 elements and attributes have been used in order to enhance the semantics of the web pages. Following code depicts a part of the view - *add_user_view*.

```
var MongoClient = require('mongodb').MongoClient;
var util_model = require('./util-model');

var url = 'mongodb://localhost:27017/';
var dbname = 'bcd';

module.exports = {
  getExamManager:function(userobj,res,ssn){
    MongoClient.connect(url, function(err, db) {
      if (err) throw err;
      var dbo = db.db(dbname);
      // var query = {manager:'School Exam',users: { $elemMatch: {email:
'rx',password:'1x'} }};
      var query = {manager:userobj.category,users: { $elemMatch: {email:
userobj.email,password:userobj.password} }};
      console.log('query:'+query);
      dbo.collection("exammanager").find(query).toArray(function(err, result) {
        if (err) throw err;
        console.log(result);

        if(result.length>0) {
```

4.5.4 Library

Library is a collection of functions which is one type of reusable components in Node.js such as helpers. Node Express consists of several built in libraries. It also allows the developer to extend an existing library or creating own library from scratch.

Node.js also provides a rich library of various JavaScript modules which simplifies the development of web applications using Node.js to a great extent. Node.js library is asynchronous, that is, non-blocking. It essentially means a Node.js based server never waits for an API to return data. The server moves to the next API after calling it and a notification mechanism of Events of Node.js helps the server to get a response from the previous API call.

Chapter 5 | Evaluation

5.1 Test Plan of EMBC

Test plan is the documentation which guides the testing process in order to deploy proper EMBC software testing. It includes the scope, objectives and the constraints of the EMBC testing process, required resources, schedule and especially the test cases, test results and evaluation. It gives how the testing will proceed, who will do the testing, what will be tested, in how much time the test will take place, and to what quality level the test will be performed.[1]

Following table show high level test plan of the Examination Management System.

Module Name	Function name	Test Priority
Master file module	Insert Master details.	High
	Delete Master file details	High
	Update Master file details	High
	View Master file details	Medium
	Search by exam name	Low
	Search by customer name	Low
	Confirm deletion of master files	Medium
Exam Reservation module	Insert reservation details.	High
	Delete reservation details	High
	Update reservation details	High
	Confirm deletion of reservation details	High
	View reservation details.	High
	Search reservation details	High
	Check customer history	High
	Check exam availability	High
	Confirm exam dates	High

	Search confirmed exam dates	Medium
Reports	Generate session exam reports	High
	Generate session venue reports.	High
	Generate monthly staff reports	High
	Generate monthly exam reports	High
	Generate monthly venues reports	High
	Generate monthly resource and accessories reports	High
	Generate monthly reservation list	High
Notifications	View notifications	High
Venue Allocation	Allocate venues	High
	Cancel allocation	High
	Check venue availability	High
	View branches allocation details	High
	View status of the venue	High
User Management	Add users	High
	Delete users	High
	Confirm deletion of users	Low
	Edit users	High
	View users	High
	Login users	High
Close exam module	Save Close exam Details	High
	Update close exam details	High
	View Close exam history	High

Table 5.1 Test Plan of EMBC

5.2 Test Cases

- Administration Module

Test No.	Test Description	Steps to Test	Expected Result
1	User Login[valid]	Enter valid user ID and password. Click login button.	Load the relevant default section according to the user role.
2	User Login [invalid]	Enter invalid user ID and/or password. Click login button.	Display error & redirect to the home page.
3	User Login [invalid/empty]	Click login button without entering user ID and/or password.	Display error & redirect to the home page.
4	Display Greeting section.	Login and check top right corner.	Should consist user first name and user role.
5	Admin cannot be deactivated.	Check admin entry in user's section.	No button to deactivate admin.
6	Admin cannot be edited.	Check admin entry in user's section.	No button to edit admin.
7	Deactivate User	Click deactivate button in user entry.	Change the user status as inactive & display confirmation.
8	Reactivate User	Click reactivate button in user entry.	Change the user status as active & display confirmation.
9	Reset user password	Click reset password button in user.	Change user password to default, confirm.
10	Edit User	Click edit user button, make changes and click save button.	Save changes, confirm.

11	Input NIC [valid]	go to New User, enter NIC / passport No with correct format old/new, click Add User button.	No any error
12	Input NIC [invalid/existing]	go to New User, enter an existing NIC, click Add User button.	Display error and prompt to correct.
13	Search Log	go to maintenance, select and enter User ID, click Search button.	Display entries relevant to that user.
14	Data Backup	Click Generate Backup button	Generate backup file.
15	Edit user profile[valid]	Click My Profile in top right corner menu, enter new password, confirm	Save the changes and confirm.

Table 5.2 Test Case of Admin Module

- Exam Module

Test No.	Test Description	Steps to Test	Expected Result
1	View Exam	Navigate to Exam section and then Exam sub section.	Display the first set of most recent Exam.
2	View Exam.	Click View Exam button in the particular Exam entry.	Display the full details of that Exam.
3	Add new Exam [valid]	Go to new Exam, add details and click Add Exam button.	Exam added, confirm and display print receipt button.
4	Add new Exam [invalid venue]	Go to new Exam, add details with current venues and click Add Exam button.	Display error and re prompt to correct.

5	Add new Exam [existing branch]	Go to new Exam category, add details with entering similar venue and click Add Exam button.	Display error and re prompt to correct.
6	Add new branch [past branch]	Go to new Exam category, examine the branch list for past branches.	Past branches not in the list.
7	Print receipt	Click Print receipt button in confirmation after adding exam.	receipt generated.
8	Search exam date	Go to Search exam section, make criteria, click Search button.	Relevant dates are listed down.

Table 5.3 Test Case of Exam Module

- Report Module

Test No.	Test Description	Steps to Test	Expected Result
1	Generate monthly venue report	Navigate to Reports section, select year, month and branch. click Generate exam Report button.	Monthly venue Report is Generated.
2	Generate annual exam report	Select year and branch. click Generate Exam Report button.	Annual exam Report is Generated.
3	Generate monthly staff report	Select year, month and agent. click Generate Staff Report button.	Monthly staff Report is Generated.
4	Generate annual staff report	Select year and branch. click Generate staff Report button.	Annual staff Report is Generated.
5	Generate all exams report	Navigate to Reports section, click Generate all exams Report button.	All exams Report is Generated.

Table 5.4 Test Case of Report Module

- Finance Module

Test No.	Test Description	Steps to Test	Expected Result
1	View transactions	Navigate to payment.	Display most recent set of transactions.
2	Pay Credit	Select the card type. Fill the amount and click Pay button.	The total balance of credit is decreased, add transaction and confirm.
3	Receive Debit	Select the bank. Fill the amount and click Receive button.	The total balance of debit is decreased, add transaction and confirm.

Table 5.5 Test Case of Finance Module

- Candidate Module

Test No.	Test Description	Steps to Test	Expected Result
1	Add new candidate.	Click add new candidate link & fill out correct data & click save.	Provide interface to enter new candidate info ,also generate a ID for the new entrant to save data to DB
2	Manage existing candidate details.	Click update/view/search according to relevance.	candidate details should be able to be updated and view/search according to the candidate ID.
3	Enter new exams product.	Click add new exam product link.	Provide interface to enter new exam branch Information
4	Find available venues quantity.	Click find button next to available venue quantity.	Search database for quantity and display response to query.
5	Find price of selected subjects.	Click find button next to price.	Search database for price and display response to query.
6	Generate candidate payment invoice.	Click payment button.	Generate and display printable receipt in a separate popup window.
7	Show allow exam date selection.	Click date textbox.	Popup calendar to select correct date.
8	Calculate subject values.	Click calculator button.	Calculate the values and display in textbox.
9	Display help popup.	Click help popup link.	Shows help popup for exam, customer, venues, exam dates.

Table 5.6 Test Case of Candidate Module

- Web Module

Test No.	Test Description	Steps to Test	Expected Result
1	Main menu navigation	Click each menu item of the <i>main menu</i> .	Load the relevant page.
2	Place inquiry	Fill in the form in the <i>contact</i> page. Press <i>send</i> button.	Add the inquiry entry & display confirmation
3	Customer/Candidate Login.	Enter <i>id</i> and <i>password</i> of the customer/candidate. Click <i>login</i> .	Customer/ exam officers are able to login.
4	Add subjects to the shopping cart	Clicks add <i>to the shopping cart</i> button of the particular exam product.	Update the shopping cart.
5	View shopping cart.	Click <i>view</i> button of the shopping cart area.	Display the shopping cart.
6	Remove item from the shopping cart.	Click <i>remove item</i> button in front of the particular item.	Remove the particular item from the shopping cart.
7	Clear shopping cart.	Click <i>clear</i> button of the shopping cart area.	Remove the entire item in the shopping cart.
8	View exam history	Login to the exam officer account. Click <i>exam</i> menu item.	Display the exam register by the candidate
9	Cancel registration	Click <i>cancel</i> button in front of the particular registration.	Cancel the registration & display confirmation.
10	Edit profile	Edit the profile in <i>profile</i> page. Click <i>save changes</i> button.	Save the changes & display confirmation
11	Change password	Enter similar password for <i>new password</i> & <i>retype password</i> fields. Click <i>save changes</i> button.	Save the new password & display confirmation

Table 5.7 Test Case of Web Module

Moreover, tests like path testing, statement testing, syntax checking, interface testing was carried out to ensure consistency and integrity.

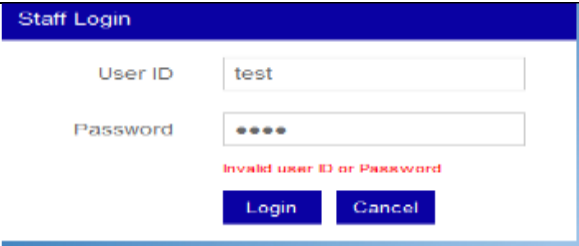
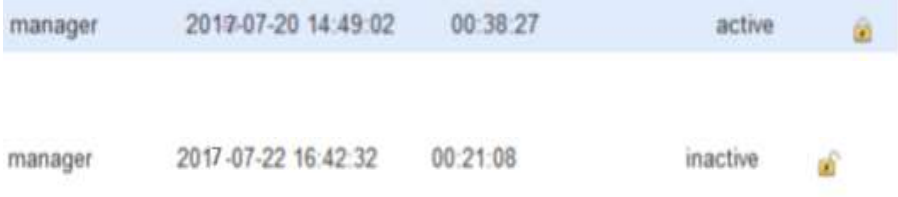
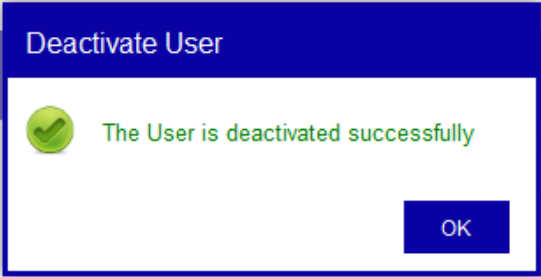
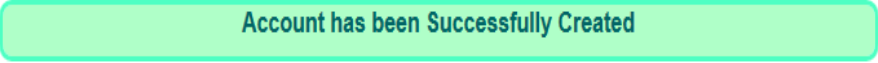
5.3 Test Data and Test Results

The collection of data which is used in the testing process is referred to as test data.

Dummy datasets were used in the unit testing and the integration testing while the datasets extracted from the existing system were used in the system testing of EMBC.

The test results generated in the execution of the test cases were also documented which can be very useful in the further evaluation and the future maintenance processes. [1]

- Admin Module

Test No	Actual Result [screen shots]	Status
1.		ok
2.		ok
3.		ok
4.		ok

5.		ok
----	--	----

Table 5.8 Test results for Admin Module

- Candidate Module

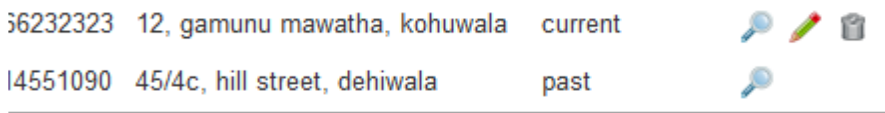


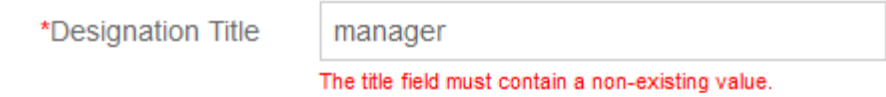



Test No	Actual Result [screen shots]	Status
1.		ok
2.		ok
3.		ok

Table 5.9 Test results for Candidate Module

- Staff Module

Test No	Actual Result [screen shots]	Status
1.		ok
2.		ok
3.		ok
4.		ok

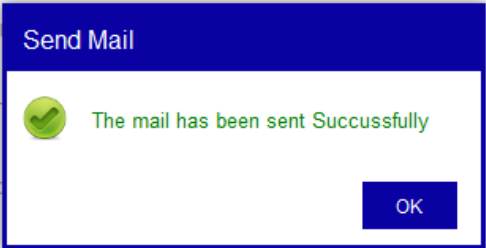
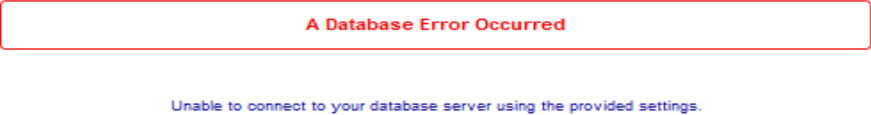


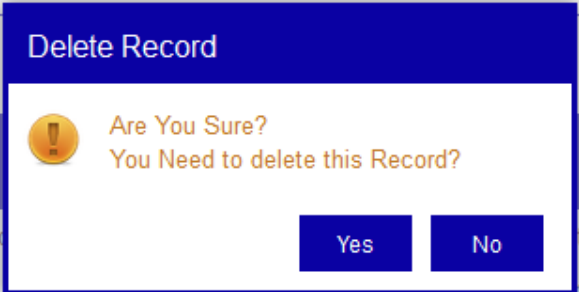
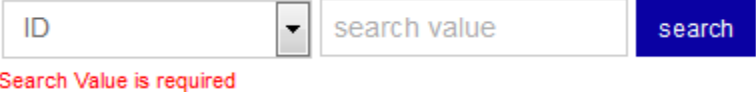

5.	 A dialog box titled "Send Mail" with a green checkmark icon and the text "The mail has been sent Succussfully". An "OK" button is at the bottom right.	ok
6.	 A red-bordered box with the text "A Database Error Occurred" in red. Below it, in smaller blue text, is "Unable to connect to your database server using the provided settings."	ok
7.	 Two side-by-side "Shopping Cart" boxes. The left box shows "Total Items 0" and "Amount Rs. 0.00". The right box shows "Total Items 1" and "Amount Rs. 3500.00".	ok
8.	 A table with three columns: "Date Placed", "Date Completed", and "Status". The first row shows "2017-07-20 16:41:43", "pending", and three icons (a magnifying glass, a person, and a trash can).	ok
9.	 A light blue box with the text "The new comment is added successfully." in green.	ok
10.	 A dialog box titled "Delete Record" with a yellow warning icon. It contains the text "Are You Sure? You Need to delete this Record?". There are "Yes" and "No" buttons at the bottom.	ok
11.	 A search form with a dropdown menu labeled "ID", a text input field with "search value", and a "search" button. Below the input field is a red error message: "Search Value is required".	ok
12.	 An orange rounded rectangle with the text "Enter valid number of records and try again!" in red.	ok

Table 5.10 Test results for Staff Module

- Finance Module


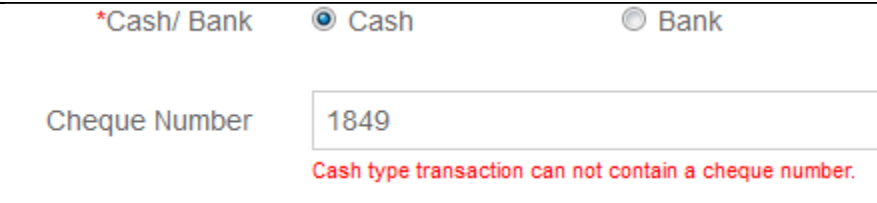

Test No	Actual Result [screen shots]	Status
1.		ok
2.		ok
3.		ok

Table 5.11 Test results for Finance Module

EMBC system using testing methods are unit testing, Integration testing, System testing, Regression testing and Acceptance testing and also black box and white box testing.

After completing the system testing the system expose to its real users to examine the system at the client's premises with own data. The users were selected as representing the all business process of the EMBC. Some of the customers who are close with the client were also invited to assess the functionalities of the frontend website for the evaluation.

Structured questionnaire was used to get user feedbacks under the set of criteria and to get further suggestions. Then all the feedbacks were summarized and assessed while the minor modifications were also implemented according to the suggestions of the users.

5.4 Evaluation Results of BC Management

The Overall Feedback ratings of each employee were taken and converted into a graphical evaluation chart can be display in either bar chart or graph chart. These graphs will be shown in documentation chapter of Testing in dissertation and also sample user evaluation feedback table below shows. Some suggestions were taken into consideration at the implementation as well. Hopefully other suggestions will be implemented with the future enhancements.

Job Roles	Background Info of EMBC					
	Admin	Exams	Staff	Venues	Backup	Reports
Country Director						
Country Exam Manager						
Head of Exams Operations						
Examination Product Managers						
Examination Officers						
Exam Supervisors						
Invigilators						
Candidates						

Table 5.12 Employee Feedback sampling

The results of the user feedback analysis are given in following figure 5.1

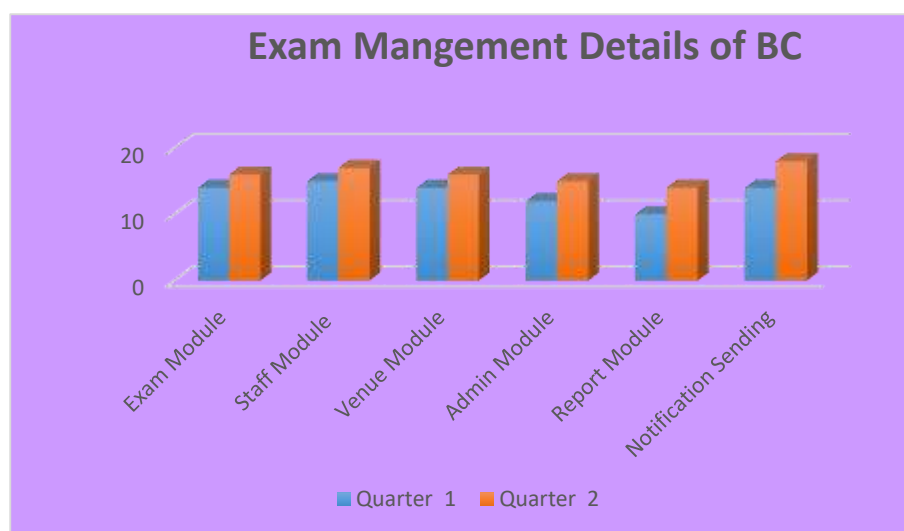


Figure 5.1 User Evaluation Feedback chart in EMBC

Modules	Quarter 1	Quarter 2
Exam Module	14	16
Staff Module	15	17
Venue Module	14	16

Admin Module	12	15
Report Module	10	14
Notification Sending	14	18

Table 5.13 User Evaluation Feedback Results

Ratings	A - Very Good	B - Good	C - Acceptable	D - Low
----------------	----------------------	-----------------	-----------------------	----------------

Rating Scheme

No	Questions	A	B	C	D
1.	Ease of understanding module functions.				
2.	Interactivity of EMBC intranet.				
3.	Recognition for look and feel.				
4.	Coverage of required functionalities.				
5.	Consistency of navigation menus and forms.				
6.	Ability to find way to perform transactions by accessing correct links.				
7.	Speed of transactions per minute.				
8.	Ability to understand error messages.				
9.	Degree of Information provided in Reports.				
10.	Potential benefits gained through the system.				
11.	Ability to maintain data, to keep it up-to date.				
12.	The advantage span between old manual system and EMBC.				
13.	Efficiency of Help menus provided.				
14.	Easiness of invoice and reports generation.				
15.	Ease of entering/handling form fields, and handle manipulations.				
Suggestions					
1.	It would be appreciated if we had more help/assistance files.				
2.	Auto complete options can be included.				

3.	Add functionality to handle advance payments to exams.				
4.	More graphical reports are requested to enhance clarity.				
5.	Make the interface more attractive with animations.				

Table 5.14 User Acceptance Test Results sample sheet

5.5 Test Results for User Acceptance

Different user levels in the BC hierarchy consist with higher management members such as; Country Director, Country Exam Manager, Head of Exam Operations, Exam products Manager, Exam Officer, Exam Supervisors and Invigilators representative with the external parties are the only personnel that the system would interact with.

Therefore, interaction is only with the higher management and with the external parties. At the testing stage, it was informed that external parties could not participate at the testing sessions and the testing criteria had been informed to the Head of Exam Operations.

The overall system including external parties' criteria had been tested by the Head of Exam Operations. Parallel to the Head of Exam Operations, other workers of the second level of the company hierarchy were tested and provided their feedback.

Using the standard set of questions provided in papers, the feedbacks were collected. The introduction of those questions to the exam staff members was difficult at the beginning as they didn't have enough experience of such questionnaires.

5.6 User Acceptance Test Result Sheet

Please refer the appendix C - Test Results for the assessment of sample questionnaire.

Chapter 6 | Conclusion

6.1 Critical Assessment of the Project

Although the system was evaluated as all its objectives were achieved successfully, it is still worthy to self-assess the system from the developer's point of view.

Administration, Exam, Candidate and Staff modules of the backend application were identified as the most critical pieces of the system by considering the objectives and hence paid more attention for them in the development process.

However, because of some unmanageable external issues such as browser supportive, mature of the technology and the expense, it was unable to use some enhanced features for the current system further. Most of them have been suggested for the future improvement of the system and would be increased the potential of the system in the future.

6.2 Future Improvements

Although the EMBC was full filled all of its requirements successfully some of the improvements have been identified throughout the development process which would be considered in the future versions of the EMBC.

- Introducing Exam android app
Add more effective app support staff level making more effective of data capturing. Data entering accuracy of the Exams and staff activities can be improved using system generated mobile android app for the BC Exam System.
- Integrated application and back office functions related to technology of current website and internal system as Enterprise Resource Planning (ERP) to manage the business in future.
- Provide payment gateway facility after processing registration of exam payments and for special tasks by implementing this suggestion, users can get relevant information from the system through online payment.

- Improve the Security by placing a standard Firewall, Gateways and use Cryptographic methods to constrict further security as the Intranet deals with large amount of Sensitive Information.

6.3 Lessons Learnt

As a student taking a Master program, this was a great opportunity for me to apply the previously learned lessons into a working system. The domain area was considerably large, therefore it helped to gain experience in many business techniques and it broadened my horizons into understanding, how to map those related business processes into a computerized system. It also provides me a valuable opportunity to practice the knowledge and the skill gained during the MIT programed.

The development of the EMBC helps to gain a solid experience of developing a system going throughout the SDLC. The analysis and designing phases provide opportunity to practice various software engineering approaches such as requirement gathering techniques, OOD techniques and designing systems using UML which would be a real benefit in my future career. Using IntelliJ IDEA helps me to gain a solid experience on MVC in the implementation. This phase also helps me to improve my knowledge on Node.js, Angular2, Mongo DB and so on. Evaluation phase was a good platform for me to practice how to evaluate a system especially in the client side.

Better experience was obtained on how to communicate with a real customer. Furthermore, the working environment consisted with web related languages; some of which I have learned before and I gained a lot of new knowledge in some new technologies such as Angular.js and Node Express, while developing the system. Apart from previously learned lessons, I could learn to write reports according to the recognized standard and to present reports to interested parties who wish to read.

It was also a worthy practice for me regarding achieving objectives within a schedule, facing challenges, improving writing skills and finally to be a professional.

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Appendix A | System Documentation

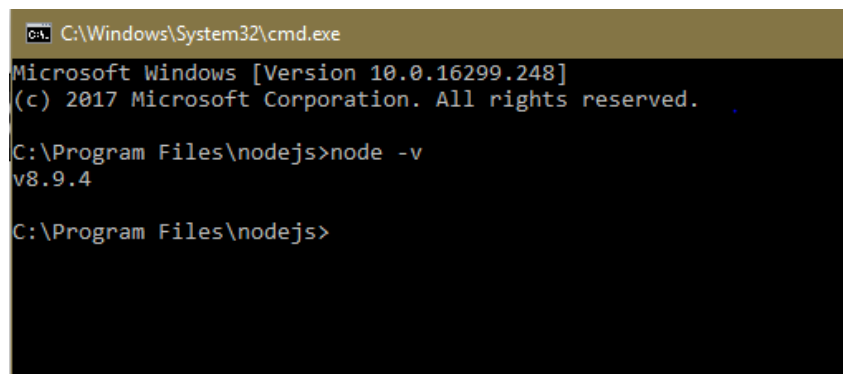
This documentation provides the details and guidance needed to install and configure the EMBC on a local computer using Server.

These steps explain about the hardware and software environment which needs to be installed. When installing the system, this documentation can be followed by the interested parties.

Application Installation

1st Step - Installing Node.Js

- To install into the local computer, download and follow the setup steps to installation. When set up node.js time installing Node Package Manager (npm).
- We can see installation node.js version in node console



```
C:\Windows\System32\cmd.exe
Microsoft Windows [Version 10.0.16299.248]
(c) 2017 Microsoft Corporation. All rights reserved.

C:\Program Files\nodejs>node -v
v8.9.4

C:\Program Files\nodejs>
```

Figure A1. Installing Node.js

The path of the install folder would be in - *C:\Program Files\nodejs*

- Use the prompts to install the Node.js. By default, the installer uses the Node.js
C:\Program Files\nodejs\bin
- then type your software folder copy in the place
C:\EMBC\bin>node www


```

C:\Windows\System32\cmd.exe - node www
Microsoft Windows [Version 10.0.16299.192]
(c) 2017 Microsoft Corporation. All rights reserved.

E:\EMBC\bin>node www
variable_1_neededmongodb://localhost:27017/
GET / 304 14.514 ms - -
GET /stylesheets/bootstrap.min.css 304 10.696 ms - -
GET /javascripts/jquery.min.js 304 10.445 ms - -
GET /javascripts/angular.min.js 304 18.346 ms - -
GET /javascripts/bootstrap.min.js 304 18.311 ms - -
GET /stylesheets/style.css 304 10.570 ms - -
GET /stylesheets/font-awesome.css 304 26.492 ms - -
GET /images/bc_logo.PNG 304 2.138 ms - -
GET /images/webcover2-01.png 304 0.872 ms - -
GET /fonts/fontawesome-webfont.woff2?v=4.7.0 304 0.502 ms - -
variable_1_neededmongodb://localhost:27017/
GET / 304 3.502 ms - -
GET /stylesheets/bootstrap.min.css 304 5.957 ms - -
GET /javascripts/jquery.min.js 304 3.178 ms - -
GET /javascripts/bootstrap.min.js 304 2.061 ms - -
GET /stylesheets/style.css 304 1.948 ms - -
GET /stylesheets/font-awesome.css 304 2.015 ms - -
GET /javascripts/angular.min.js 304 12.179 ms - -
GET /images/bc_logo.PNG 304 1.097 ms - -
GET /images/webcover2-01.png 304 0.450 ms - -
GET /fonts/fontawesome-webfont.woff2?v=4.7.0 304 0.361 ms - -

```

Figure A2. Configure Node.js with EMBC

2nd Step - Installing Web Browsers

- Install Browsers (refer Table A.2 for the Version and Recommended Browsers).



Figure A3. Web Browser configuration of EMBC website

3rd Step - Database Installation

This section guides you how to install the database using **Mongo DB**. Please refer the vendor's documentations if you use another tool for database installation.

1. To install on the local computer,
 - First download Mongo DB software and run into local pc
 - Then Run the Mongo DB Console server as cmd
 - Type following command as

```
mongod.exe --dbpath=C:\mongo_database
```

- Finally display in mongo console as

```
C:\ProgramFiles\MongoDB\Server\3.6\bin>mongod.exe--
```

```
dbpath=C:\mongo_database
```


5th step - (Launching System)

1. Verify the server is running; go to the following ways to access the frontend homepage. Open the installed web browser and type the URL
 - For the local computer: **localhost:3000/**
 - Press “Enter” button to access the system.
 - Access the admin panel using the user ID and password.



Figure A6. Configure server

2. Then find the user id of the Super Admin account under the user name to access the backend application with default password. (Super Admin is the start-up account provided you to log to the backend & create the actual users).

It is strongly recommended you to change admin password immediately after the first login in order to ensure the security of the application. Also you should deactivate Super Admin account after creating the manager, account and should not be used for any other thing.

Appendix B | Design Documentation

Administration Module

Four user roles in EMBC as follows

- **Super Admin**
This is a virtual admin with full access for all modules. However only recommend to create new admin. Then admin create exam managers and exam officers. Super admin account cannot be edited, reactivated, deactivated, reset its password, edit profile itself through the application. Direct database editing is needed for those.
- **Admin**
Only allow to access administration module. Admin cannot be modified or create another admin. Admin is only allowed to create and modify lower levels, which are manager and officer
- **Exam Manager**
Allow to access exam, candidate, venue, staff, financial and report modules.
- **Exam Officer**
Allow to access exam and venues modules

Inactive users are shown in red-colored-text. All most all the activities are recorded in the system log. Cancel, reactivate, edit categories, Agents and dealers not record, because can reactivate and no critical effect. Generating business documents, such as sales invoice not recorded, because it is a part of another process which is recorded.

Use case Name	Backup Data
Actors	Admin
Description	Admin gets current data backup.
Pre-conditions	Admin must logs in to the system
Main Flow	
<ol style="list-style-type: none">1. Admin navigates to the 'maintenance' section of the system.2. System displays the section with backup option.3. Admin clicks 'Generate backup' button.4. System generates backup and prompts to save.	

5. Admin saves the backup in particular location.	
Alternate Flows	
none	
Post-conditions	The backup is generated successfully.

Table B.1 Use case narrative for Backup Data

Use case Name	Edit Profile
Actors	User
Description	User changes the password.
Pre-conditions	User must logs in to the system
Main Flow	
<ol style="list-style-type: none"> 1. User clicks ‘my profile’ button on the main menu. 2. System displays user’s profile page. 3. User changes the password and confirms through email. 4. System updates the password and confirms to email. 	
Alternate Flows	
3.1 One or more field is invalid. 3.1.1. System displays error and prompts to correct.	
Post-conditions	The user’s password is updated successfully through user email.

Table B.2 Use case narrative for Edit Profile

Reports Module

This includes generating exams, candidates and staff reports generating business process related documents such as exam data sheet, payment invoice and so on. Reports can be either hard copy or on-screen tables. Report generating Module is only for authorized users according to their needs. They have a lot of variations according to the criteria, month and year as shown in **reports** screen. The inactive options are shown in red texts in the list in general.

The use case diagram of the Report module is given below in the figure B.1

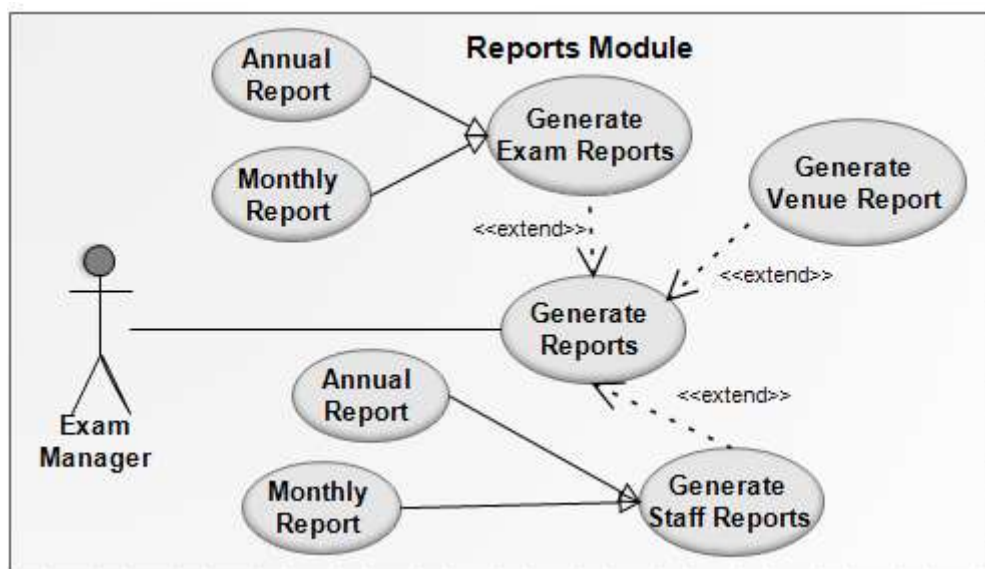


Figure B.1 Use case diagram for the Report Module

Use case Name	Generate Reports
Actors	Manager
Description	Manager generates the relevant reports.
Pre-conditions	Manager must log in to the system.
Main Flow	
2. Manager navigates to the 'Reports 'section. 3. System displays the section. 4. System provides options to generate various reports. 5. System generates the particular report.	
Alternate Flows	
3.1. Manager generates exam report. 3.1.1. "Generate Exam Reports" use case is executed. 3.2. Manager generates candidate report. 3.2.1. "Generate Candidate Reports" use case is executed. 3.3. Manager generates staff report. 3.3.1. "Generate Staff Report" use case is executed.	
Post-conditions	none

Table B.3 Use case narrative for the Generate Reports

Use case Name	Generate Exam Reports
Actors	none
Description	Manager generates the Exam reports.
Pre-conditions	The use case "Generate Reports" must be executed.

Main Flow	
<ol style="list-style-type: none"> 1. Manager specifies the criteria in exam report section. 2. Manager clicks ‘Generate Exam Report’ button. 	
Alternate Flows	
none	
Post-conditions	The exam report is generated.

Table B.4 Use case narrative for Generate Exam Report

Use case Name	Generate venue Report
Actors	none
Description	Manager generates the venue report.
Pre-conditions	The use case “Generate Reports” must be executed.
Main Flow	
<ol style="list-style-type: none"> 1. Manager clicks ‘Generate Venue Report’ button. 	
Alternate Flows	
none	
Post-conditions	The venue report is generated.

Table B.5 Use case narrative for Generate Venue Report

Financial Management

The purpose of this module is to just managing the credits of the exam fee respectively related to the candidates and institutes not to monitor the monetary status of the business. So it not follows any standard book keeping rules. All exam fees made in cash on the time. Institution also made on credit.

The following figure B.2 use case diagram shows the activities in Finance module.

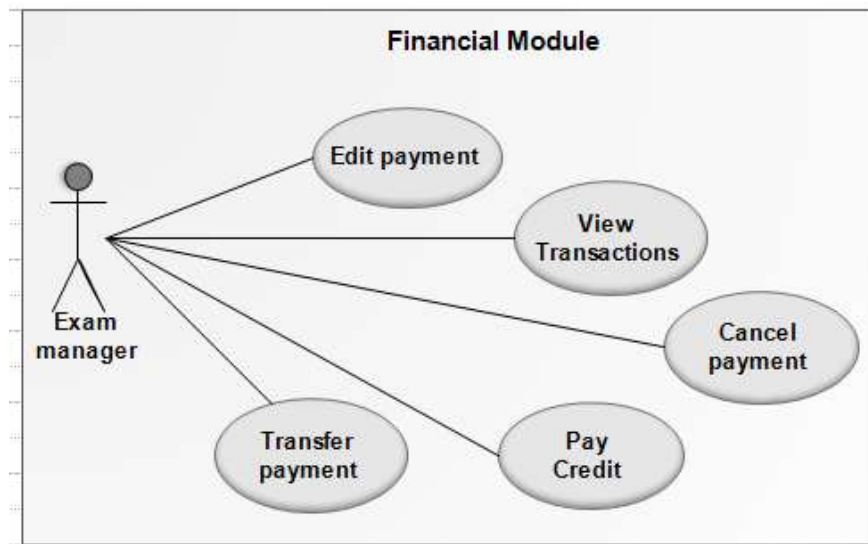


Figure B.2 Use case diagram for the Financial Module

Use case Name	View Transactions
Actors	Manager
Description	Manager views the transactions.
Pre-conditions	Manager must log in to the system.
Main Flow	
<ol style="list-style-type: none"> 1. Manager navigates to the 'Financial' section. 2. System displays the section with the recent transaction details. 	
Alternate Flows	
None	
Post-conditions	none

Table B.6 Use case narrative for View Transactions

Use case Name	Pay Credit
Actors	Manager
Description	Manager adds a credit paid to an exams.
Pre-conditions	Manager must log in to the system.
Main Flow	
<ol style="list-style-type: none"> 1. Manager navigates to 'Creditors' sub section. 2. System displays list of creditors with amount. 3. Manager clicks pay credit button in front of particular creditor. 4. System displays a form to fill. 5. Manager fills and submit. 6. System validates, updates the balance and confirms. 	

Alternate Flows	
6.1 One or more field is invalid.	
6.1.1 System shows error(s) and prompts to correct.	
Post-conditions	The credit is added successfully.

Table B.7 Use case narrative for Pay Credit

Web Module

The Web module represents the frontend of the EMBC which is responsible for facilitates the candidates and the staff to interact with the business. Some of the tasks handled by this are placing registration online, viewing exam dates and so on.

The following figure B.3 use case diagram shows the main activities in Web module.

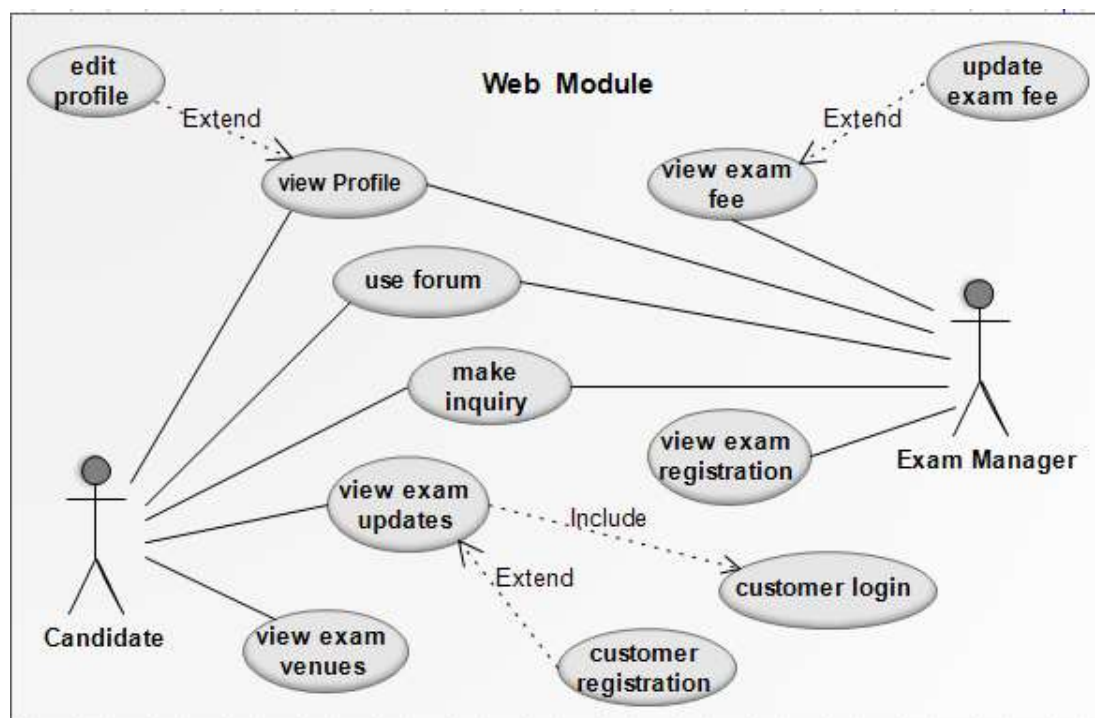


Figure B.3 Use case diagram for the Web Module

Sequence Diagrams for EMBC

The below figure B4 shows Sequence diagram for Staff process.

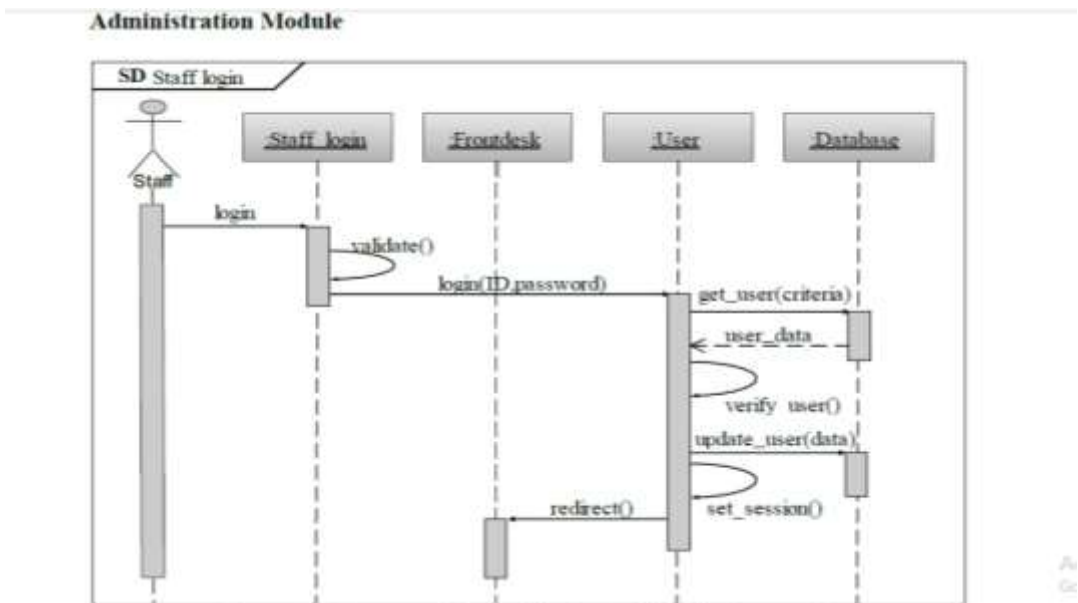


Figure B4 Sequence diagram for Staff Module

The below figure B5 shows Sequence diagram for Add candidates to EMBC process.

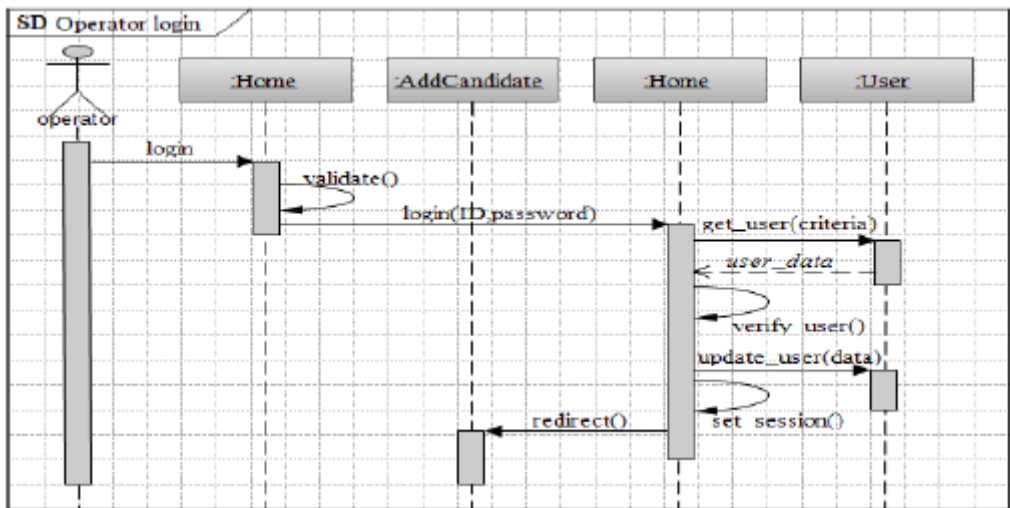


Figure B5 Sequence Diagram for Candidates Module

Activity Diagrams for EMBC

The below figure B6 shows Activity diagram for Candidate payment process.

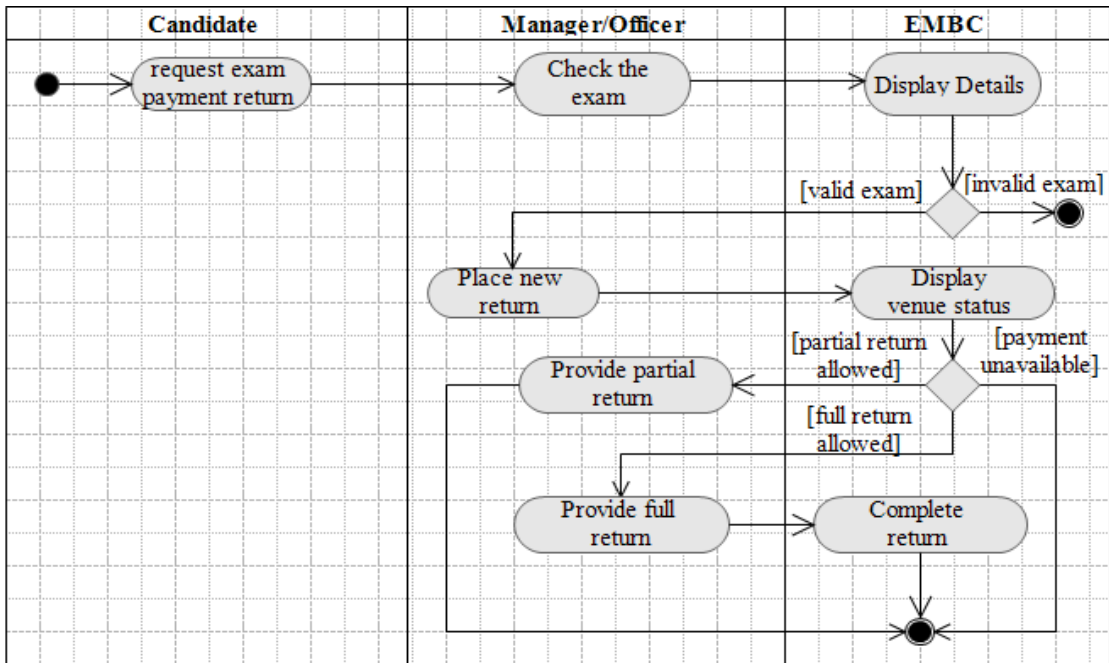


Figure B6 Activity Diagram for Candidates Module

The below figure B7 shows Activity diagram for Add Exam process.

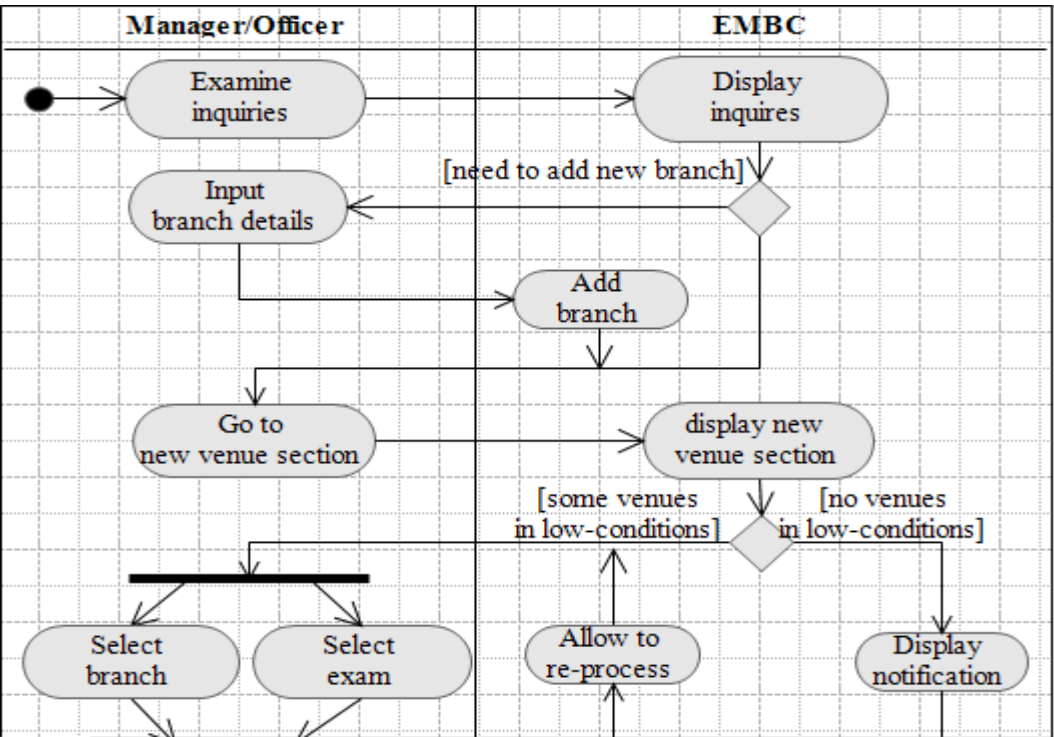


Figure B7 Activity Diagram for Exam Module

Structure of the Classes in EMBC

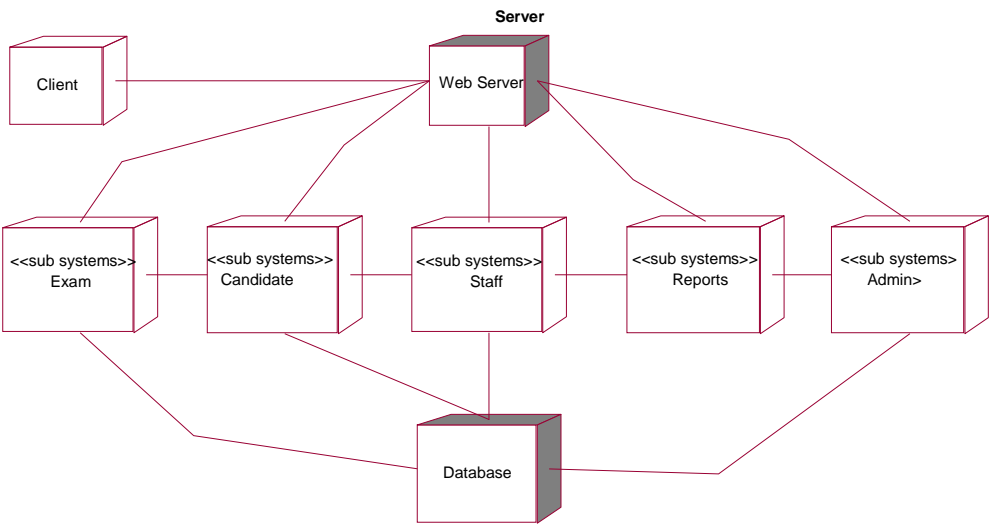
Following figure B.8 represent the properties and methods of classes in EMBC.

User - NIC: Integer - first_name: String - last_name: String - user_role: String - designation: String - last_login: Date Time - status: Boolean +add_user() +edit_user(id) +search_user(key) +reset_psw(id) +deactivate_user(id) +reactivate_user(id)	Exam Category - id: Integer - name: String - status: Boolean +add_category() +cancel_category(id) +reactivate_category(id)	Exam Transfer - exam_id: Integer - candi_id: integer - branch_id: String - quantity_transfer: Integer - quantity_provided: Integer - user_added: Integer - date_added: Date Time - user_completed: Integer - date_completed: Date - trans_status: String +add_trans() +edit_trans(id) +complete_trans(id) +search_return(key)	Staff - staff_id: Integer - branch_id: Integer - date_join: Date - user_active: Integer - exams: Array - exam_status: Boolean +add_staff(id) +complete_exam(id) +cancel_exam(id) +view_exam(id) +print_exam(id) +search_exams(key)
Log - log_id: Integer - category: String - description: String +add_entry() +search(key)	Branch - branch_id: Integer - name: String - contact: String - status: Boolean +add_branch() +edit_contact(id) +cancel_branch(id) +ractivate_venue(id)	Payment Return - return_id: Integer - date_pay: Date Time - user_reg: Date Time - date_cmp: Date Time - user_cmp: Date Time - pay_returns: Array - exam_status: String +add_payment() +cancel_payment(id) +complete_payment(id) +search_payment(key) +generate_return_invoice	Location - branch_id: Integer - venue_no: String - candi_id: Integer - staff_id: Integer - discount: Float - date_exam: Date - user_exam: Integer - exams: Array +add_exam() +view_exam(id) +print_receipt(id) +search_exam_id(key)
Exams - title: String - type: String - branch_id: Integer - venue_id: Integer - category_id: Integer - exam_fee: Float - reg_fee: Float - discount: Float - date: Date - time: time - payment: float - staff_id: Integer +add_exam() +edit_exam(id) +view_exam(id) +search_exam(key)	Venue - venue_id: Integer - name: String - contact: String - status: Boolean +add_venue() +edit_contact(id) +cancel_venue(id) +ractivate_branch(id)	Requisition - request_id: Integer - note: String - date_added: Date Time - user_added: Integer - date_com_can: Date - user_com_can: Integer - status: String +add_request() +cancel_request(id) +complete_request(id)	Backup +get_backup()
	Candidate - candi_id: Integer - branch_id: Integer - date_apply: Date Time - user_pay: Integer - candi_cont: Array +add_candidate() +view_candidate(id) +search_cadidate(key) +generate_invoice(id)		Report +generate_report(data)
	Payment - exam: array		

Figure B8 Classes of the EMBC

Deployment Diagram for EMBC

The below diagram shows the physical architecture of the hardware and software in the system.



Deployment Diagram for Exam Management System

Figure B.9 Deploy Diagram of the EMBC

Architectural Design for EMBC

Architectural Design establish the design process for identifying the sub-systems making up the framework and communication.

The following figure B.10 illustrates the components of EMBC using a Component Diagram.

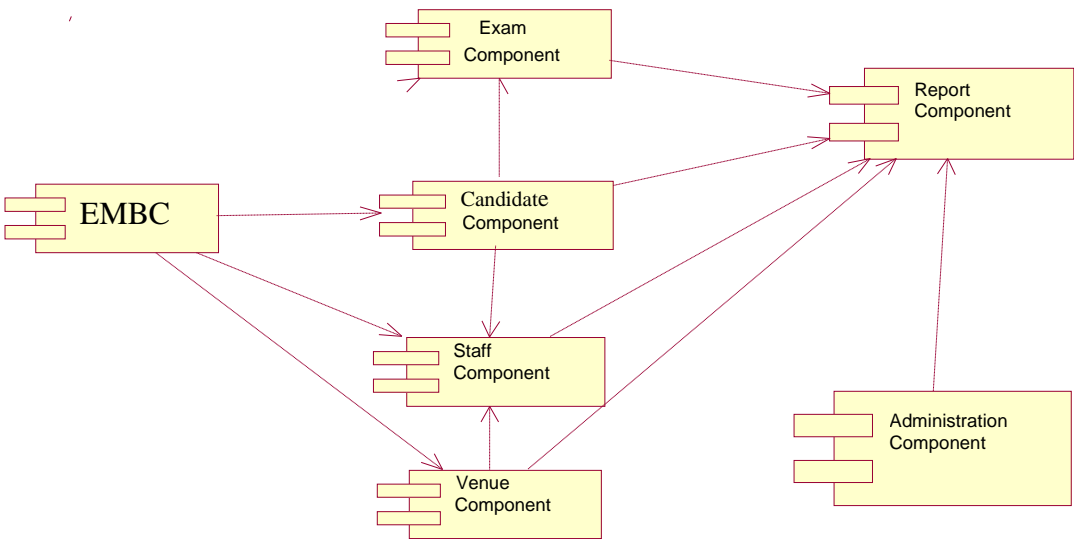


Figure B.10 Components of the EMBC

Appendix C | User Documentation

Users who have privileges to access the system about how to navigate within the system and how to use its functions are helped by this document. Eligibility to access the system is available to super admin, administrator, higher managers, exam managers, exam officers, exam staff and candidates.

Different user levels are available to each and every member and different profile pages are provided for their management. The administrator's profile which has all the system privileges is described by this document. This documentation provides you a guidance to use the backend web application efficiently.

Login page and other functionalities



Open the web browser that configured in the installation. Type the URL in the address bar of the browser ***http://localhost:3000/EMBC***. After navigation, user can find the Login in right top corner for invigilators and candidates can login Exam Registration hyperlink as Schools, IELTS, Professional and Cambridge English links shows under figure C.1

Figure C.1 Application Login of EMBC

After login, by entering username and password it directs user to the page which is under figure C.2



Figure C.2 Administrator Home page

Change Password Facility

By clicking, link which is located in the figure C.2 the current password can be changed by the user. After clicking that link the pop up appears which is shown under figure C.3 in password reset. Current user's password can be changed by entering new password accurately into the fields.

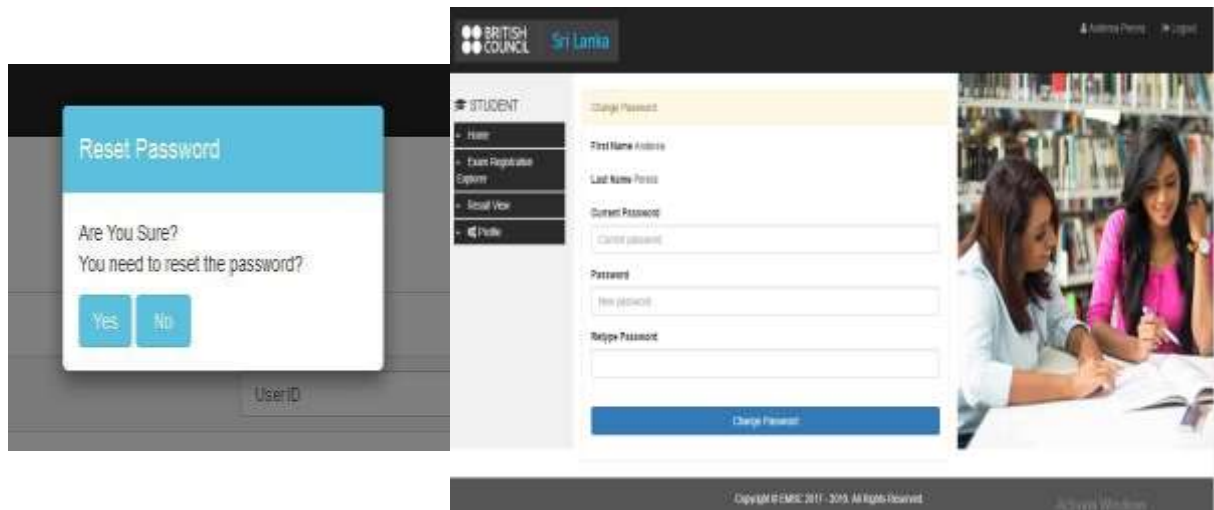


Figure C.3 Password Reset page

Administration module creates username and passwords to users then after login to system they can reset their password for only special privilege user roles such as exam manager and candidates.

Logout from the System

To logout from the system, the link can be found on the top right hand corner of the figure C.4. After clicking this link user can successfully logout from the system and it will direct user back to the Login Page.



Figure C.4 Logout Area of EMBC.

Data Manipulation in Tables and Operations

This is a common operation which comes with more pages. Please see the figure C.5 to get an idea about it and the arrow heads under the figure.

This belongs to link. (Note-: This facility is met in many pages of the system and this introduction will help to get an idea.) The figure C5 shows exam data details.

The screenshot shows the 'Exam Manager' interface for the British Council Sri Lanka. The main section is titled 'Exam Registration Details' and displays a form for a specific exam registration. The form includes fields for personal details (First Name, Last Name, NIC / Passport, Country, Date Of Birth, Phone Number, Address, Gender, Email) and exam information (EXAM, Venue, Exam Session, Status). The exam session is '2018 OL April IAL' with a status of 'OFFLINE'. The total fee is '5000'. The registration time is 'Tue Apr 24 2018 18:15:29 GMT+0530 (Sri Lanka Standard Time)'. There are 'Accept' and 'Reject' buttons at the bottom right.

Field	Value
RefNo	1524573889636
First Name	Charu
Last Name	Halpage
NIC / Passport	N123456789
Country	sri Lanka
Date Of Birth	2000-01-15
Phone Number	4774607720
Address	371/A, Negombo Road, Wellgampaya
Gender	male
Email	sudamB@gmail
EXAM	School Exam Edexcel
Venue	Colombo-DVS
Exam Session	2018 OL April IAL
Status	OFFLINE
Total	5000
Reg Time	Tue Apr 24 2018 18:15:29 GMT+0530 (Sri Lanka Standard Time)

Figure C.5 Table View of data.

Working with Searching Area

The screenshot shows the 'STUDENT' interface for the British Council Sri Lanka. The main section is titled 'Exam Registration Explorer' and displays a table of exam registrations. The table has columns for RefNo, Exam[Type], Venue, Status, and Reg DateTime. The first entry is for a 'School Exam [Edexcel]' at 'Wellala-Lyceum International' with a status of 'OFFLINE' and a registration date of '2018 OL May - June IOCSE'. There is a search bar at the top right and a 'Show 10 entries' dropdown at the top left. The bottom of the page shows 'Showing 1 to 1 of 1 entries' and navigation buttons for 'Previous', '1', and 'Next'.

RefNo	Exam[Type]	Venue	Status	Reg DateTime
1524589509908	School Exam [Edexcel]	Wellala-Lyceum International	OFFLINE	2018 OL May - June IOCSE Tue Apr 24 2018 22:35:00 GMT+0530 (Sri Lanka Standard Time)

Figure C.6 Searching Area in EMBC.

Working with Action Buttons

Action buttons provides specific functions you can do on the particular record, such as view details and edit records. Most of the buttons are common for the whole application, while some specific buttons available for specific function related to that particular area.

Following figure C.7 represents the activity buttons used for common activities.

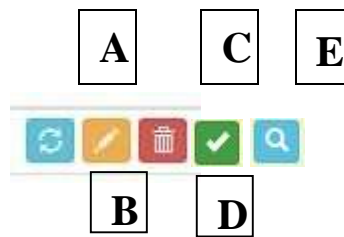


Figure C.7 Action Buttons

- **A – Reset Button.** Click this button to change details of the relevant record.
- **B – Edit Button.** Click this button to display data in edit mode to make changes.
- **C – Cancel Button.** Click this button to cancel/remove particular record.
- **D – Process Button.** This represents particular process depends on the section.
- **E – View Button.** Click this button to view full details of the relevant record.

Working with Forms



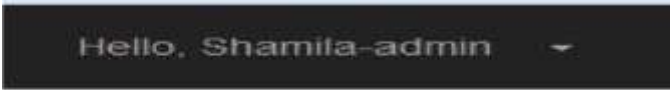



Forms are used throughout the application to add new user and to edit existing data. The following figure C.8 shows some form elements.

A screenshot of a web form for adding a user. The form includes fields for NIC No., User Name, Designation, and User Role. Red dashed boxes highlight error messages for the first three fields, indicating they are required. The User Role field is a dropdown menu with 'Operator' selected. Buttons for 'Add User' and 'Clear Details' are at the bottom.

Figure C.8 Form Notifications

Appendix D | Test Results

Administration Module

Test No.	Actual Result [screen shots]	Status
1		ok
2		ok
4		ok
5		ok
7		ok
10		ok


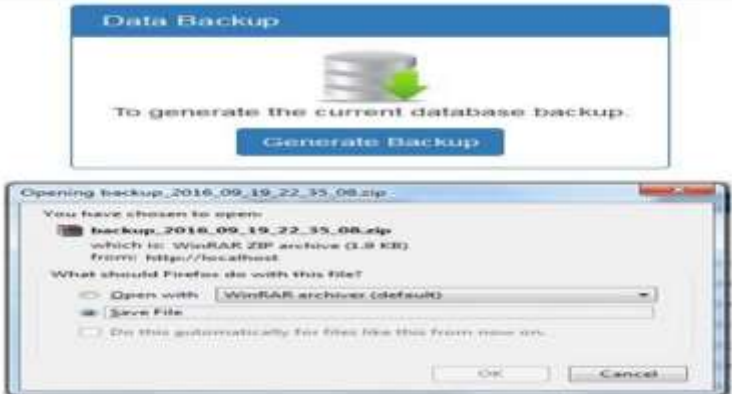
12		Ok
14		ok

Table D.1 Test results for the Administration Module

Assessment of User Feedbacks

As mentioned in evaluation chapter, structured questionnaire was used to capture the user feedback which is given in following Table D.2.

Role Manager	Poor	Average	Good	Excellent
<i>Interface</i>				
Simplicity			x	
Understandability				x
Consistency				x
Easy to work with				x
Messages			x	
Help to avoid mistakes			x	
<i>Process</i>				
Close to the existing process				x
Improving the accuracy				x

Improving the efficiency				x
<i>Reports</i>				
Completeness				x
Relevance				x
Simplicity				x

Table D.2 Sample Questionnaire

USER EVALUATION

In order to check the ideas of the end users regarding the system, a user evaluation feedback Form was prepared and distributed among all the employees and they filled the form and gave their personal views by going through the system. The following Figure C1 shows the user acceptance result sheet

The figure consists of two photographs of a User Acceptance Test Result Sheet. The left photograph shows the top section of the form, which includes a header in Arabic and a table for recording test results. The right photograph shows the bottom section of the form, which includes a table for recording test results and a signature line.

Figure D.1 User Acceptance Test Result Sheet

Appendix E | Management Reports

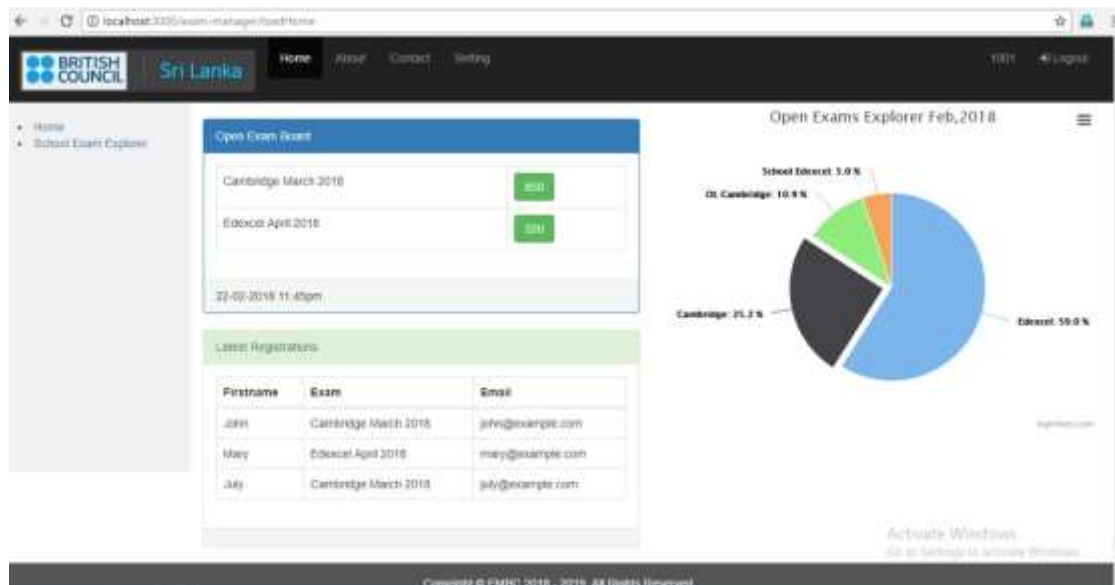


Figure E.1 School Exam Explorer

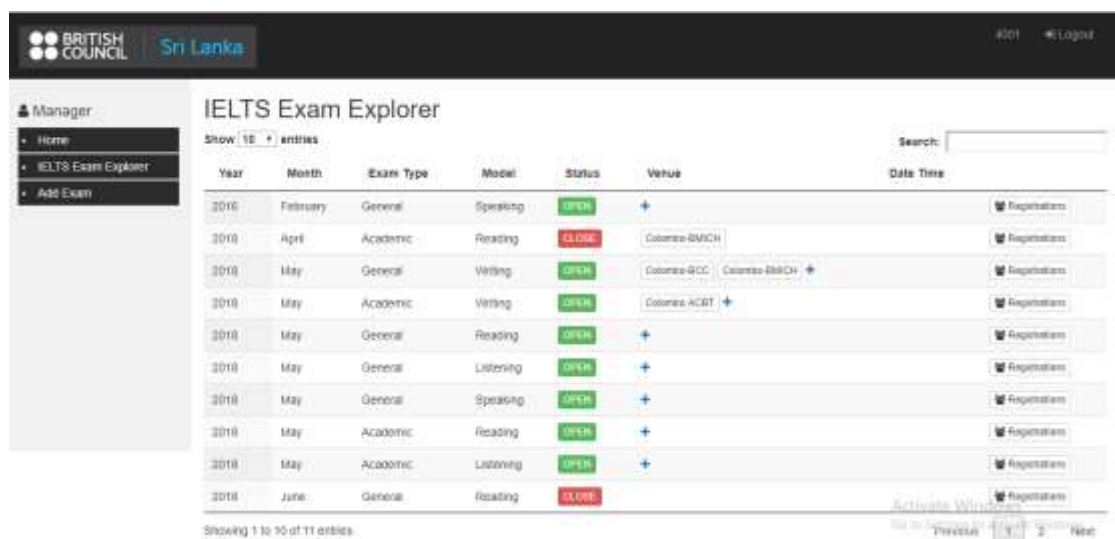


Figure E.2 IELTS Exam Explorer

EMBC

Exam Management System - British Council

Student Registration Report [Edexcel]

First Name	Last Name	Gender	Date Of Birth	NIC/PPT
Ravinath	Fernando	male	1986-12-12	856254125V
Charu	Halpage	male	2002-01-15	N123456789
Andrea	Perera	female	2002-02-19	N987456123

Wed Jul 11 2018 00:21:53 GMT+0530 (Sri Lanka Standard Time)

Address : 49 Alfred House Gardens, Colombo 03

TP: +94 (0)11 7521 521

[Print](#)

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Figure E.3 Edexcel Exam Student Registration

3/22/2018

EMBC

Exam Management System - British Council

Edexcel - OL June IAL - 2017

Venue Registration

Date Time 22-03-2018 8 am

Venue Registration - AL May IGCSE 2017

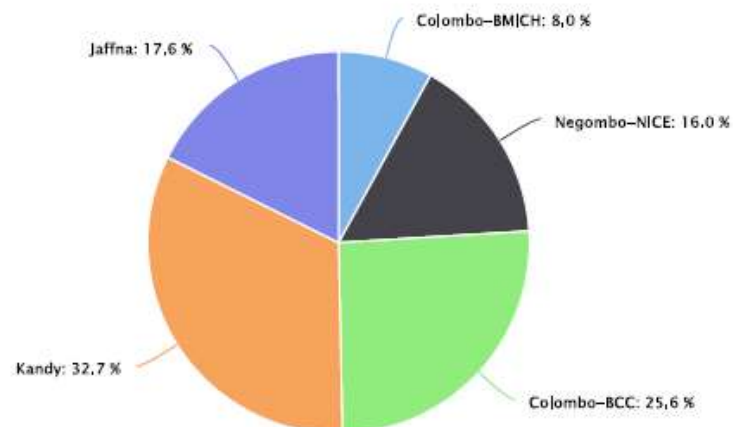


Figure E.4 Edexcel Exam May/June session 2017

Glossary

MEAN – is a software package of Open Source Bundled. Include Mongo DB, Express, Angular and Node.js.

Mongo DB – MongoDB is a free and open-source cross-platform document oriented database program. Classified as a NoSQL database program, MongoDB uses JSON-like documents with schemas.

Angular – AngularJS is a JavaScript-based open-source front-end web application framework. for dynamic web apps. It lets you use HTML as your template language and lets you extend HTML's syntax to express your application's components clearly and succinctly. AngularJS's data binding and dependency injection eliminate much of the code you would otherwise have to write.

Node JS - Node.js is an open source server environment runs on various platforms (Windows, Linux, Unix, Mac OS X, etc.) **Node.js** uses an event-driven, non-blocking I/O model that makes it lightweight and efficient. **Node.js'** package ecosystem, npm, is the largest of open source libraries in the world.

Full Stack - develop with both the front and back end of a website. It familiar with HTML, CSS, JavaScript, and one or more back end languages **and** can handle all the work of databases, servers and clients. Depending on the project, customers need may be a mobile stack, a Web stack, or a native application stack.

MVC – The MVC architectural pattern with slight variation. MVC stands for Model, View and Controller. MVC separates application into three components.

RUP – Stands for Rational Unified Process. Iterative software development methodology. Develop by Rational Software Co-operation.

MD5 - (Message Digest Algorithm) Use when converting data into unreadable format.

Encryption Algorithm - is a mathematical method used to transform Information (plain text) into an unreadable form (cipher text).

HTTPS (Hypertext Transfer Protocol Secure) - is a combination of the Hypertext Transfer Protocol (HTTP) with SSL/TLS protocol to provide encrypted communication and secure identification of a network web server.

Object Oriented Development - is a standard approach to software development based on objects and its instances as UML.

Design pattern - is a way of reusing abstract knowledge about a problem and its solution. It is simply a description of the problem and the essence of its solution.