

Web based Examination Management System for TVEC

**P. M. C. P. Gunathilake
2021**



Web based Examination Management System for TVEC

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

**P. M. C. P. Gunathilake
University of Colombo School of Computing
2021**



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.

Student Name: **P.M.C.P. Gunathilake**

Registration Number: **2018/MIT/025**

Index Number: **18550255**



Signature:

Date: **25th November 2021**

This is to certify that this thesis is based on the work of

Mr. P.M.C.P. Gunathilake

under my supervision. The thesis has been prepared according to the format stipulated and is of acceptable standard.

Certified by:

Supervisor Name: **Prof. G.D.S.P. Wimalaratne**



Signature:

Date: **26th November 2021**

Abstract

One of the core activities of the tertiary and vocational education commission's quality assurance and assessment division is to conduct NVQ level 5 examinations for the technical, vocational education and training sector. Every year, there will be two examinations held for different industry sectors. In past years, NVQ level 5 examination related activities such as call application, student registration, issue admissions, arrangement of papers, invigilator allocations, etc., had been conducted by using a manual process. It takes lots of time and requires more human resources to complete those activities. Another disadvantage of this manual process is the maintenance of different types of documents in hardcopies and it becomes a challenging task to search information when required.

An ICT enabled system would be great solution to overcome the above-stated problems with just few clicks of work. This newly developed system used web technologies such as PHP framework-Code Igniter with MYSQL database and apache webserver. This newly implemented system handled all the information with the central database, and only the authorized users able to access these information and services through the internet.

To test the new system, it used manual test cases and automated test cases. The quantitative analysis method used to evaluate the usability of the system based on user feedback. It mainly focused on the appearance, usability, functionality, performance, and security of the system. Based on the usability evaluation result, each category scored more than 85% of both agrees and strongly agreed categories. This web-based solution was enabled more user-friendly environment to handle examination related activities. In addition to that, this system facilitates the registered students to view their basic information by using their national identity card number. The newly developed system includes all the features to facilitate for the students, training centers and staff of the TVEC.

Acknowledgements

In performing my final project, it makes successful one with the massive help and guideline of some respected persons. First of all, I am grateful to Prof. G.D.S.P. Wimalaratne for his outstanding supervision and assistance in all the stages of the project completing with success. His experienced guidance and enhanced skills were very much helpful for me to make this implementation successful. Further, I express my gratitude to the University of Colombo School of Computing for offering this master degree program and I should be thankful to all the MIT lecturers of UCSC and Visiting lecturers who spent their valuable time to make us more knowledgeable and skillful on the field of information technology.

Lastly, I would like to deliver my wholehearted thanks to my family members and friends who give me their cordial cooperation. I couldn't complete a severe task and complete the project without such help.

Table of Contents

Declaration	iii
Abstract	iv
Acknowledgements	v
List of figures	viii
List of tables	x
List of Acronyms.....	xi
Chapter 1: Introduction	1
1.1 Motivation	1
1.2 Aims and objectives	1
1.3 Scope	2
1.4 Structure of the thesis.....	3
Chapter 2: Background	4
2.1 Introduction	4
2.2 Manual processes of the examination	4
2.3 Requirement analysis	6
2.4 Review of similar systems.....	8
2.5 Comparison of the proposed system with similar systems.....	13
2.6 Related technologies	14
2.7 Related design strategies	16
2.8 Feasibility study	17
2.9 Summary	18
Chapter 3: Design.....	19
3.1 Introduction	19
3.2 Process model.....	19
3.3 System architecture	20
3.4 Design patterns.....	21
3.5 Design methodology	22
3.6 User interface design.....	31
3.7 System access overview	37
3.8 System security	37
3.9 Summary	38
Chapter 4: Implementation.....	39
4.1 Introduction	39

4.2	Methodology	39
4.3	Environment	39
4.4	Database implementation	41
4.5	Code implementation	44
4.6	Security implementation	44
4.7	User interface implementation	45
Chapter 5: Testing and Evaluation		48
5.1	Introduction	48
5.2	Identified test methodology	48
5.3	Test plan	49
5.4	Automated testing	56
5.5	User evaluation	57
5.6	Evaluation results	58
5.7	Summary	62
Chapter 6: Conclusion		63
6.1	Introduction	63
6.2	Achievement of the objectives	63
6.3	Lessons learnt	64
6.4	Challenges faced	64
6.5	Future enhancements	65
References		66
Appendix A – Usability evaluation questionnaire		69
Appendix B – Response for questionnaire		73
Appendix C - System manual		80
Appendix D - User manual		83
Appendix E - Management information reports		88
Appendix F – Automated testing		90

List of figures

Figure 2. 1 Current examination process	5
Figure 3. 1 Diagram of the incremental model	20
Figure 3. 2 Architectural diagram	20
Figure 3. 3 Model-View-Controller (MVC)	22
Figure 3. 4 High-level use case diagram for web-based examination management system	23
Figure 3. 5 Class diagram for the proposed system	27
Figure 3. 6 Sequence diagram for user login	28
Figure 3. 7 Sequence diagram for user registration	28
Figure 3. 8 Activity diagram for user registration	29
Figure 3. 9 ER Diagram for the proposed system	30
Figure 3. 10 Landing page of the system	31
Figure 3. 11 User login interface	31
Figure 3. 12 Summary information page	32
Figure 3. 13 Institute registration interface	32
Figure 3. 14 Student registration interface	33
Figure 3. 15 Student information page	33
Figure 3. 16 MIS report module	34
Figure 3. 17 Number of students in module wise	34
Figure 3. 18 Number of students pass rate in module wise	35
Figure 3. 19 Number of students in course wise	35
Figure 3. 20 Admission card	36
Figure 3. 21 Students' attendant sheet based on center and course	36
Figure 3. 22 System access overview	37
Figure 3. 23 Enable XSS filtering	38
Figure 4. 1 SQL quarry for creating a database	41
Figure 4. 2 SQL quarry for creating table "Create_Exam"	42
Figure 4. 3 SQL quarry for creating table "Examination_center"	42
Figure 4. 4 SQL quarry for creating table "staff"	43
Figure 4. 5 Coding of the user login interface	44
Figure 4. 6 SHA1 encryption	44
Figure 4. 7 Manage examination	45
Figure 4. 8 Assign students to exam	45
Figure 4. 9 Dashboard	46
Figure 4. 10 Display lists of students	46
Figure 4. 11 Assign students to examination	46
Figure 4. 12 Manage user roles	47
Figure 5. 1 Login function test result	56
Figure 5. 2 Automated test result of the training center registration UI	57
Figure 5. 3 User evaluation result under the appearance	58

Figure 5. 4 User evaluation result under usability	59
Figure 5. 5 User evaluation result under functionality	60
Figure 5. 6 User evaluation result under performance	60
Figure 5. 7 User evaluation result under security	61
Figure 5. 8 Summary of usability evaluation	62

List of tables

Table 2. 1 Pre and Post examination activities	11
Table 2. 2 Comparison of similar systems with a proposed solution	13
Table 4. 1 Minimum hardware requirement for development.....	40
Table 4. 2 Minimum hardware requirements for server	40
Table 4. 3 Minimum hardware requirements for user	40
Table 5. 1 User login test plan	50
Table 5. 2 Training center registration	50
Table 5. 3 Student registrations	51
Table 5. 4 Test case for user login	52
Table 5. 5 Training center registration number validation	53
Table 5. 6 Validate student NIC number	54
Table 5. 7 Validate the uniqueness of the NIC number.....	55
Table 5. 8 Likert scale	57
Table 5. 9 User evaluation result under appearance	58
Table 5. 10 User evaluation result under usability	59
Table 5. 11 User evaluation result under functionality.....	59
Table 5. 12 User evaluation result under performance	60
Table 5. 13 User evaluation result under security	61
Table 5. 14 Overall usability responses	61

List of Acronyms

EMS	Education Management System
ICT	Information and Communication Technology
IT	Information Technology
NVQ	National Vocational Qualification
SMS	Short Message Service
TVEC	Tertiary and Vocational Education Commission
UCSC	University of Colombo School of Computing
UI	User Interface

Chapter 1: Introduction

1.1 Motivation

TVEC conducts two common examinations per year (TVEC 2009) for the NVQ level 5 & 6 students. Those students will participate in different occupational areas such as Quantity Surveying, Construction Technology, ICT, Cosmetology and etc. There are total numbers of 12,000 students who will be participating in this common examination. In every year, the total number of students and occupations will be increased gradually. This examination management process is getting harder and harder without implementing proper IT solutions.

Therefore it is more convenient to use information system's based solutions to organizations, collect data and process them according to the needs of the management. This proposed web-based examination management system converted the existing manual processes like registering students for examination, issuing admission, keeping past recodes and providing required reports, and all other examination-related activities to an automated system.

After successful implementation of the system, it will reduce the time taken for the NVQ level 5 examination management processes by converting the entire manual tasks to an IT system and it is support to increase the staff's productivity. In addition to that, it will increase the accuracy of the reports. Finally, students may receive their certificates without any delay.

1.2 Aims and objectives

This project aims to develop a web based examination management system for the TVEC to improve the activities related to the current examination conducting process.

The main objective of this system is to provide a "Web Based Examination Management System" to automate the activities carried around the examination management process by the assessment quality assurance division of the TVEC, in a more secured, accurate and efficient way. In addition to that, this new system will provide an accurate, reliable, efficient and user-friendly system for users.

Further following objectives will help to

- Convert the manual examination management process into the IT system and it is support to increase the productivity of the staff.
- Register students for the examination through an online system without any errors.
- Enhance the quality of the examination management process.
- Reduce the time taken to conduct examinations.
- Save the cost by reducing the document work.
- Remove the repeating data.
- Increased the accuracy of the reports.
- Decrease the workload of the users.
- Minimize the audit queries.
- Build up better communication (information exchanged) between training providers, students, and TVEC.

1.3 Scope

The primary purpose of the proposed project is to reduce the manual process of examination management, improve the quality of the examination process and the staff's productivity. This system will provide user credentials with user authentication levels such as training providers and examination management staff. Then training providers may have the facility to register their students with this online system and apply for the NVQ level 5 examinations. It leads to TVEC examination management staff to perform many different tasks.

This system facilitates the management of examination related activities such as maintain courses and modules, manage examination centers, issue admission to the students, result management, record examination related expenses, get student attendants, result list and record disciplinary actions. After completing the tasks, the user should log out of the activity, and the system allows them to log out. It will improve the security of the system to ban unauthorized access to the system.

1.4 Structure of the thesis

All the chapters of this thesis are aligned with the proposed project which is carried out during the various stages of the project. Each chapter will contain the required details to understand the project development and implementation process.

Background chapter, describe the details about existing similar systems globally. Further, it gives details of new technologies which are useful for this proposed project.

Design chapter describes the development methodologies used to complete the objectives. The object-oriented approach adopted during the project is explained including diagrams used for designing and outlines of the main user interfaces with screenshots.

Implementation chapter describes the implementation steps and used tools according to the analysis and design. This will describe what kind of languages are used, the database and how the database integration is established. Further, it will be discussed the hardware and software requirement.

Testing and evaluation chapter explains the testing and evaluation process of the system. Further, it was discussed different test methods and evaluates the functions of the system by using some test cases. This testing and evaluation are some of the important factors of the sustainability of the system. User evaluation is also included in this chapter.

Conclusion chapter, the general conclusion of the project which includes outcomes of the project, a general assessment of the work done and possible further improvements are discussed in this chapter which is the final chapter.

Chapter 2: Background

2.1 Introduction

To identify the difficulties of the manual process of examination management, there are many information technology software systems developed to enhance the quality of the activities in the examination process. This chapter explained existing similar systems with their features. In addition that describes the latest technologies used in the world and alternative technology options that can be used for the project.

2.2 Manual processes of the examination

Every year, TVEC is conducting two examinations for NVQ levels 5. TVEC decided the dates for the examinations and informed training providers. Then training providers should send their students' information by using Excel files or hard copies to the assessment division before the closing date.

The next step is manually check the students' lists sent by the training providers, and if there are any errors, then coordinate with the relevant training centre and re-correct it. After that, identify the examination centres, assign students to those centres, and issue admission to the training centre through email. While processing the applications, identify the paper setters with paper moderators and assign them to paper setting and moderating tasks. Furthermore, assign examination supervisors and invigilators for the examination centres. After processing the applications, manually prepare the reports to assigned examination supervisors and invigilators for the examination centres. Further, those reports were used to prepare the budget estimates to conduct the examination.

After conducting the examination, all the attendant sheets were checked with the admission manually before released the final results. After releasing the result, students may have the opportunity to apply re-correction of the results. At the end of the examinations, it is essential to generate different reports required for top-level management. The following figure 2.1 shows the existing manual process of examination management.

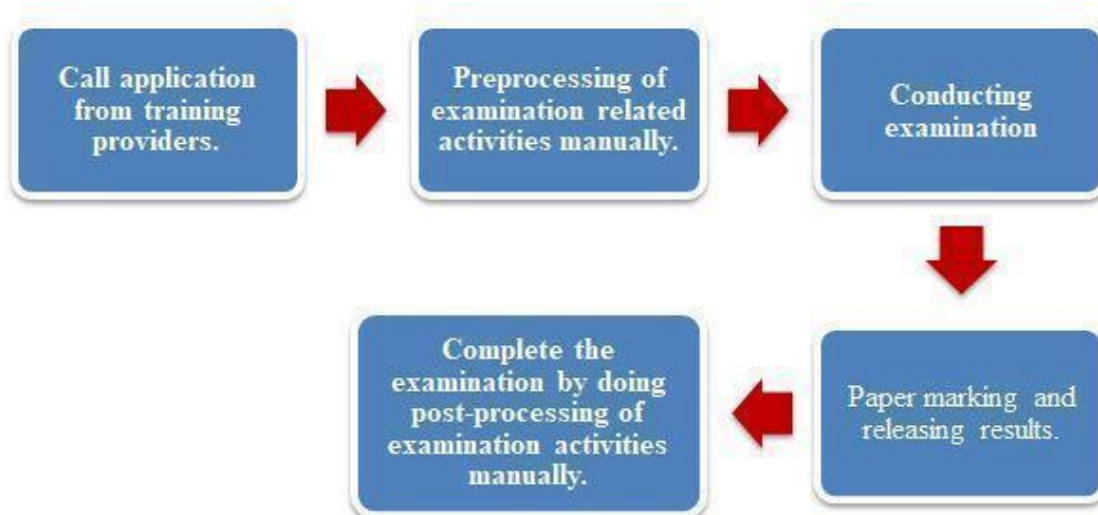


Figure 2. 1 Current examination process

2.2.1 Drawbacks of the existing manual system

Regarding the existing process, all the examination related activities are conducting by using the traditional paper-based method. This manual process required a large number of human resources, and also it may consume more time to complete the tasks. Using this kind of hard copy takes more time to search for the information, and sometimes information may not be available when required. In addition to that, updating the data and storing those hard copies are also challenging tasks for the staff when using this manual system. Another major disadvantage is the low accuracy of the information when generating different types of reports. Every year, the number of students who applied for the examination will increase then it is becoming a difficult challenge to conduct examinations using this kind of manual system. Finally, it will affect to issue result for the students.

2.2.2 Comparison of web-based EMS with the existing system

Accuracy of the Data

When collecting student information manually it may contain lots of errors, but through the proposed web-based system it can be minimized by applying validation for the online forms. Then will be increased the accuracy of the data.

Time-consuming and human capital

In the manual examination management process, it takes more time consuming and need more human capital to manage those activities. Through this new system, all the data is stored in one database and it will help users to manage their processes through user-friendly interfaces. Then it takes less time and human capital to manage all activates. Another advantage is system users can

handle activates online at any time anywhere. Further, this central database will help to generate more accurate reports in a short time without involving more people. Therefore TVEC can be release final results without any delays.

Security and storing data

In this current process, all the data is stored in hard files without adequate security. These files may be misplaced and difficult to search and update data. Another disadvantage is the difficulty to find a place to store those files securely. As the solution for these security issues, proposed system will handle all the data in one database with more security. Users are allowed to access those data based on their authorization levels. To prevent data losses, it is easy to maintain database backups.

2.3 Requirement analysis

In the software development life cycle, identifying the clear requirements for the system is the real challenge task. This requirement gathering and analysis is an iterative process with continuous feedback from each activity to other activities which involves domain understanding.

For this project, requirements were gathered by holding several meetings with the client (deputy director, assistant director and program Coordinator in the assessment and quality assurance division) and observed the manual process of the examination which is carried by the assessment quality assurance division. Further director (information systems) was interviewed to identify the current information technology infrastructure of the organization. Those discussions were very helpful to get a clear idea of the requirements. After those productive meetings, the existing manual process was identified to convert an automated system.

2.3.1 Functional requirements

It describes the functions this web-based solution must perform. In addition to that, the functional requirements have highlighted the expectation of the user. The following specification describes all functionalities of the web-based system.

User Login

1. The system shall verify the valid user ID and Password.
2. The system shall not allow entering the system with an invalid user ID and Password.
3. The system shall have the facility to change user passwords.
4. The system shall allow entering the system and display information based on the authentication level.

Administrator

1. The system shall allow registering users and issue user ID and password.
2. The system shall allow managing user authentication levels.
3. The system shall allow active or inactive registered users.
4. The system shall allow resetting the user's password.

Training provider

1. The system shall allow reregistering their students in the system for examination.
2. The system shall allow downloading examination admissions.
3. The system shall allow downloading of results.
4. The system shall allow to update examination payment.
5. The system shall allow sending re-correction requests.

Examination management staff

1. The system shall allow updating examination dates.
2. The system shall allow to update examination payment information, issue admission to students, manage course information, add, update and delete paper setters, paper moderators, invigilators, and paper markers, add, update and delete examination centres.
3. The system shall allow assign students to the examination centres and assign invigilators to the examination centres.
4. The system shall allow to add, update and delete examination result, course and unit wise, examination budgeting and payment handling and record disciplinary actions.
5. The system shall allow generating different reports and display results in the dashboard.

Students

1. The system shall allow entering the student to enter their valid national identity card number.
2. The system shall allow viewing their basic information through the online system.

2.3.2 Nonfunctional requirements

Nonfunctional requirements will be based on reliability, security, accuracy, consistency and user-friendliness, efficiency and maintainability. In the system development life cycle, those nonfunctional requirements should be considered.

Performance requirements

- 1 The system should be reliable to use and should provide meaningful full messages when an error occurs.
- 2 GUI should be user friendly and should maintain consistent user interfaces.
- 3 Data processing time should be less.
- 4 Font type, size and colour of the web pages should be user friendly.
- 5 Web site navigation should be easy and clear.
- 6 The system should have used a secondary navigation system that shows a user's location on a web page (breadcrumb trail).
- 7 The system should be easily maintained by a trained person.
- 8 User passwords should be stored in database in encrypted format.
- 9 The system should run on minimum hardware requirements.
- 10 Data should be accurate.

2.4 Review of similar systems

A similar system survey is done to identify features of the systems. The main purpose of this survey is to gather knowledge of previously carried out systems to study their methodologies and features.

Some of the similar systems are listed below.

2.4.1 Deskera examination management system

This examination management system was managed by the planning and execution of the examination. This system consisted of 8 main features as manage different examination types, configure examination rules, manage examination venues, book resources with logistics management, manage faculty availability and invigilator assignment, plagiarism detection with misconduct management, manage examination timetable, manage defaulter records, disciplinary action which are required of the examination management (Deskera 2008).

2.4.2 Creatrix examination management system

According to Creatrixcampus.com 2021, it is the fully automated examination management system for schools, colleges and universities. Further, was managed each process at every stage with complete confidentiality and significant cost reduction. This system contains the main four key features.

Plan & Register

All the examination preprocessing activities such as student registration, generate time table, assign invigilators, allocated exam hall, generate attendant sheets and issue indexes for seating plans with shuffling features done under this feature.

Question Paper Setup

Setup question papers and get approvals processed within the system and under complete encryption. Further, this system supports setting up question banks, questions mapped with Bloom's taxonomy and generating the different difficulty levels of question papers.

Conducting Exams

The entire workflow was controlled by the system during the examination. It was managed activities such as room allocation, rescheduling, incident/misconduct management and so on. In addition to that this feature supports creating multiple types of question papers such as multiple-choice questions filled in the blank, true or false, column matching and more. This will increase the secrecy and credibility of the examination process.

Evaluate & Publish

This feature is supported to process the examination result and published it. Further, it managed all information related to student and invigilator attendance by session/hourly/day wise attendance. In addition to that, it generates transcripts, reports and displays information on the dashboard.

2.4.3 Fedena - college and school management software

Fedena is an ERP solution for school management. It supports all the activities related to school management. The examination management system is one of the core modules out of the 20 core modules. There are four main features such as exam management, generate detailed reports, grade book management, the online examination which are available under the examination management module (Fedena.com. 2021).

2.4.4 Apply online form - online application & exam management system

Based on Applyonlineform.com 2021, this system was offered an end to end solution for online examination management. It manages online admission and collects fees with a built-in payment gateway electronically. Also, this system can be customized based on the organizational requirement. This solution was hosted in cloud servers and used encrypted terminologies to make

the completed process error-free. There are four main categories available under an examination management system.

Online registration process

It provides exam registration and online application form submission facility and based on the examination rules and regulations the application form layout can be customized.

Fee payment procedure

Accept online payment through the payment gateway. All the application fee transaction was secured by using a secure socket layer protocol.

Online exam management

For online examination, it provides a secure exam browser that enables freezing the candidate's browser while taking the exam and disable internet browsing.

Exam result processing

All the results were processed and published by using secured cloud servers. The system facilitates different grading logics for different sections & questions type.

2.4.5 VirtualX Pro

Myvirtualx.com 2021 states that VirtualX Pro is a fully automated examination management system that can significantly help any organization improve efficiency when conducting online examinations. Another advantage is VirtualX pro offers a hosted service, able to customize according to the organizational requirements and able to connect learning management systems through API.

VirtualX Pro support role-based access and security for users, generate reports and results, schedule exams for individuals or groups, notify the examinee, support question bank, IP based access-controlled during the examination, multiple language support to manage examination.

VirtualX Pro is a powerful fully web-based online examination management system that caterers to all online examination management requirements.

2.4.6 Swift HCM suite exam management system

This system offered a cloud-based exam platform for online examinations. This platform provides to create, manage, evaluate and analyse the examination. Further, this system is integrated with a reporting tool that enables the evaluation and analysis of the learner's progress. This system

contained key features like a user-friendly interface, intuitive dashboard, authoring questions, designing exams, exam library, and powerful analytics (Swifthcm.com 2021).

2.4.7 Databee exams manager

Exams Manager is designed to manage all activities related to the examination office at the universities or higher education institutes. This system comes with a lot of rich features which are supported to do the examination management process easily and accurately. It also helps to reduce the cost and time for the examination preparation. (Databee.com.au 2021)

Databee Exams Manager provides many facilities such as ease of use, flexibility, mobility, secure exam paper upload, supervisors, alternative exam conditions, correspondence, exam allocation, exam paper printing, distance exams, incidents management, personalized exam timetables, reports, student attendance, etc. to manage examination.

2.4.8 Belmont

This examination management system offers the entire lifecycle of the examination process on a common and secure platform, offering ease of accessibility to administrators and candidates. Further, it will have the facility to manage both online and offline examinations, real-time attendance, course regulation, exam fee verification and result. This system provides build-in reports and customized reports as well. (belmonttech.net 2018)

This system covers following table 1, which shows the pre and post examination activities

Pre exam	Post exam
1. Processing candidate application forms	1. Record of internal/sessional grades
2. Entry of subject and paper details	2. Record of information such as absenteeism, unfair means used during the exam & withheld cases
3. Admit Card, Time Table, Centre List generation	3. Result processing and evaluation
4. Centre allocation	4. Corrections to name/address and other contact details
5. Seating plan	5. Merit list generation
6. Invigilator allocation as per staff's location preference	6. Result publishing
7. Incorporation of online/offline payment gateways	7. Generation of topper's list, result withheld list, convocation list and notices, degree certificates

Table 2. 1 Pre and Post examination activities

2.4.9 MeritTrac

This system is supported to conduct online examinations. It facilitates student registration, creating an exam and candidate verification. These exam systems come with online invigilation and proctoring features to ensure a fair examination process.

It spans end-to-end examination management services – from application processing and pre-exam services to exam administration, on-screen marking, and result processing. The examination solutions support not only paper-based and computer-based testing (CBT) but also Optical Mark Recognition (OMR).

In addition to that this system was introduced new system to minimize fraud and cheating. To do it, AI can help reduce fraud by taking the images of students in examination halls and verifying them against scanned documents. Plagiarism detectors can help detect copying while webcams help monitor multiple exam locations for malpractice. AI-based algorithms can validate even keystroke signatures by evaluating keyboard pressure and speed. (merittrac.com 2021)

2.4.10 mettl

This online examination management system supported pre-exam activities like create and schedule exams, setup anti-cheating tools, setup evaluation rules. The examination system covers Conduct exams digitally, Proctor using AI technology, Generate student's credibility reports. Post exam activities such as assign answer sheets to evaluators, monitor and manage the evaluation process and declare results online will cover this system.

To enhance the security of the examination system, it is used 3-point student authentication, a secure browser to ensure a safe exam environment and AI-based and human-based proctoring tools.

2.5 Comparison of the proposed system with similar systems

All of the above-mentioned systems are categorized under the examination management stream. Following table is used to compare similar systems in prior works with the proposed system, using several functional criteria. Based on the criteria, the table highlights the gaps of similar systems and the gaps the proposed system will possibly fill.

Filled with the “✓” symbol means the system complied with the criteria and the “X” symbol means the systems not complied.

Criteria \ Systems	Deskera	Creatrix	Fedena	Apply online form	VirtualX Pro	Swift HCM suite	Databee Exams Manager	Belmount	Meritrac	mettl	Proposed System
Manage offline examination	X	X	X	X	X	X	X	✓	X	X	✓
Facility to log in different training providers	X	X	X	X	X	X	X	X	X	X	✓
Student registration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Issuing admissions	X	✓	X	X	X	X	X	✓	✓	✓	✓
Assigning examination centers	✓	✓	✓	X	X	X	✓	✓	✓	X	✓
Mange paper setters, paper moderators and invigilators	X	✓	X	X	X	X	X	✓	✓	X	✓
Examination result publishing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Manage examination budgets	X	X	X	X	X	X	X	X	X	X	✓
Available different types of reports	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Display information in the dashboard	X	✓	✓	X	X	✓	X	X	X	✓	✓
Mange re-correction request	X	X	X	X	X	X	X	X	X	X	✓
Handle disciplinary actions	✓	X	X	X	X	X	X	X	X	X	✓

Table 2. 2 Comparison of similar systems with a proposed solution

2.6 Related technologies

This new solution was proposed as a web-based solution. Then it could be used with the latest web-based technologies to develop the front end and back end of the system.

2.6.1 Cloud server

Without running in-house servers, it gives lots of benefits when using cloud servers. The cost-saving potential is the major reason for cloud services adoption by many organizations. Further cloud computing gives the freedom to use services as per the requirement and pay only for usage (Guru99.com. 2021). In this cloud computing, there are three major cloud computing offerings such as Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) (Guru99.com. 2021). Based on the client requirement it can be selected out of these three services. All the data with high security will be handled by the cloud owner. In this case, the entire infrastructure is handled by cloud owners. Therefore even if it provides many services with the security client company should decide whether it is going to keep secret data on-premises or in the cloud base.

2.6.2 Bootstrap

Bootstrap is a free and open-source front end development framework for the creation of websites and web apps. This framework was built based on HTML, CSS, and JavaScript (JS) to facilitate the development of responsive application. According to the WhatIs.com. 2021, the main advantage of bootstrap is device responsiveness. It will detect the screen size of the device which is used by the client and the web page may rearrange according to the screen size without dropping the quality of the contents. In addition to that, it is an open-source free framework for front-end development.

2.6.3 PHP

PHP is the free scripting language that is used for server-side scripting. Further, it was used to develop a static website, dynamic website and web application. PHP scripts can only be interpreted on a server that has PHP installed and the client computers can access PHP scripts by using a web browser only. It can be used inside of the HTML codes and it was interpreted at runtime (Guru99.com. 2020).

2.6.4 MySQL

MySQL is a freely available open-source Relational Database Management System (RDBMS) that uses Structured Query Language (SQL). It was identified as quick processing, proven reliability, ease and flexibility of use in many open-source PHP applications (Hosting. S. 2021).

2.6.5 Apache webserver

Apache is an open-source and free web server software that powers around 40% of websites around the world. The official name is Apache HTTP Server, and it's maintained and developed by the Apache Software Foundation (Hostinger Tutorials 2021).

The main purpose is to establish a connection between a server and the browser of website visitors (client-server architecture). Further, Apache is considered as cross-platform software which is supported on both Linux and Windows servers.

2.6.6 CodeIgniter

CodeIgniter is a simple but powerful PHP framework. This framework is supported by developers who need a simple and elegant toolkit to create full-featured web applications. It will be based on MVC architecture. In addition to that, CodeIgniter was offered built-in protection against CSRF and XSS attacks (CodeIgniter.com 2021).

2.6.7 HTML and CSS

HTML (the Hypertext Markup Language) and CSS (Cascading Style Sheets) are two of the core technologies for building web pages and web Applications. HTML was used to build the structure of the web page with the contents and CSS was used to attract the web page by adding colours, layouts and fonts. W3.org 2021 states that, another advantage of the CSS is, it can be used same CSS file for different web pages then it will improve the consistency of the website.

2.7 Related design strategies

2.7.1 Comparison of web based EMS with similar systems

1. All the above software systems were designed to conduct online examinations, but NVQ level 5 examinations are not online examinations. Therefore it is not matched with TVEC requirements.
2. All software has a monthly fee and there is an additional cost per student if exceeded the capacity limits. Then TVEC has to spend a huge amount of money on the software license per year.
3. Another challenge is software customizations there will be additional charges for any software customization because it cannot use as it is. Then it needs to customize according to the TVEC requirements.
4. Similar systems were developed to manage the examination in one organization like a school, university, etc., TVEC is conducting examinations for students from different training centres and those training organizations will register their students with this system.
5. All the systems are operating on the service provider's cloud servers then it creates security issues for students' data and other related data.
6. All the NVQ 5 examinations are conducting module wise and the final grade will be calculated based on the module result. Those similar systems design for one time examinations such as entrance examinations, school examinations, competitive examinations, etc.
7. All the systems are not managing invigilators through the online systems except the Deskera Examination management system.
8. There are no similar systems from the above review systems with budget estimate calculation features.

When examine all the above factors, those similar systems were not fulfilled the requirements of the TVEC to conduct NVQ level 5 examinations. Therefore a web-based online system was proposed for the examination management system. This newly developed system facilitates to view basic information of the registered students. Web technologies, PHP & MySQL are used as the development tools based on the Model View Controller (MVC) architecture. In addition to that, one of the PHP frameworks (CodeIgniter) is used for this development. In this MVC framework, the Controller receives all requests for the application and then works with the Model to prepare any

data needed by the View (W3schools.in 2020). The View then uses the data prepared by the Controller to generate a final presentable response. This architecture helps to avoid complexity by dividing an application into three units.

Since this is a web-based system, examination management could be installed in a web server in the Windows or Linux operating system. Cross-platform and free open source software called XAMPP server is a solid and stable high-performance platform for windows (Hanna F 2021). The advantage of the Apache, PHP and MySQL combination in the latest versions which is open source is unified with commercial operating system windows. Then the system is made available to the authentic users in the TVEC and TVEC registered institute through the Internet.

2.8 Feasibility study

The feasibility study is important to identify whether the project of a web based examination management system is economical, technical and operationally feasible. Then it will be satisfied with the organizational current requirement and support the future changes as well. This feasibility study is carried out from the following different categories.

2.8.1 Operational feasibility

When considering users' point of view, this new system is fully GUI based and user-friendly and they can easily understand the functionality of the system. It was identified that most of the users didn't have much technical knowledge. According to the study, it is concerned the organization is comfortable implementing this system and it will help to reduce the workload of the examination activities.

2.8.2 Technical feasibility

This system was developed as a web based system. It used a free open source web server called apache to host the system and for the database it used MYSQL. This system was developed based on a PHP framework such as “CodeIgniter”. These technologies are not consumed much hardware resources. To connect the system from outside the TVEC, required an internet connection but inside users can use a local network.

2.8.3 Economic feasibility

TVEC is a fully government-funded organization therefore it has a limited budget for this kind of development. To manage this development within the limited budget, free and open-source

software is used for this online system development. Further, existing hardware is used to deploy the system. This EMS software is cost-effective.

2.8.4 Schedule feasibility

For this project, the time has been scheduled from start to end, and the project has been carried out step by step likewise requirement collecting, analyzing, designing, development, testing, maintenance and documentation of the system.

2.8.5 Implementation feasibility

To implement this system, TVEC already has in-house and cloud servers with sufficient capacities. Those servers have high bandwidth internet connectivity. Therefore this project can easily be made available online without much consideration of the hardware and software. From the user's point of view, it is required a good internet connectivity with web browser. This database and software are required to be set up at the administration side. When completion of the installation the administrator and other users can access this system from their places through the internet at any time.

2.9 Summary

In this chapter, get some understanding of the existing manual examination management system and considered literature survey to study similar systems which are used for examination management. It is important to study the nature of the examination system, quality aspect of the examination system, various phases of the examination, and limitations of manual examination and currently available examination software before introducing a new system. Through the requirement analysis, it is pointed out the specific outcomes expected from the proposed system that are required to overcome current challenges. Further study new technologies which are supported to develop the new system.

Chapter 3: Design

3.1 Introduction

New ICT enabled system design mainly focused on the architecture of the system, module and components of the system with a flow of data in different interfaces of the design components of the system (Didacus Odhiambo, 2018).

System design takes more time for this project and it is the most important part of this project. This chapter consists of the process model, system architecture, design pattern, design methodology, database design, designing of user interface and security which are used to design the web-based examination management system.

3.2 Process model

There are many different process models like Rapid Application Development (RAD), Agile, Iterative model, Spiral model, Prototyping model and Incremental which can be used to guide the modern software development projects. The incremental model was chosen from a different kind of process model.

Incremental development is a process of partial implementation of the entire system. In each increment, the working product will be released as a part of the total project. From the client-side, this early delivery of the part of the operational product will be increased satisfaction. Another advantage of this method is the client can evaluate the released increment and suggested modifications that can be implemented in future increments. This process model is very much suited to the small project and limited development team members with initially identified clear requirements. (Neha, 2020).

At the initial stage, all the functional requirements of the proposed examination management system were identified and based on that it was separated into modules such as user management, student registration, manage course and module, etc, following figure 3.1, displays the incremental model related to the examination management system development. Therefore proposed system could be developed module wise. Further, this project is not a large scale project and one developer can be used to develop this project. At the client-side, it is easy to review the system module wise and it gives an advantage for further improvement of the system. After considering those facts, the

incremental process model very much complies with this proposed system development therefore incremental process model was selected for this development.

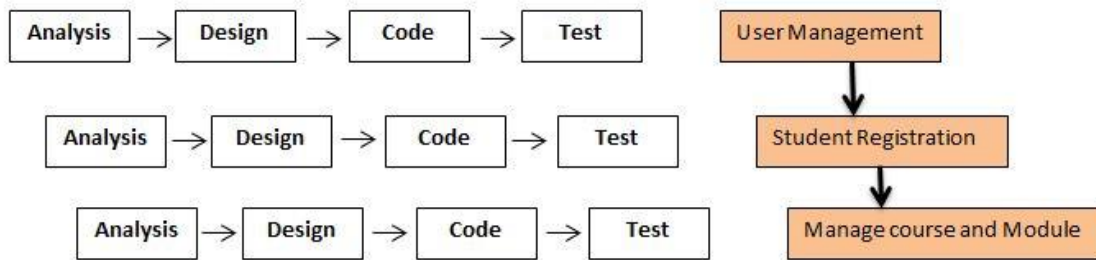


Figure 3. 1 Diagram of the incremental model

3.3 System architecture

This system architecture is a conceptual model that defines the structure, behavior, and more views of the web-based EMS. Architecture gives a high-level explanation of formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system.

Figure 3.2 an architectural diagram, shows the system that is used to abstract the overall outline of the software system and the relationships, constraints, and boundaries between components.

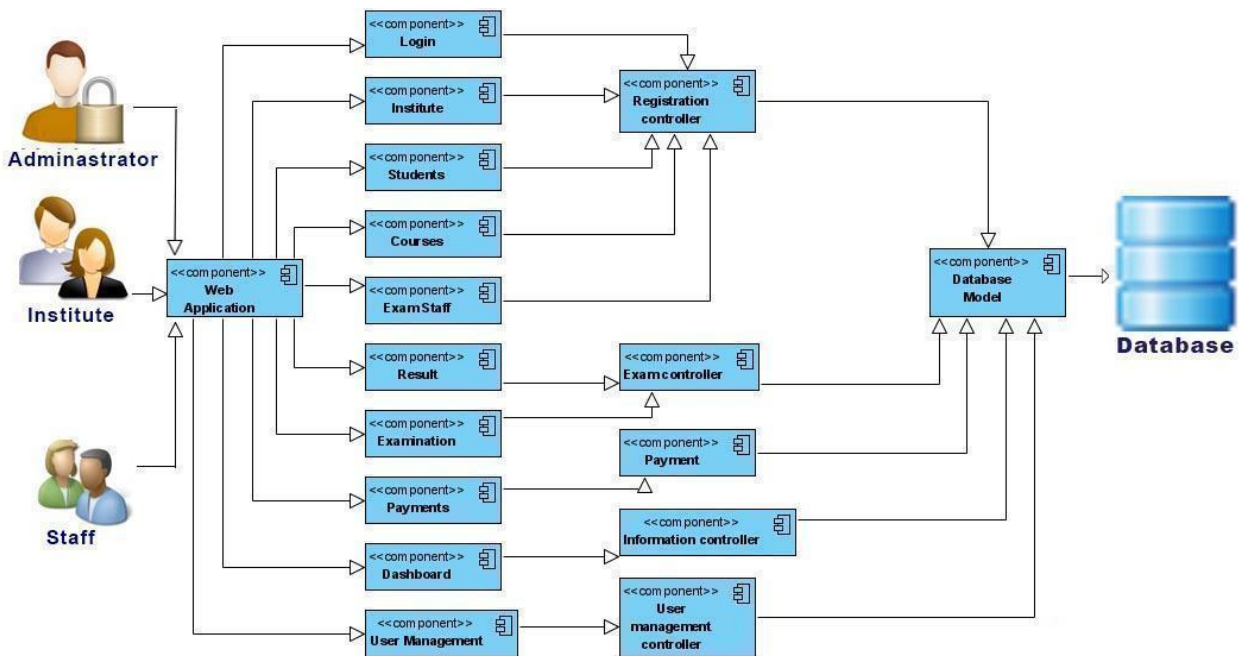


Figure 3. 2 Architectural diagram

3.4 Design patterns

In the design patterns, there are several design patterns like Model-View-Controller (MVC) pattern, micro services pattern, client-server pattern, controller-responder pattern and layered pattern that can be used for the software development project. MVC pattern was preferred from a different kind of pattern for this project and it was suited for web-based development.

Model-View-Controller (MVC) pattern

Anand Butani (2020) state that when the application is used MVC pattern then it divides an application into three main components called model, view and controller.

Model, this part of the MVC pattern was handled application data and functionality. It allows to builds the connection with the database which supports the dynamic data structure of the software application.

View, this is a visual representation of the data- like a chart, diagram, table, and form. This part has handled the functionality that directly interacts with the user graphical user interfaces (GUI) like clicking a button or an enter event.

Controller, basically it connects the model and view. The controller gets the inputs to form a view and retrieves or updates data from the model. After that the controller passes data from the model back to the view for the user to see in a fine display.

All the components developed by using the MVC design pattern are independent of each other. Then it helps developers to reuse the components and code easily for other applications. It is easy to testing, maintain and modify codes. The following figure 3.3, display MVC design pattern.

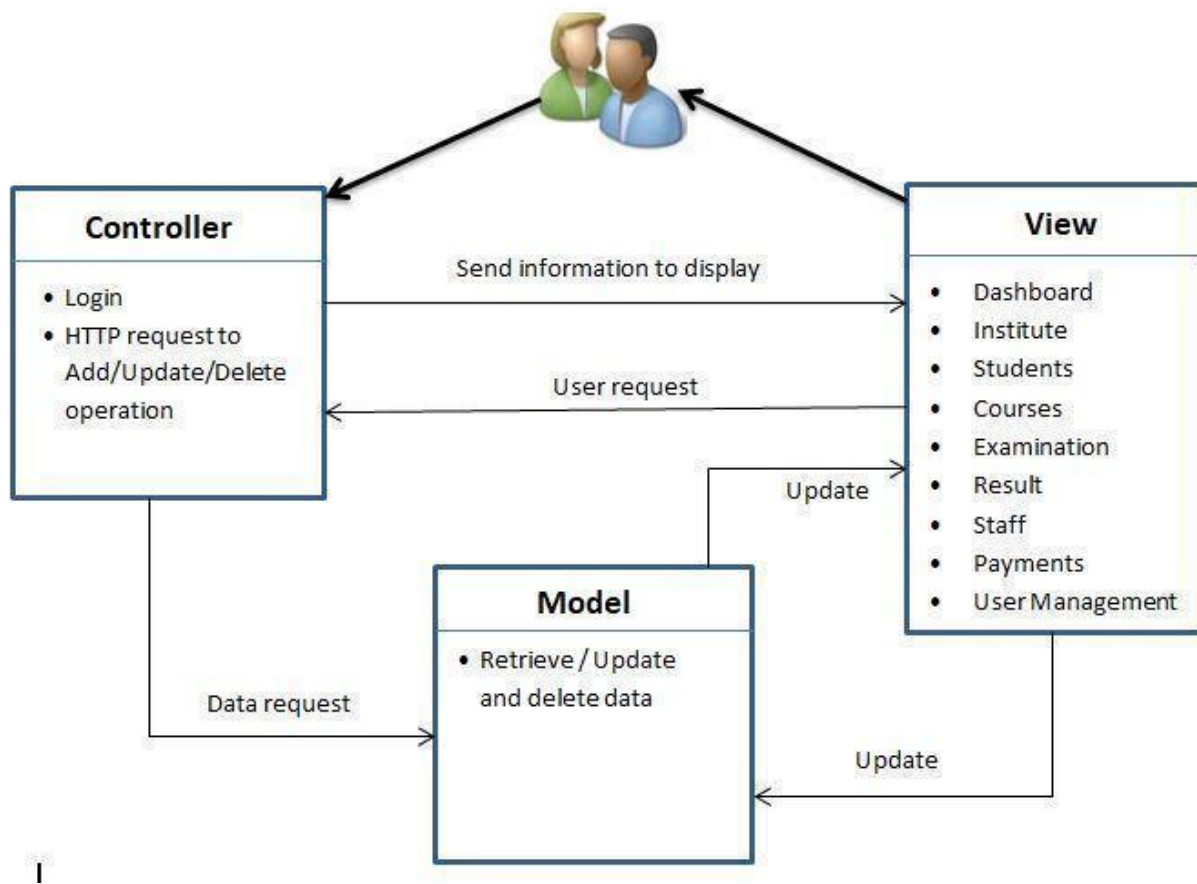


Figure 3. 3 Model-View-Controller (MVC)

3.5 Design methodology

In the System design of Web-based Examination Management System, the following object models were used for the designing process of the system.

- Use Case diagram – it represents the functions of a system from the users’ point of view.
- Use case narratives - it was explained how the use case interaction between an actor to achieve a goal of observable value.
- Class diagram – it represents the static structure in terms of classes and relationships.
- Sequence diagrams – shows how the objects interact over time.
- Activity diagrams – shows object states at a specific timeline.
- Database design - Entity-relationship diagram represents the structure and the relationship of the database
- User Interface design – it gives the graphical view of the system.

3.5.1 Use case diagram

According to tutorialspoint.com, typically use case diagram represent the interactions between an actor and a system to complete the process. Actors may include human users, internal systems or other external systems. Further, the relationships such as include, extend and generalization are depending on the behavior of the process. Figure 3.4 is the use case diagram that represents the high-level use case diagram that defines all activities carried out in the EMS.

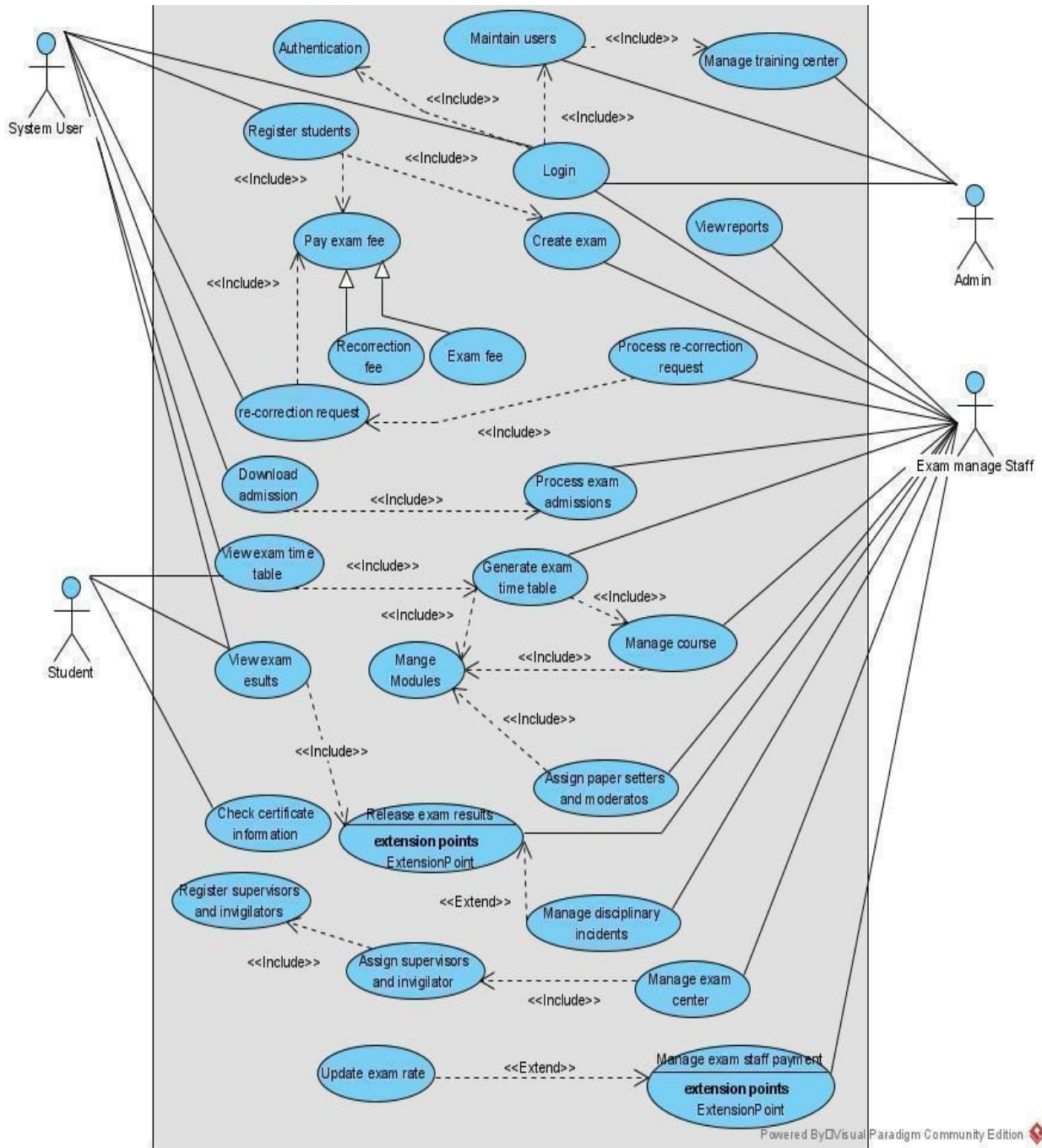


Figure 3. 4 High-level use case diagram for web-based examination management system

3.5.2 Use case narratives

Use Case ID:	01
Use Case Name:	User Management Module
Actors:	Administrator
Description:	<p>This use case describes which actor has privileges to create the other user accounts at which phase</p> <p><u>User Registration:</u> The training centre should send their application through the system and after verifying the data administrator will approve the registration. In addition to that active/inactive the users by admin.</p> <p><u>Login:</u> Unique user name and password will be provided to all users</p> <p><u>Forgot Password:</u> Allow user to recover their forgotten password by entering a registered email ID</p> <p><u>Change Password:</u> user allow to change the password by old password with the new password</p>
Preconditions:	<p>Web browser opened and system URL accessed.</p> <p>The user who has the privileges to create the user account need to be logged into his user account</p>
Postconditions:	Registered users have to use the system, others have no access.
Normal Course:	<p><u>User Registration:</u></p> <ul style="list-style-type: none"> ● The applicant applies with the necessary data. ● System checks all information is in the correct format. ● Notification will be display for the admin login for new registration requirements. ● If the data is satisfied, new applicants can be approved by the admin. ● The system will send the user id and password to the application's email. <p><u>Login:</u></p> <ul style="list-style-type: none"> ● Go to the login page and enters the user name and password. ● For the invalid entry, the user is redirected to the login page with an error message. ● For the valid entry, the user is redirected to his/her portal page where access is restricted according to the user account privileges. <p><u>Forgot Password:</u></p> <ul style="list-style-type: none"> ● The system sends the user name with a new password to their registered email address. <p><u>Change Password:</u></p> <ul style="list-style-type: none"> ● The system allowed to change the password by using an old password with a confirmation message.
Alternative Courses:	<p>If the user already resisted, the system displays the error message and redirect to the login page.</p> <p>To change the registered email address, need to send the request to the Administrator.</p>

Use Case ID:	02
Use Case Name:	Register students
Actors:	System user, Exam manage staff
Description:	This use case describes the event of registering the students to examination using the student registration module using their National Identify Card (NIC) numbers, Name, Address, Gender, Course, Module, E-mail & Mobile phone numbers.
Preconditions:	Web browser opened and system URL accessed. The user who has the privileges to register students is to be logged into his user account. Application call for the examination.
Postconditions:	Further process Student management module is managed and maintained.
Normal Course:	<ol style="list-style-type: none"> 1. Open browser. 2. Navigate to the Examination management system URL. 3. Log into the system user account. 4. To create/register eligible students: <ol style="list-style-type: none"> a. Navigate to the student registration option. b. Select the student course and module. c. Submit the student details one by one or in excel format to bulk update. 5. To update the student details: <ol style="list-style-type: none"> a. Navigate to the student page b. Select the student who needs to be updated. c. Update the information 6. To view the registered student details: <ol style="list-style-type: none"> a. Navigate to the student page b. Search & sort students by NIC, name, email, mobile no, address, course and module
Alternative Courses:	If the student already registers, then no need to add basic information again. Then display the student information and the system user can add course and module for that student.

Use Case ID:	03
Use Case Name:	Mange supervisors and invigilators
Actors:	Exam manage staff
Description:	This use case describes how to onboard and manage supervisors and Invigilators
Preconditions:	Web browser opened and system URL accessed. The user has the privileges to register supervisors and invigilators to be logged into his user account. Available of basic information of the supervisors and invigilators
Postconditions:	Available supervisors and invigilators for further process
Normal Course:	<ol style="list-style-type: none"> 1. Open browser 2. Navigate to the Examination management system URL 3. Login to the exam manages user account. 4. Create/register supervisors and invigilators <ol style="list-style-type: none"> a. Navigate to the supervisor's option and give the supervisor details & submit b. Navigate to the invigilator's option and give the invigilator details & submit 5. View supervisors/invigilators <ol style="list-style-type: none"> a. Navigate to the supervisors/invigilators option b. Search & sort occupation by id, name, address, contact no, email, status 6. Update invigilators: <ol style="list-style-type: none"> a. Navigate to the supervisors/invigilators option b. Search & select supervisors/invigilators c. Update the profile details 7. Inactive supervisors/invigilators <ol style="list-style-type: none"> a. Navigate to the supervisors/invigilators option b. Inactivate the selected supervisors/invigilators
Alternative Courses:	

3.5.3 Class diagram

Based on the Guru99.com 2021, UML class diagram gives an overview of a software system by displaying classes, attributes, operations, and their relationships. Further, this diagram displayed the different types of objects in the system and the relationship between them. Figure 3.5, illustrated the class diagram for this examination management system.

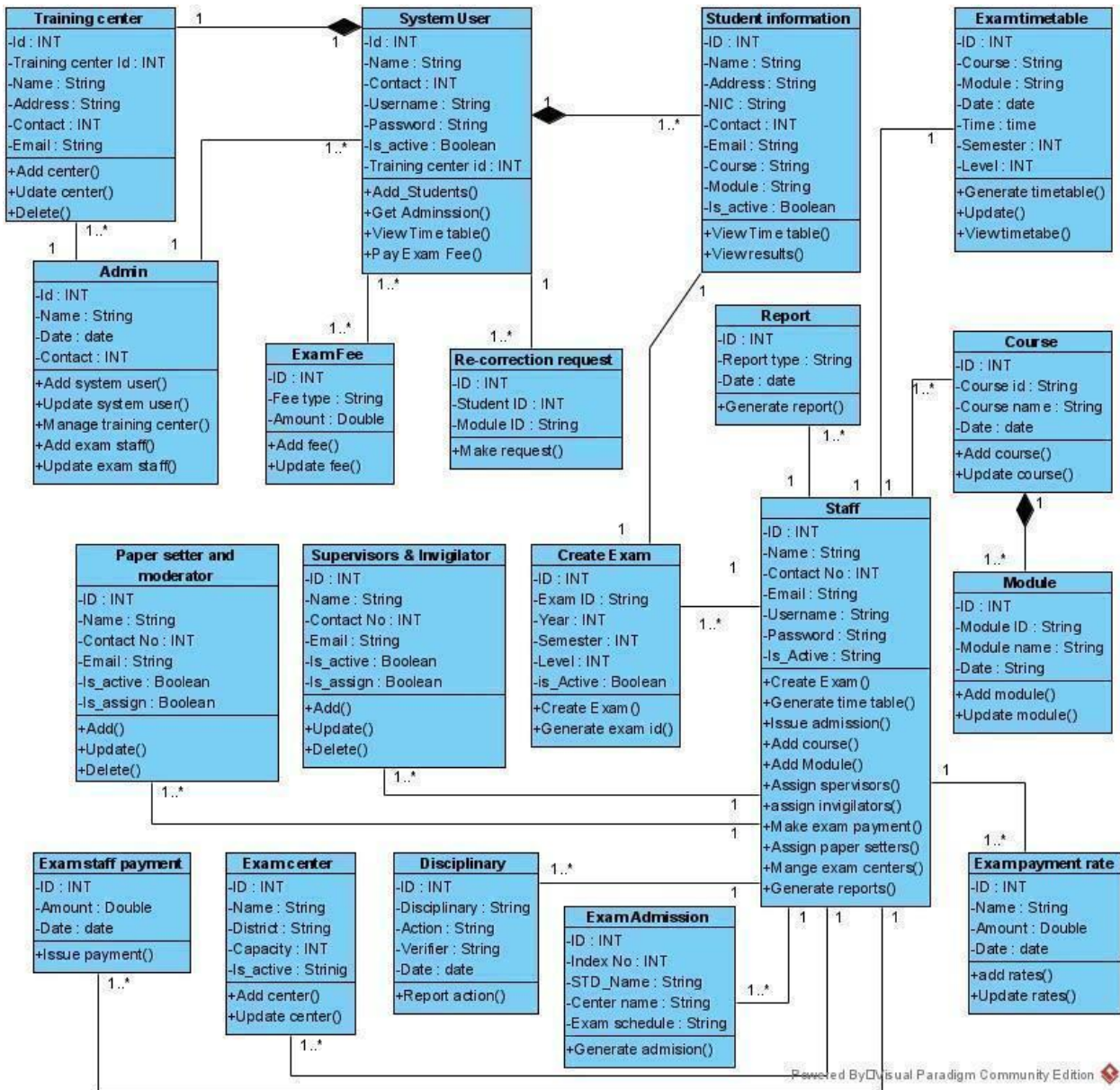


Figure 3. 5 Class diagram for the proposed system

3.5.4 Sequence diagram

1. Sequence diagram for user login

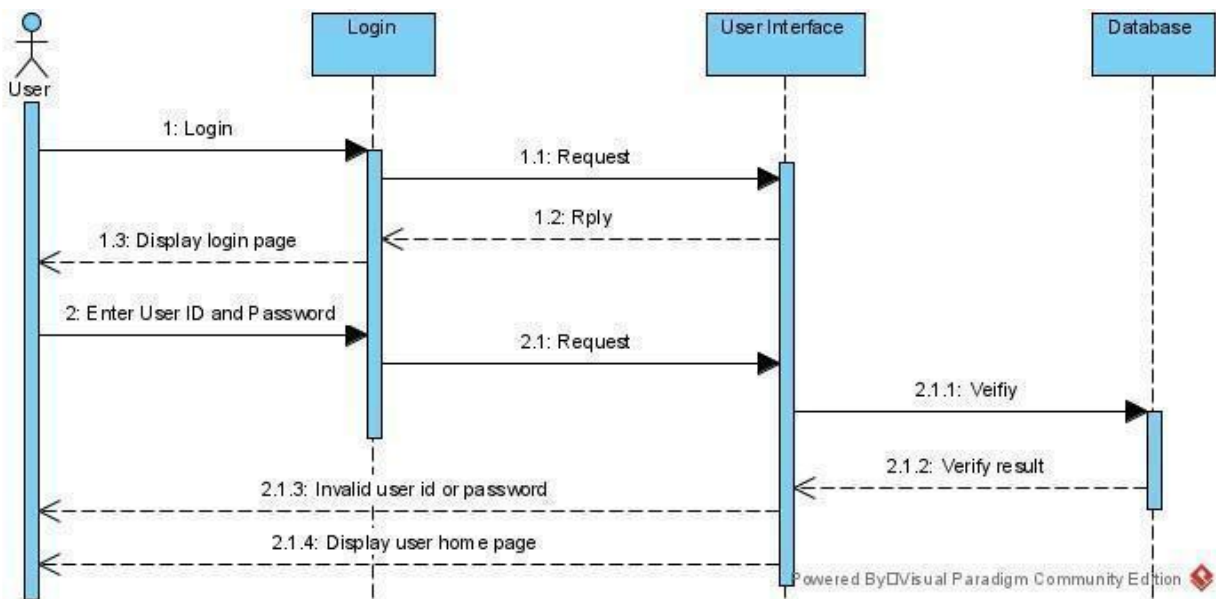


Figure 3. 6 Sequence diagram for user login

2. Sequence diagram for user registration

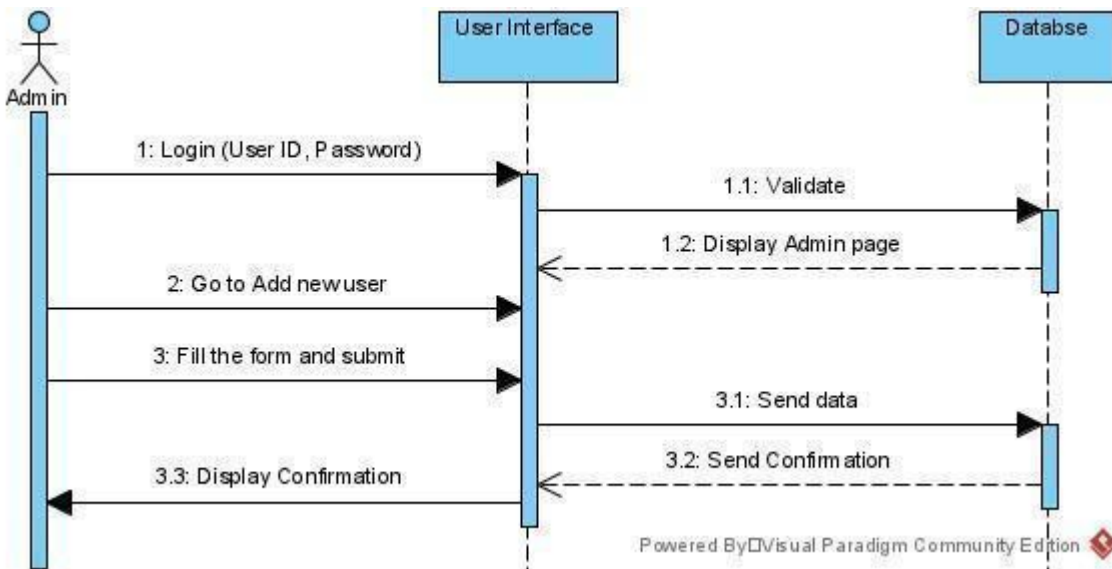


Figure 3. 7 Sequence diagram for user registration

3.5.5 Activity diagram

1. Activity diagram for user registration

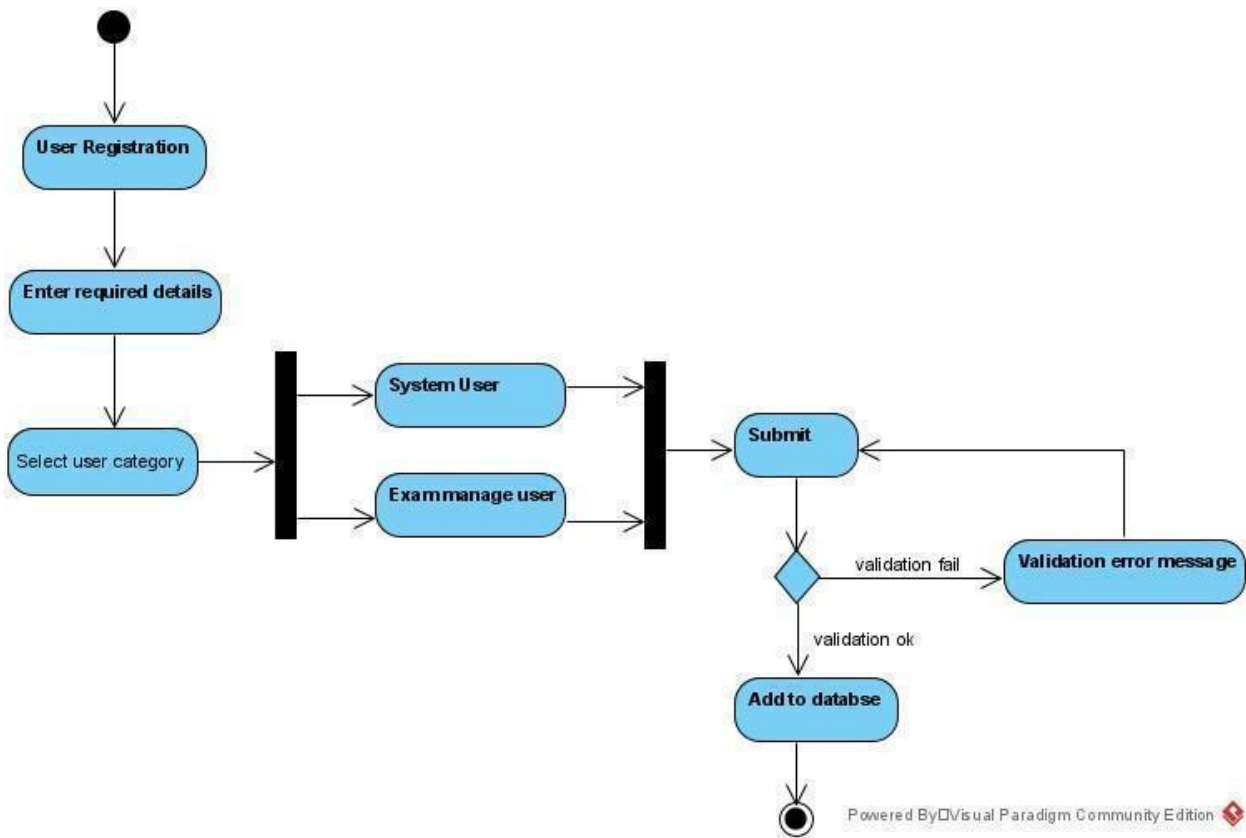


Figure 3. 8 Activity diagram for user registration

3.5.6 Database design

Relational database concepts were used to design the database for this system. The concept of database normalization was used to avoid redundancy, data anomalies and improve data efficiency.

At the point of view of softwareideas.net, an entity-relationship diagram describes the data model of a system using entities that represent data types and relationships according to their dependencies in between entities. Further observation, ER diagrams are used for designing database schemas with entity attributes, primary and foreign keys. Figure 3.9 is the database diagram that depicts the entities and attributes of the proposed system and also relationships among entities.

3.6 User interface design

a) Landing Page

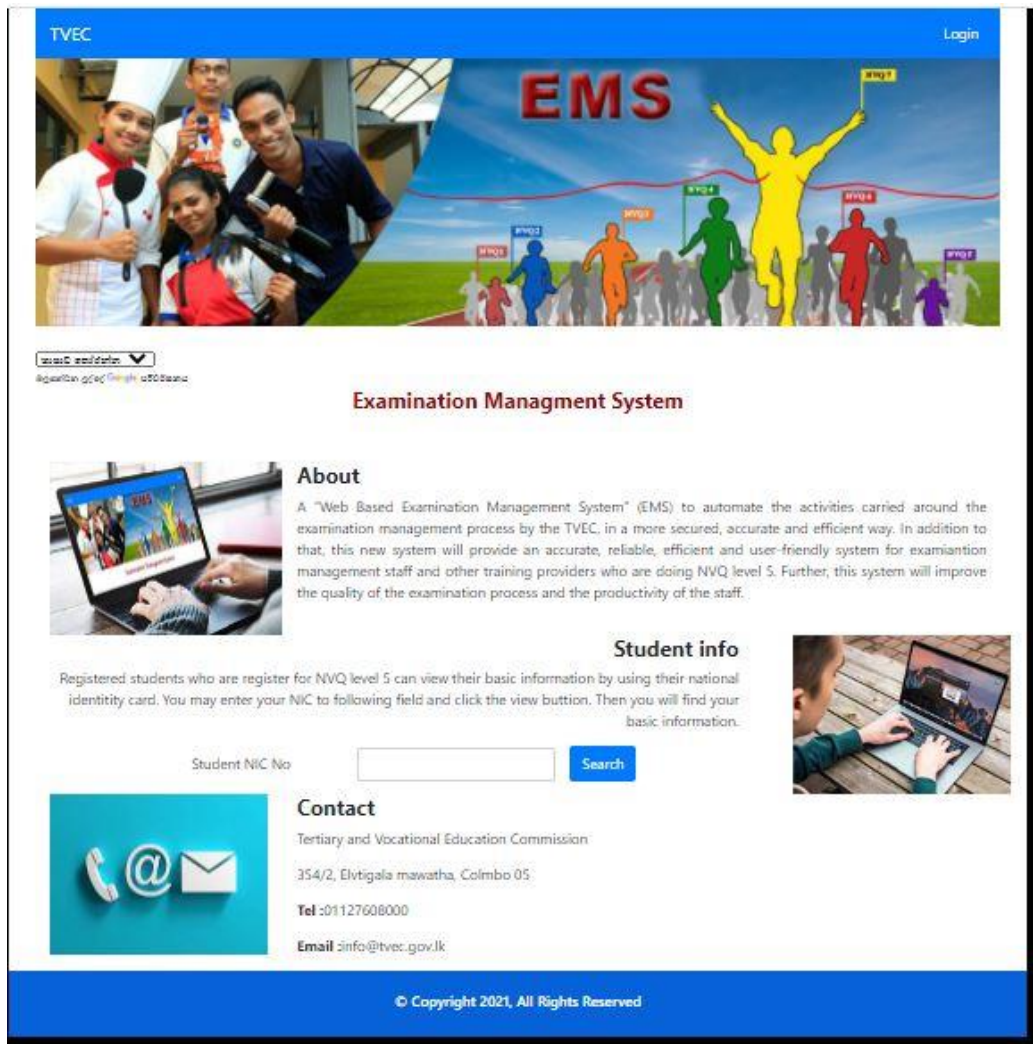


Figure 3. 10 Landing page of the system

b) Login



Figure 3. 11 User login interface

c) Main web page

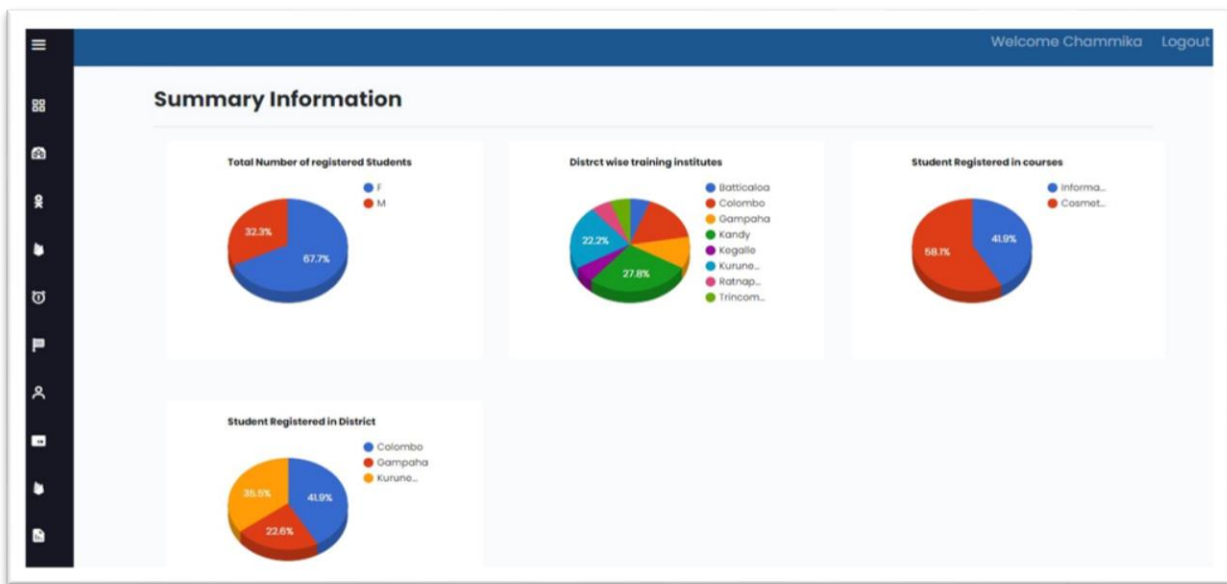


Figure 3. 12 Summary information page

d) Display Institute information

The screenshot shows the "Manage Training institute" interface with a table of registration details. A button "Add New Training Center" is visible at the top left of the table area.











Registration No	Name	Address	District	Email	Contact No	Action
P01/0023	SOFT IT training	354/2, Elvitigala Mw, Narahenpita	Colombo	chammika@tvec.gov.lk	117608008	 
P01/0026	IT center	Kiribathgoda	Gampaha	ICT@gmail.com	769898231	 
P01/0028	Creative Info	Kadawatha	Gampaha	info@ict.org	775896322	 
P08/0258	Vocational training center	No.45, Peradeniy road, Peradeniya	Kandy	vtcKandy@gmail.com	812265982	 
P08/0260	NVTI	No.45, Kandy road, Peradeniya	Kandy	vtcNVTI@gmail.com	564684601	 
P12/0035	VTC center	Kurunegala	Kurunegala	vtc@gmail.com	789854845	 

Figure 3. 13 Institute registration interface

e) Student registration

Register Student

Student NIC No

Student Name

Gender Male Female

Contact No

Email

Course

Training Center

Figure 3. 14 Student registration interface

f) Student dashboard

Student Dashboard

Basic Information

NIC	Name	Gender	Contact No	Email	Course	Training Center
996451003V	M. H. M. Shashika Rasanjalee Padmasiri	F	0771097096	shashirasanjalee530@gmail.com	Information and Communication Technology	Soft IT training

NVQ Level 5 Results

Module Name	Marks	Semester	Result
Database Systems 1	50	1	Pass
Software Programming	40	1	Pass
Graphic Design	45	1	Pass

NVQ Level 5 Time Table

Module Name	Start Date and Time	End Date and Time	Semester
-------------	---------------------	-------------------	----------

Figure 3. 15 Student information page

g) MIS report generate module

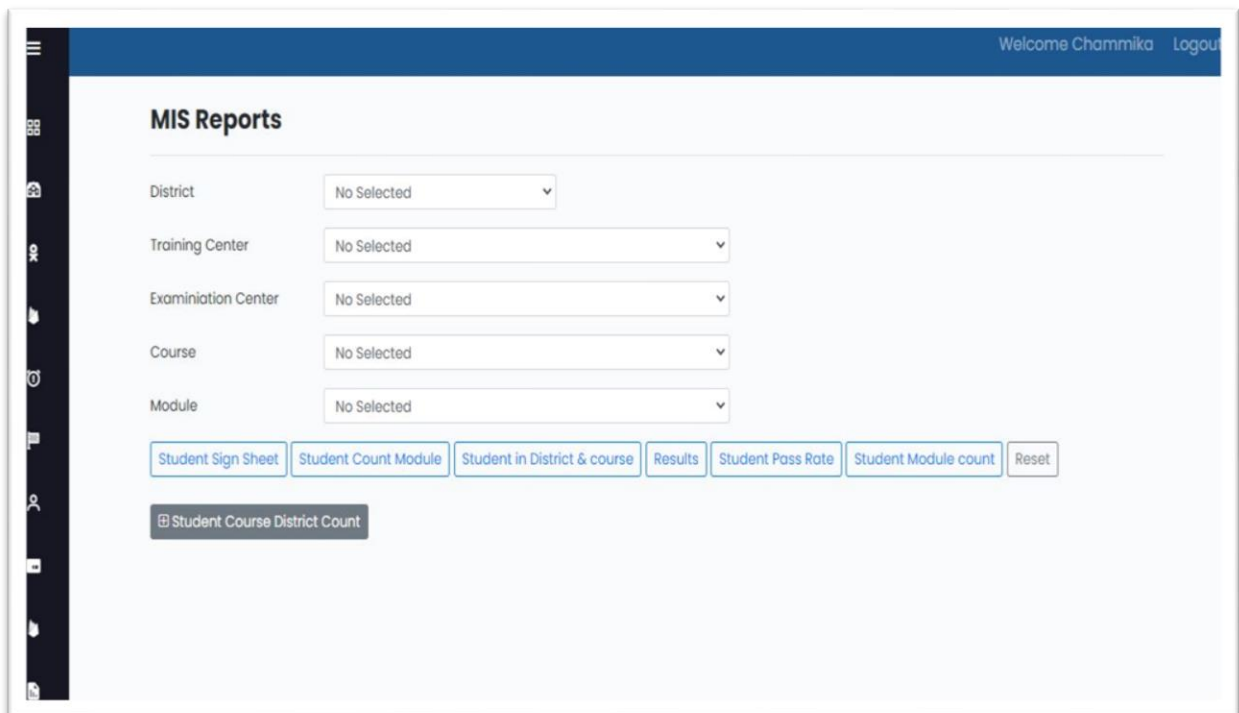


Figure 3. 16 MIS report module

h) MIS reports

Figure 3.17 shows the total number of students applies for the exam in ICT modules.

Module Name	No. of Student
Database Systems 1	12
Database Systems 11	3
Graphic Design	11
Software Programming	13
Software Testing	4
System Analysis and Design	10
Web Programming	1
Workplace Communication Management	11
Workplace Information Management	11

Figure 3. 17 Number of students in module wise

Figure 3.18 shows the pass rate of the modules related to the ICT course.

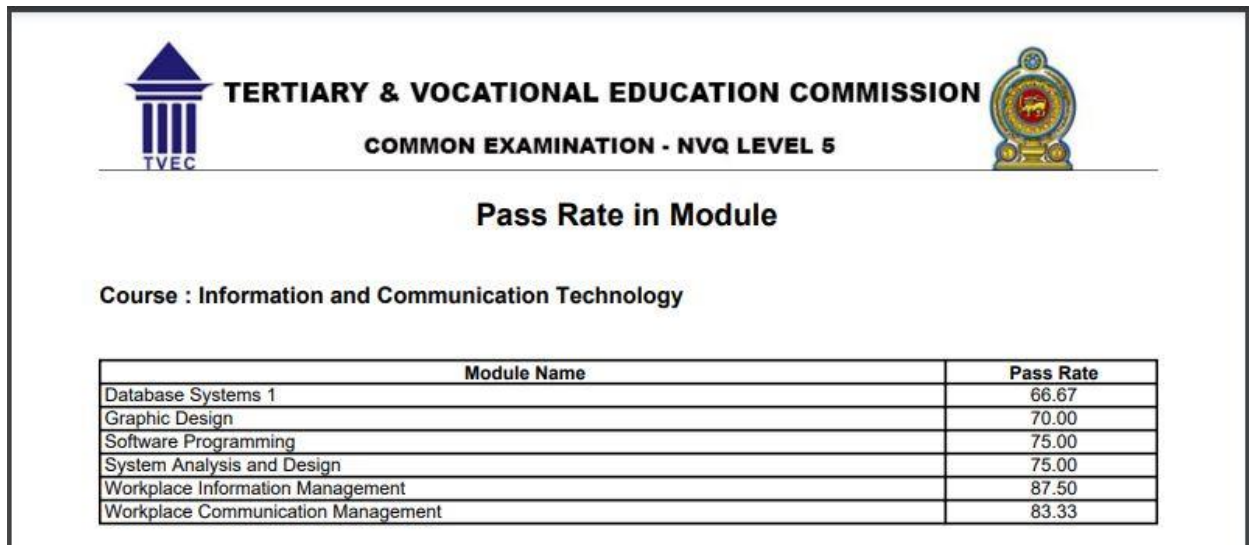


Figure 3. 18 Number of students pass rate in module wise

Figure 3.19 shows the total number of students registered for different courses.

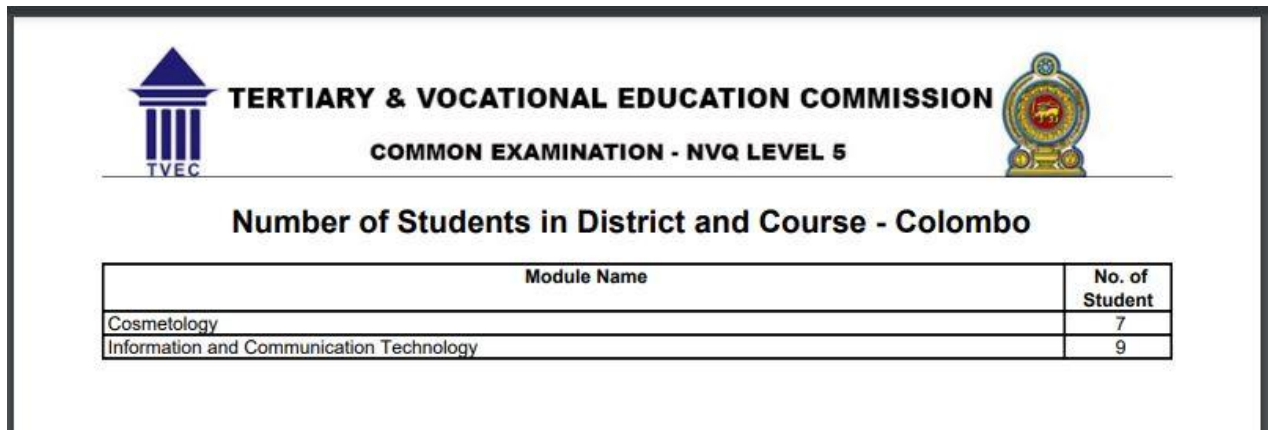




Figure 3. 19 Number of students in course wise

Figure 3.20 shows the admission used for the examination.


TERTIARY & VOCATIONAL EDUCATION COMMISSION
COMMON EXAMINATION - NVQ LEVEL 5


1. Index Number :	551210045
2. N.I.C. Number :	996451003V
3. Name (with Initials) :	M. H. M. Shashika Rasanjalee Padmasiri
4. Course :	Information and Communication Technology
5. NVQ Level :	5
6. Semester :	1
7. Examination Centre :	NVTI Narahenpita
8. Modules :	K72T001M01 Database Systems 1 K72T001M03 Graphic Design K72T001M04 Software Programming

This candidate is allowed to sit for this written examination.

.....
Director (Assessment Quality Assurance), TVEC

Part B -Attestation



I certify that the above student is a registered student of the institute and he/she is eligible to appear for the examination.

.....

Principal/Course Coordinator/ O.I.C
Date
Official Stamp

Figure 3. 20 Admission card

Following figure 3.21 shows the attendant sheet to get the signature of the students at examination.


TERTIARY & VOCATIONAL EDUCATION COMMISSION
COMMON EXAMINATION - NVQ LEVEL 5


Attendance List

Examination Center : NVTI

Course : Information and Communication Technology

Student Name	Index No	Signature
M. H. M. Shashika Rasanjalee Padmasiri	551210045	
Pathegama Widanagama Isuru Dilanka Madhushan	551210046	
Hamda Haileel	551210047	
A.M.A.L Aththanayake	551210049	
Fathima Fahmidha	551210056	

Figure 3. 21 Students' attendant sheet based on center and course

3.7 System access overview

This examination management system is developed a full web-based and centralized web server will be located at the head office or cloud. Clients from the head office and different parts of the country will be connected to the main server through the internet using web browsers. Figure 3.14 is the system access overview diagram for the proposed examination management system.

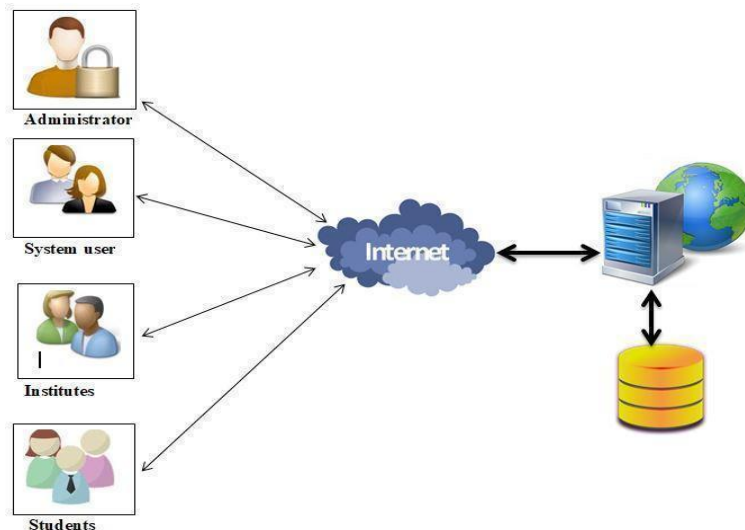


Figure 3. 22 System access overview

This proposed web-based examination management system was developed based on a centralized database. This system can be hosted in the cloud web server or locally hosted web server. The entire users can access this system through the Internet with their user credentials. Based on the authority level user will display functions.

3.8 System security

This system will access through the internet. Then it will be important to handle the security aspects of the system and information. When considering security aspects there are three major concern of the physical, logical, and behavioral security. All three must work together if the quality of security is to remain high (w3computing.com (2021)).

- **Physical**

The computer and the server should be placed in a secure place and preventing unauthorized access, and that equipment should prevent disasters as well.

- **Logical**

To improve security, user passwords should encrypt before storing the database. Furthermore it recommends setting up a firewall and use SSL for secure communication. CodeIgnitor has inbuilt facility to prevent XSS attacks. Following figure 3.19 shows that enable the protection of the SXX attacks.



```
-----  
Global XSS Filtering  
-----  
  
Determines whether the XSS filter is always active when GET, POST or  
COOKIE data is encountered  
  
WARNING: This feature is DEPRECATED and currently available only  
for backwards compatibility purposes!  
  
*/  
$config['global_xss_filtering'] = TRUE;
```

Figure 3. 23 Enable XSS filtering

- **Behavioral**

Some policies and procedures should be implemented to prevent attacks on information systems come from inside the organization. Therefore, after implementing the system it is recommended to introduce a nondisclosure agreement for the user.

3.9 Summary

This chapter aimed to explain the process model, system architecture and design pattern which are used for the proposed system. Further different types UML diagrams were used to study the proposed system. The major part of this project implementation has been covered over this chapter in detail with supporting different types of diagrams, architectural plans and user interface design.

Chapter 4: Implementation

4.1 Introduction

This chapter presents the important steps carried out in the implementation phase of web base examination management system. It includes details of the hardware and software tools such as scripting languages, frameworks, platforms, database systems, etc., which are required to implement this proposed system. Further explain, this chapter includes some of the code segments which are used in the system development.

4.2 Methodology

Incremental model is used as implementation methodology and it was found to be very much suitable for this web based examination management system because it can be used to develop a working version that the users also can involve from the beginning. The further system can be implemented module by module and it can be tested for any defects and errors. Based on the test result clients may approve for deployment and new functions may be available for end-users.

4.3 Environment

This proposed solution is fully web-based and it used free and open-source software tools used to develop the system. To implement the system, XAMPP is used to deploy the Apache web server, PHP and MYSQL database which are the main required software. PHP framework called "CodeIgnitor" was issued to develop this system based on the MVC architecture.

The below sections describe the selected programming language, database system and other tools which are used to develop the system effectively.

4.3.1 Hardware environment

Table 4.1 shows the minimum hardware configurations for the system development environment.

Hardware Item	Minimum configuration
Processor	Core i3 2.4 GHz with 4MB cache
Ram	8 GB
Hard Disk	500 GB
Display	1024 x 786 Compliant colour monitor

Table 4. 1 Minimum hardware requirement for development

Table 4.2 shows the minimum hardware configurations for the webserver to hosting the web-based EMS.

Hardware Item	Minimum configuration
Processor	Core i5 2.4 GHz with 8MB cache
Ram	16 GB
Hard Disk	1T HDD
Display	1024 x 786 Compliant colour monitor

Table 4. 2 Minimum hardware requirements for server

Table 4.3 shows the minimum hardware configurations for the system users.

Hardware Item	Minimum configuration
Processor	Core i3 2.4 GHz with 4M B cache
Ram	4 GB
Hard Disk	500 GB
Display	1024 x 786 Compliant colour monitor

Table 4. 3 Minimum hardware requirements for user

4.3.2 Software environment

- a. Software requirement for system development
 - Apache web server
 - PHP scripting language
 - CodeIgniter 3
 - MYSQL database
 - PHPMyAdmin to connect MYSQL database
 - Notepad++ to edit the PHP scripting
 - Visual Paradigm for UML diagrams
 - Photoshop for image editing
- c. Software requirement for the webserver
 - Apache
 - PHP
 - MYSQL
 - PHPMyAdmin
- d. Software requirement for user computer
 - Web browser
 - PDF reader
 - Internet connection

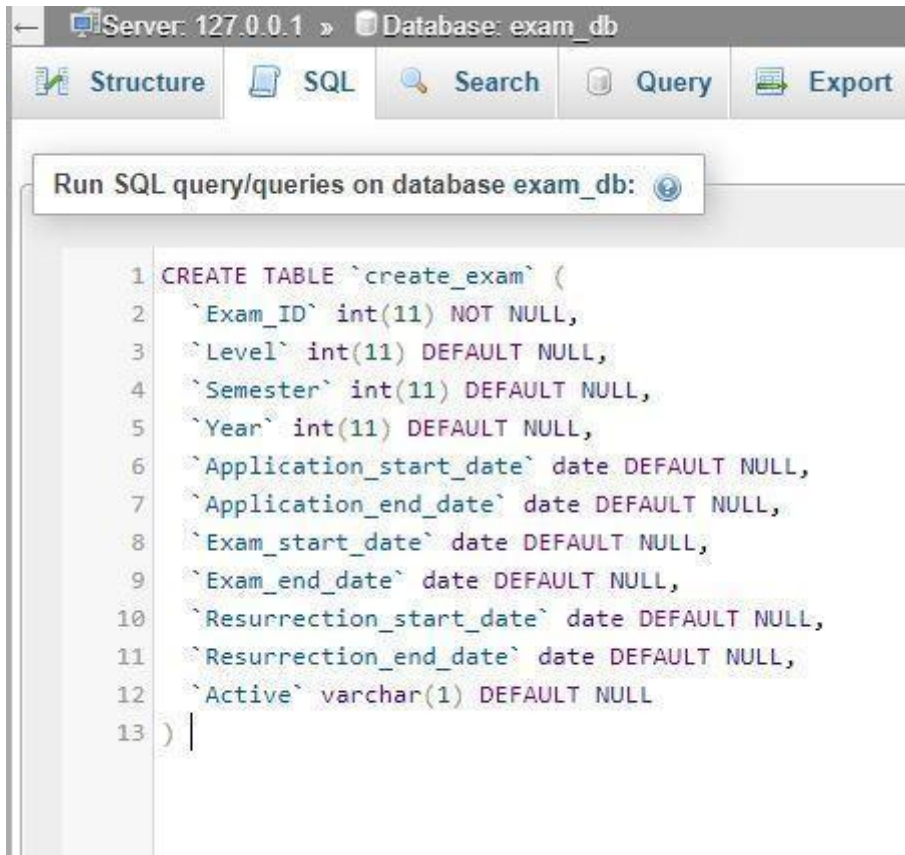
4.4 Database implementation

XAMPP software package was used in the implementation of the database. SQL queries were used to handle the database activities. Figure 4.1 shows the SQL query to create a database.



Figure 4. 1 SQL query for creating a database

Following figure 4.2 shows the SQL query to create a table called Create_Exam

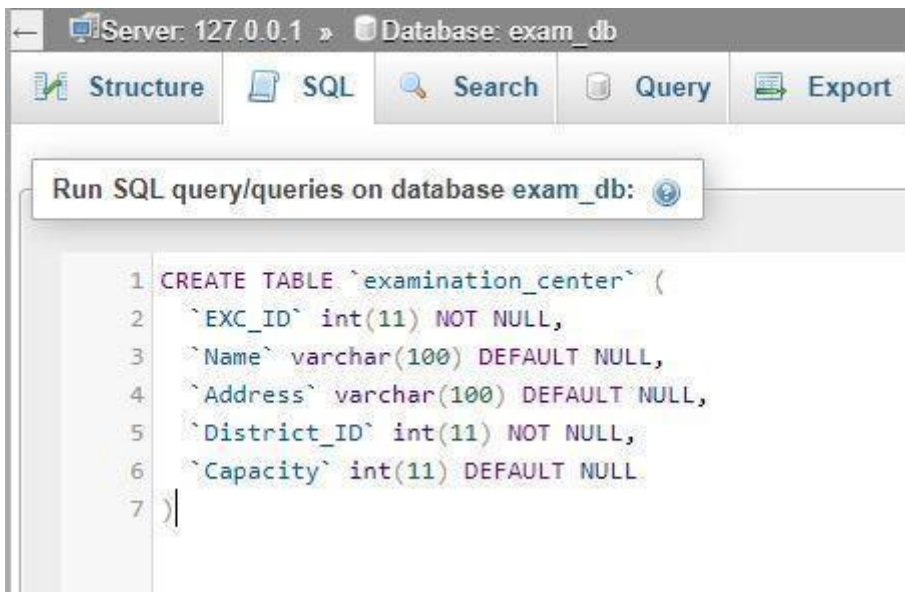


The screenshot shows a SQL query editor window with the following content:

```
Server: 127.0.0.1 » Database: exam_db
Structure SQL Search Query Export
Run SQL query/queries on database exam_db:
1 CREATE TABLE `create_exam` (
2   `Exam_ID` int(11) NOT NULL,
3   `Level` int(11) DEFAULT NULL,
4   `Semester` int(11) DEFAULT NULL,
5   `Year` int(11) DEFAULT NULL,
6   `Application_start_date` date DEFAULT NULL,
7   `Application_end_date` date DEFAULT NULL,
8   `Exam_start_date` date DEFAULT NULL,
9   `Exam_end_date` date DEFAULT NULL,
10  `Resurrection_start_date` date DEFAULT NULL,
11  `Resurrection_end_date` date DEFAULT NULL,
12  `Active` varchar(1) DEFAULT NULL
13 ) |
```

Figure 4. 2 SQL query for creating table "Create_Exam"

Figure 4.3 displays the SQL query to create a table called Examination_center

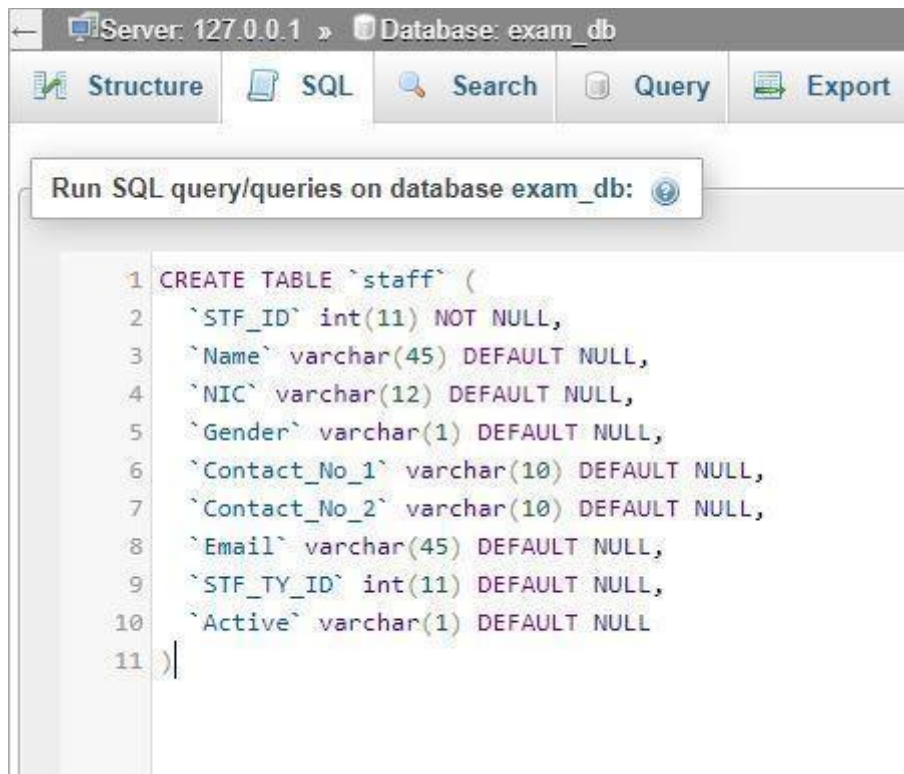


The screenshot shows a SQL query editor window with the following content:

```
Server: 127.0.0.1 » Database: exam_db
Structure SQL Search Query Export
Run SQL query/queries on database exam_db:
1 CREATE TABLE `examination_center` (
2   `EXC_ID` int(11) NOT NULL,
3   `Name` varchar(100) DEFAULT NULL,
4   `Address` varchar(100) DEFAULT NULL,
5   `District_ID` int(11) NOT NULL,
6   `Capacity` int(11) DEFAULT NULL
7 ) |
```

Figure 4. 3 SQL query for creating table "Examination_center"

Following figure 4.4 shows the SQL query to create a table called staff



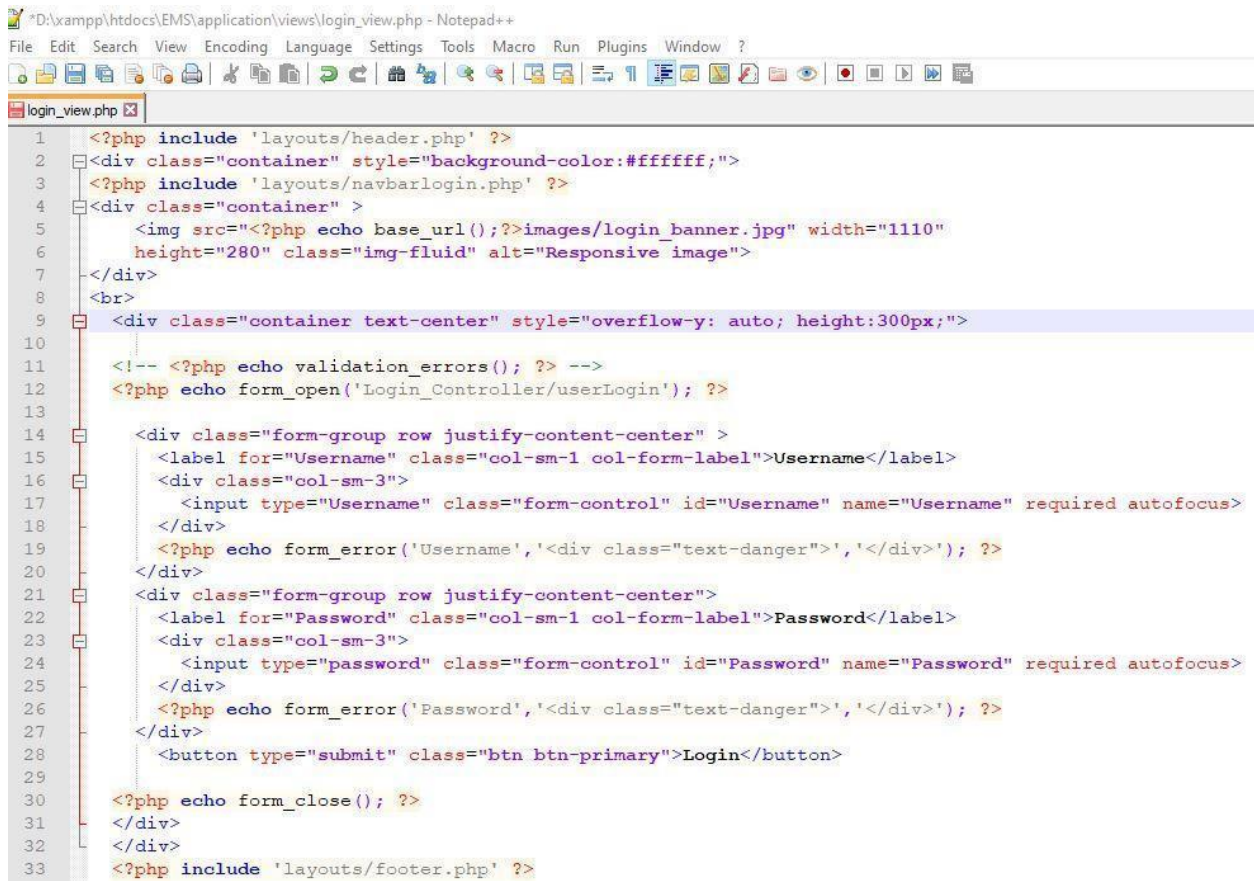
The screenshot shows a SQL query editor window with the following content:

```
Server: 127.0.0.1 » Database: exam_db
Structure SQL Search Query Export
Run SQL query/queries on database exam_db:
1 CREATE TABLE `staff` (
2   `STF_ID` int(11) NOT NULL,
3   `Name` varchar(45) DEFAULT NULL,
4   `NIC` varchar(12) DEFAULT NULL,
5   `Gender` varchar(1) DEFAULT NULL,
6   `Contact_No_1` varchar(10) DEFAULT NULL,
7   `Contact_No_2` varchar(10) DEFAULT NULL,
8   `Email` varchar(45) DEFAULT NULL,
9   `STF_TY_ID` int(11) DEFAULT NULL,
10  `Active` varchar(1) DEFAULT NULL
11 )
```

Figure 4. 4 SQL query for creating table "staff"

4.5 Code implementation

Following figure 4.5 shows the code segment of the user login interface.



```
1 <?php include 'layouts/header.php' ?>
2 <div class="container" style="background-color:#ffffff;">
3 <?php include 'layouts/navbarlogin.php' ?>
4 <div class="container" >
5 
7 </div>
8 <br>
9 <div class="container text-center" style="overflow-y: auto; height:300px;">
10
11 <!-- <?php echo validation_errors(); ?> -->
12 <?php echo form_open('Login_Controller/userLogin'); ?>
13
14 <div class="form-group row justify-content-center" >
15 <label for="Username" class="col-sm-1 col-form-label">Username</label>
16 <div class="col-sm-3">
17 <input type="Username" class="form-control" id="Username" name="Username" required autofocus>
18 </div>
19 <?php echo form_error('Username','<div class="text-danger">','</div>'); ?>
20 </div>
21 <div class="form-group row justify-content-center">
22 <label for="Password" class="col-sm-1 col-form-label">Password</label>
23 <div class="col-sm-3">
24 <input type="password" class="form-control" id="Password" name="Password" required autofocus>
25 </div>
26 <?php echo form_error('Password','<div class="text-danger">','</div>'); ?>
27 </div>
28 <button type="submit" class="btn btn-primary">Login</button>
29
30 <?php echo form_close(); ?>
31 </div>
32 </div>
33 <?php include 'layouts/footer.php' ?>
```

Figure 4. 5 Coding of the user login interface

4.6 Security implementation

To protect the unauthorized view of the user password, the entire password saved in database by using SHA1 cryptographic hash function. Following figure 4.6 shows the code implementation of the encryption.



```
function insert_user($userdata){
    $userdata["Password"] = sha1($this->input->post('Password'));
    $this->db->trans_start();
    $this->db->insert('users',$userdata);
    $insert_id = $this->db->insert_id();
    $this->db->trans_complete();
    return $insert_id;
}
```

Figure 4. 6 SHA1 encryption

4.7 User interface implementation

Figure 4.7 shows the page which includes assigning students to create examination, create exam center, issue index numbers and download timetable.

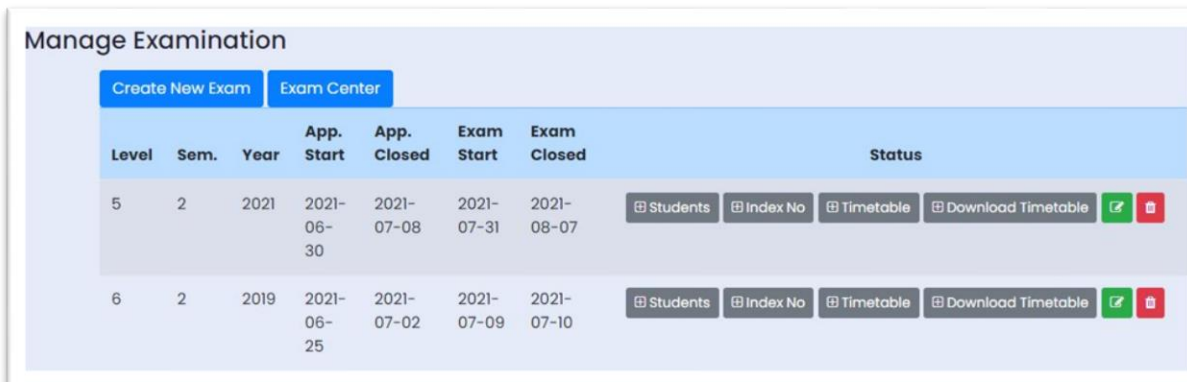


Figure 4. 7 Manage examination

According to the figure 4.8 it shows the page which includes assigning students to examination, update attendants and download admissions.

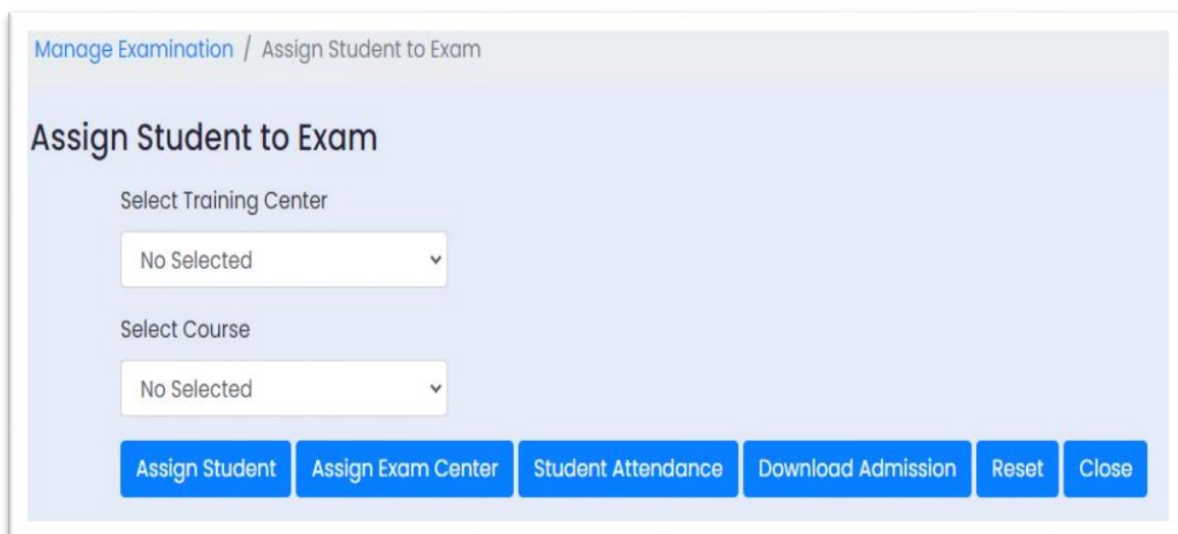


Figure 4. 8 Assign students to exam

Figure 4.9 shows the page (Dashboard) gives the visual representation of the data by using pie chart.



Figure 4. 9 Dashboard

Figure 4.10 depicts the list of registered students' page available in the system.

NIC	Name	Gender	Contact No	Email	Training Center	Course ID	Active	Status
891032030V	Saman Perera	M	0773630471	saman@gmail.com	5	10	1	<input type="checkbox"/>
890103023V	Pradeep Gunathilake	M	0773630471	chammika@tvec.gov.lk	4	10	1	<input type="checkbox"/>
995684263V	Nuwan Perera	M	0719635782	sp@gmail.com	5	8	1	<input type="checkbox"/>
988659354V	A. K. Perera	M	0773630471	id@g.com	4	10	1	<input type="checkbox"/>
965836890V	Kamal	M	7489586236	kamal@gmail.com	4	10	1	<input type="checkbox"/>
991236985V	Amal kumara	F	0719635782	mala@yahoo.com	1	10	1	<input type="checkbox"/>
893625963V	A.p Kumara	M	0773630471	ap@gmail.com	1	10	1	<input type="checkbox"/>
978456230V	Nishantha	M	0719635782	abc@gmail.com	4	10	1	<input type="checkbox"/>

Figure 4. 10 Display lists of students

Following figure 4.11 shows the page of the students assign for different modules for selected subject.

Name	All	U01	U02	U03	U04	U05	U06	U07	U08	U09	U10	U11	U12	EMPU01	EMPU02	EMPU03
Pradeep Gunathilake	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A. K. Perera	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Kamal	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Nishantha	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 4. 11 Assign students to examination

Following figure 4.12 shows the page of the assign user roles for different level access of the system.



The screenshot displays a web interface titled "Manage Users". On the left, there is a vertical sidebar with several icons. The main content area features a blue "Add User" button at the top left. Below it is a table with the following structure:

Center Name	Staff Name	User Name	Action
TVEC	Chammika	Chammika	<input checked="" type="checkbox"/> User Role
Soft IT training	Samantha	samantha	<input checked="" type="checkbox"/> User Role
GLOBAL INSTITUTE OF EDUCATION	D. Shyamali Manuwickrama	Shyamali	<input checked="" type="checkbox"/> User Role
IT center	W.A.B Priyantha.	priyantha	<input checked="" type="checkbox"/> User Role

Figure 4. 12 Manage user roles

4.5 Summary

This chapter well explained the implementation process, which was done in a well-organized and structured manner, considering all hardware and software requirements. PHP framework was mainly considered as the programming language with MYSQL as a database system. Further above figure 4.7, 4.8, 4.9, 4.10, 4.11 and 4.12 shows the sample screens of the system.

Chapter 5: Testing and Evaluation

5.1 Introduction

After completing the software, it is important to evaluate the system by using various kinds of testing and evaluation methods. It will help to identify the issues of the system development related to the functional and non-functional requirements. Further testing and evaluation reveal the software issues such as validation, coding errors, data handling issues, authentication errors, etc. In this chapter, it will discuss all the scenarios and methods used to deliver an error-free software system to replace the manual examination management system of the TVEC.

“Software testing is a process, to evaluate the functionality of a software application with an intent to find whether the developed software met the specified requirements or not and to identify the defects to ensure that the product is defect-free in order to produce a quality product.” (Rajkumar, 2021)

5.2 Identified test methodology

In this testing process, the proposed system was tested under two main categories as system functional and nonfunctional operations.

a) Functional testing

Under the functional testing, it has covered unit testing, integrating testing, system testing and acceptance testing.

b) Non Functional testing

This proposed system was developed as web based system therefor usability and user acceptance test was carried out to identify any defects from the user side.

5.2.1 Unit testing

This proposed system was developed module wise and those modules were tested separately. In the initial step, the login and log out units were tested. In the next step, the “manage training institute” unit was tested for its features. After that register course and module units was tested for its feature. Other units were tested step by step when those units were developed.

5.2.2 Integrating testing

When the unit testing was completed, integrated testing was carried out by connecting two or more units. In this system, the student registration module tested with training center registration and course registration. Without adding training center and course information, students may not allow to register with the system.

5.2.3 System testing

After completing the system, it was tested with sample data to identify any defects of functions and their features. The main concern is to test the compatibility of individual modules. As the result of that it identified some areas where modules have been designed with different specifications such as data lengths, type and element name. For the system testing, it was checked system security by login different user credentials. Further entering more data into the data fields and checked system for validation errors.

5.2.4 User acceptance testing

Before releasing the real-life operation, it is important to do the acceptance test by the customer to see whether the system is satisfying the customer's requirements according to their given specification. Student registration and training center registration modules were tested by two exam management staff and identified the length of the student name in the database field was not sufficient and it was corrected.

5.3 Test plan

This test plan was developed to test the web based examination management system functions and their features. Further, it was focused to achieve the following objectives.

- The all-inclusive test plan covers the scope of the tests which are essential to achieve the proposed system including software, hardware and other requirements.
- To describe how the tests will be conducted. Further identified the organizational provisions, define test methods and strategies to be used, and determine what to deliver.

Table 5.1 describe the test plan for the examination management system login management

#	Function	Testing Procedure	Expected Output	Priority
1	Log in to the system without user login credentials	Insert some credentials which are not in the system	Display error message “User name or Password incorrect”	High
2	Try to login system user id and password	Did not enter any user id and password	Display message by asking user id and password	Medium
3	Login to the system without a password	Enter user id Only	System asked to enter password	Medium
4	Login to the system without user-id	Enter password Only	System asked to enter user-id	Medium
5	Login to the system with correct user login credentials	Insert correct user id and password	Login to the system and will display the main page	High

Table 5. 1 User login test plan

Table 5.2 describe the test plan for the training center registration

#	Function	Testing Procedure	Expected Output	Priority
1	Register training center without any information	Do not add center registration information	Display error messages and asked for registration information	High
2	Training center registration number validation	Add same registration number which is used another center	Display error on registration number	High
3	Email address validation	Add incorrect email address	Display error message for the email address	Medium
4	Contact number validation	Add the different lengths of numbers	Display error message for a contact number	High
5	Register with all information	Add all correct required information	Successfully update the list of the training center	High

Table 5. 2 Training center registration

Table 5.3 describe the test plan for the student registration

#	Function	Testing Procedure	Expected Output	Priority
1	Register students without any information	Do not add student information	Display error messages and asked to student required information	High
2	Validate student NIC number	Add NIC number with incorrect length	Display error on NIC number	High
3	Validate the uniqueness of the NIC number	Add NIC number which is used by another student	Display error on NIC number	High
3	Email address validation	Add incorrect email address	Display error message for the email address	Medium
4	Contact number validation	Add the different lengths of numbers	Display error message for a contact number	High
5	Register students with all information	Add all correct required information	Successfully update the list of students	High

Table 5. 3 Student registrations

5.3.1 Test cases

After completing the test plane, it is required to start the testing process according to the test plan. In the test plan, each function could be a single test case. There were few test cases and generated under each test plan mention in the above tables.

Table 5.4 shows the test case for the test plan "examination management system login management" which is in table 5.1.

The following table 5.4 is the test case for Login to the system without user login credentials.

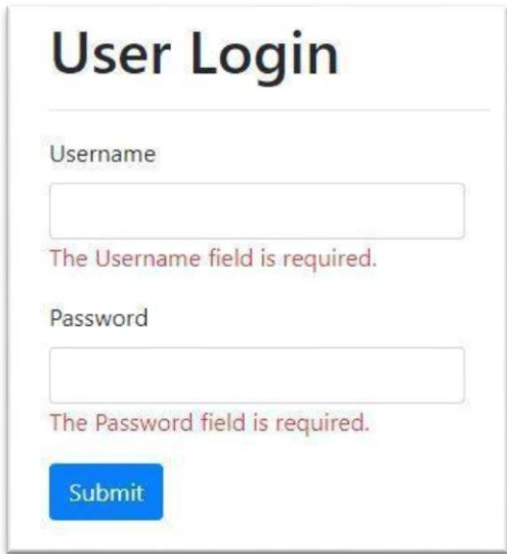
Test case ID:		TC -01	
Title:		User Login	
Description:		Allow login only correct credentials	
Preconditions:		Login page should be available for the user	
Assumption:		Browser displayed the login page correctly	
Test Steps:			
1	Navigate the login link	2	Load the login UI
3	Click submit button without given any user credentials		
Expected Result:		The system should display an error message by asking user id and password.	
Actual Output			Status
			Pass

Table 5. 4 Test case for user login

Following table 5.5 shows the test case for the test plan "training center registration" which was in the above table 5.2. Table 5.5 displays the test case for training center registration number validation.

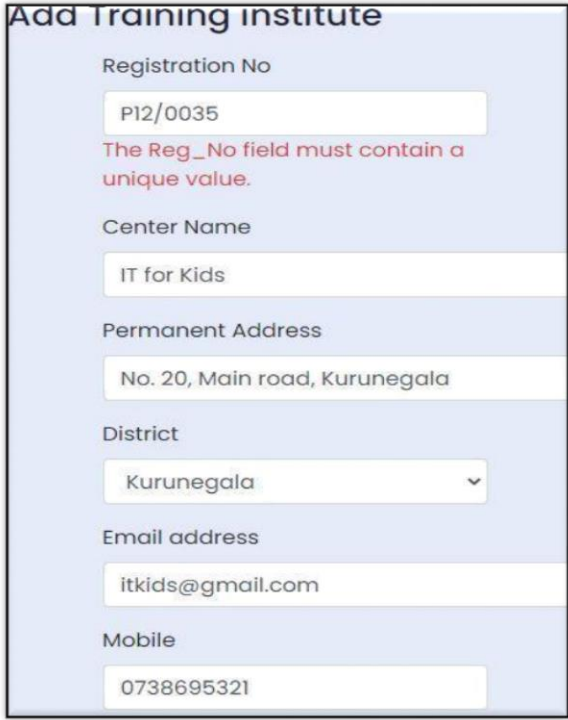
Test case ID:	TC -02		
Title:	Validate the training center registration number		
Description:	System Should allow register training center with correct and unique registration number		
Preconditions:	The training center registration page should be available for the user		
Assumption:	All the required fields will be displayed correctly		
Test Steps:			
1	Click on the Institute link from the main menu	2	Click the "Add New Training center" button
3	Enter training center information with a registration number which is used for another center	4	Click the save button
Expected Result:	The system should display an error message by asking unique registration number		
Actual Output			Status
			Pass

Table 5. 5 Training center registration number validation

Table 5.6 shows the test case for the test plan "student registration" which is discussed in table 5.3.

Table 5.6 shows the test case for Validate student NIC number.

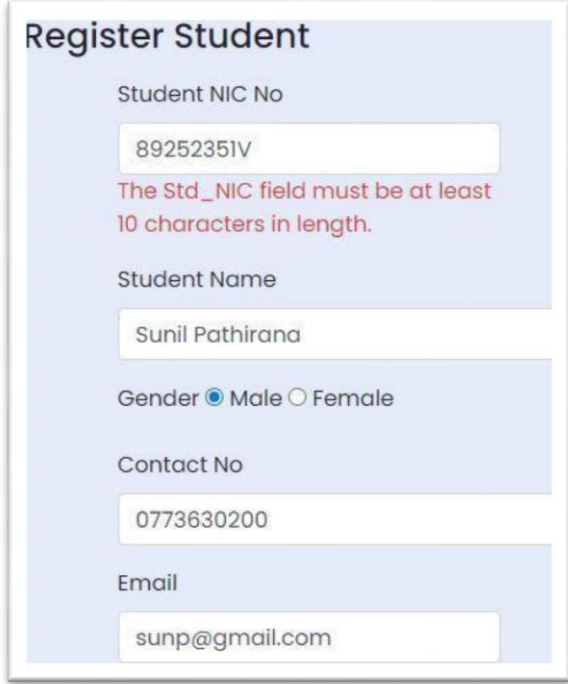
Test case ID:		TC -02	
Title:		Validate student NIC number by the length	
Description:		The system Should allow registered students with the correct NIC number.	
Preconditions:		The student registration page should be available for the user	
Assumption:		All the required fields will be displayed correctly in the browser	
Test Steps:			
1	Click on the Students link from the main menu	2	Click the "Register Students" button
3	Enter student information with NIC number which has incorrect length.	4	Click the save button
Expected Result:		The system should display an error message by asking correct NIC number.	
Actual Output			Status
			Pass

Table 5. 6 Validate student NIC number

Following table 5.7 shows the test case for the test plan "student registration" which is in table 5.3. Here it is explaining the table 5.7 is the test case for Validate the uniqueness of the NIC number.

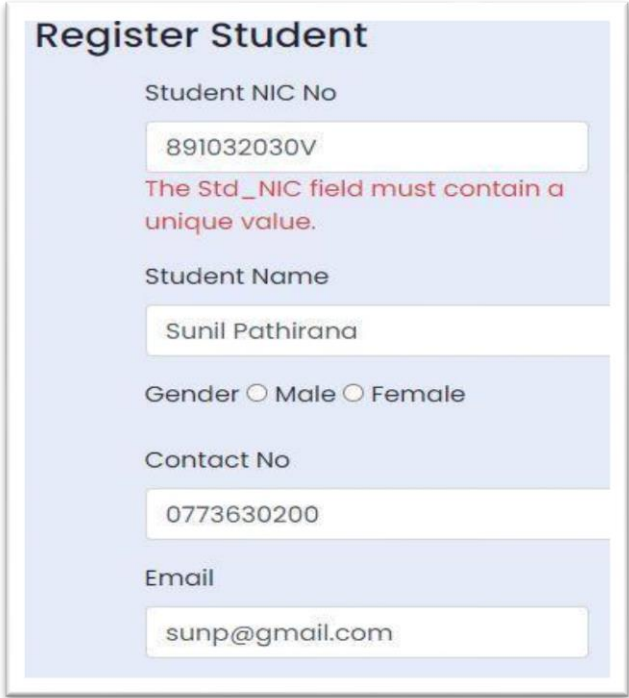
Test case ID:	TC -02		
Title:	Validate the uniqueness of the NIC number		
Description:	The system Should allow registering students with correct and unique NIC numbers.		
Preconditions:	The student registration page should be available for the user		
Assumption:	All the required fields will be displayed correctly in the browser		
Test Steps:			
1	Click on the Students link from the main menu	2	Click the "Register Students" button
3	Enter student information with NIC number which is used for another student.	4	Click the save button
Expected Result:	The system should display an error message by asking unique NIC number for that student		
Actual Output			Status
			Pass

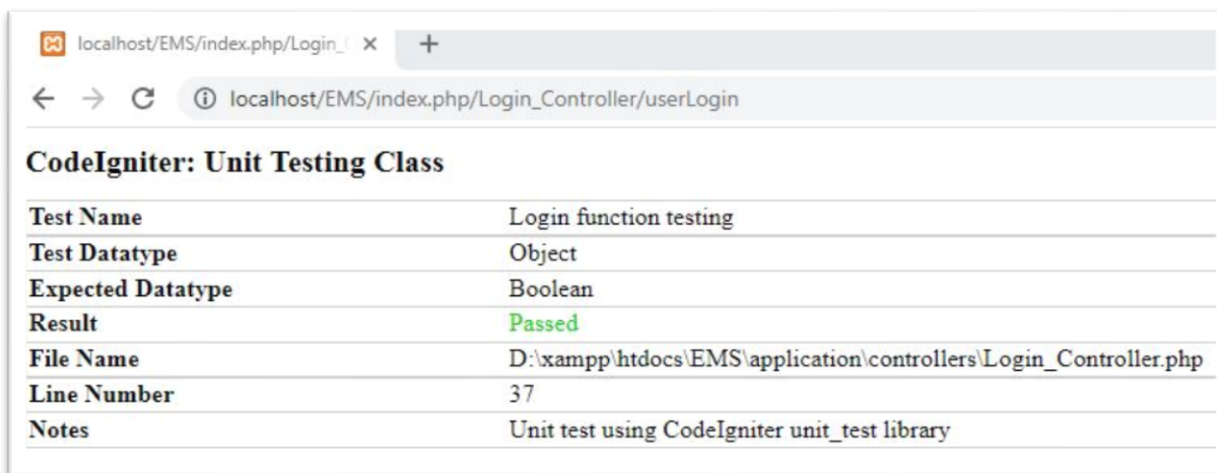
Table 5. 7 Validate the uniqueness of the NIC number

5.4 Automated testing

In the automated testing, testing tools or framework is used to test the software automatically by using pre-defined data set without doing manual data entering. Then it is easy to execute repeatedly until fixing the bugs of the software. It helps to improve the quality of the software in minimum time (Shreya Bose, 2021).

5.4.1 Automated unit testing

Figure 5.1 shows the result of the unit related to the login function. “Unit test class” of the CodeIgniter was used for this testing. For further reference, source code was added to the **Appendix F**.



The screenshot shows a web browser window with the address bar displaying 'localhost/EMS/index.php/Login_Controller/userLogin'. The main content area displays the results of a unit test in CodeIgniter. The test name is 'Login function testing', the test datatype is 'Object', and the expected datatype is 'Boolean'. The result is 'Passed' in green text. The file name is 'D:\xampp\htdocs\EMS\application\controllers>Login_Controller.php' and the line number is '37'. The notes mention 'Unit test using CodeIgniter unit_test library'.

CodeIgniter: Unit Testing Class	
Test Name	Login function testing
Test Datatype	Object
Expected Datatype	Boolean
Result	Passed
File Name	D:\xampp\htdocs\EMS\application\controllers>Login_Controller.php
Line Number	37
Notes	Unit test using CodeIgniter unit_test library

Figure 5. 1 Login function test result

5.4.2 Automated UI testing

User interface of the training center registration form of the system was tested by using automation testing. For this automation testing, TestNG, Selenium web driver and Chrome web browser with Java class were used. Following figure 5.2 shows the result of the automated testing. For further reference, source code used for the automated testing was added to the **Appendix F**.

```

Problems @ Javadoc Declaration Console Results of running class autoTestInsRegistration
<terminated> autoTestInsRegistration [TestNG] C:\Program Files\Java\jdk-16.0.2\bin\javaw.exe (Sep 9, 2021, 10:29:54 PM - 10:30:22 PM)
[RemoteTestNG] detected TestNG version 7.4.0
Starting ChromeDriver 93.0.4577.15 (660fc11082ba57405eca2e8c49c3e1af756fbfae-refs/branch-heads/4577@{#203}) on port 24537
Only local connections are allowed.
Please see https://chromedriver.chromium.org/security-considerations for suggestions on keeping ChromeDriver safe.
ChromeDriver was started successfully.
Sep 09, 2021 10:30:00 PM org.openqa.selenium.remote.ProtocolHandshake createSession
INFO: Detected dialect: W3C
PASSED: AutoTestInsReg

=====
Default test
Tests run: 1, Failures: 0, Skips: 0
=====

=====
Default suite
Total tests run: 1, Passes: 1, Failures: 0, Skips: 0
=====

```

Figure 5. 2 Automated test result of the training center registration UI

5.5 User evaluation

The sustainability of the software product is based on the user's experience (UX). At the end of the development, it is important to make ensure the user is the center of every design and development decision that make from the beginning then it will offer an exceptional user experience. Usability testing is a core component to identify the effective user experience design (Praxent, 2019).

To implementing the usability testing for the proposed system, a structured questioner was used to collect end-user feedback. Google form is used to circulate the questioner and obtain user's anonymous feedback and identify whether the project objectives were met based on a set of criteria and some actual testing. This web based examination management system was temporarily hosted on a google cloud-free server to be available to the end-users. This user evaluation main aligns with five categories such as appearance, usability, functionality, performance and security. Further, the Likert scale was used to quantify the end-user feedbacks.

Google form which is used for the feedback was attached in **Appendix A**.

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Table 5. 8 Likert scale

5.6 Evaluation results

User feedbacks were collected through the google form and those results were analyzed under five main categories such as appearance, usability, functionality, performance and security. Those analyzes results have been described below with the graphical representation.

5.5.1 Evaluation Results for appearance

To evaluate the appearance of the system, there are five questions were used. Following table 5.9 shows the summary result of the final evaluation. Figure 5.2 shows the graphical representation of the result for more explanation.

	Q1	Q2	Q3	Q4	Q5	Total	%
Strongly disagree	0	0	0	0	0	0	0
Disagree	0	0	0	0	0	0	0
Neutral	0	0	4	2	0	6	8
Agree	8	12	5	9	10	44	59
Strongly Agree	7	3	6	4	5	25	33

Table 5. 9 User evaluation result under appearance

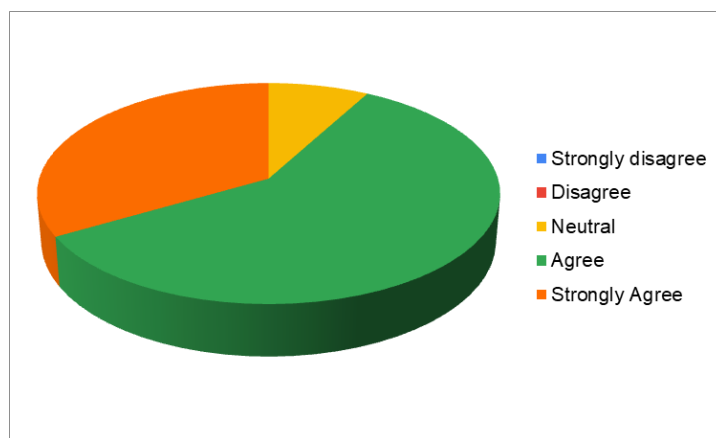


Figure 5. 3 User evaluation result under the appearance

According to the above result, the majority give positive feedbacks for the appearance of the system.

5.5.2 Evaluation Results for usability

The usability of the system was evaluated by using four questions and its summary results were displayed in the Table 5.10. Further figure 5.3 shows the graphical representation of the result for better explanation.

	Q6	Q7	Q8	Q9	Total	%
Strongly disagree	0	0	0	0	0	0
Disagree	0	0	0	0	0	0
Neutral	1	5	2	0	8	13
Agree	11	8	6	8	33	55
Strongly Agree	3	2	7	7	19	32

Table 5. 10 User evaluation result under usability

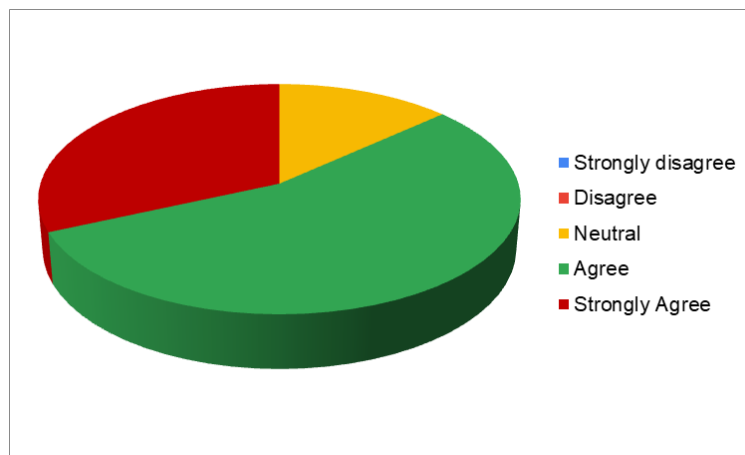


Figure 5. 4 User evaluation result under usability

According to the above result, the majority give positive feedback for the usability of the online EMS system.

5.5.3 Evaluation Results for functionality

The functionality of the system was evaluated by using three questions and its summary results were displayed in the following table 5.11. Further figure 5.4 shows the graphical representation of the result for better explanation.

Functionality	Q10	Q11	Q12	Total	%
Strongly disagree	0	0	0	0	0
Disagree	0	0	0	0	0
Neutral	0	0	2	2	4
Agree	5	4	12	21	47
Strongly Agree	10	11	1	22	49

Table 5. 11 User evaluation result under functionality

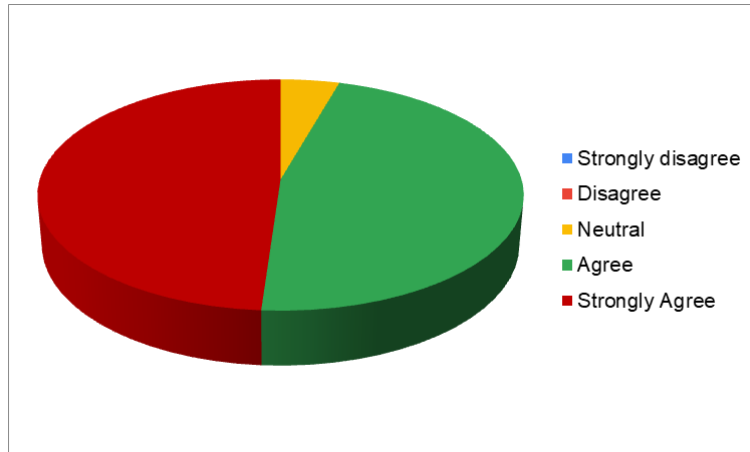


Figure 5. 5 User evaluation result under functionality

According to the above result, the majority give positive feedback for the functionality of the online EMS system.

5.5.4 Evaluation results for performance

The performance of the system was evaluated by using five questions and its summary results were displayed in the following table 5.12. Further figure 5.5 shows the graphical representation of the result for better explanation.

	Q13	Q14	Q15	Q16	Q17	Total	%
Strongly disagree	0	0	0	0	0	0	0
Disagree	0	0	0	0	0	0	0
Neutral	0	0	0	0	1	1	2
Agree	4	7	7	7	6	31	42
Strongly Agree	11	8	8	8	8	43	56

Table 5. 12 User evaluation result under performance

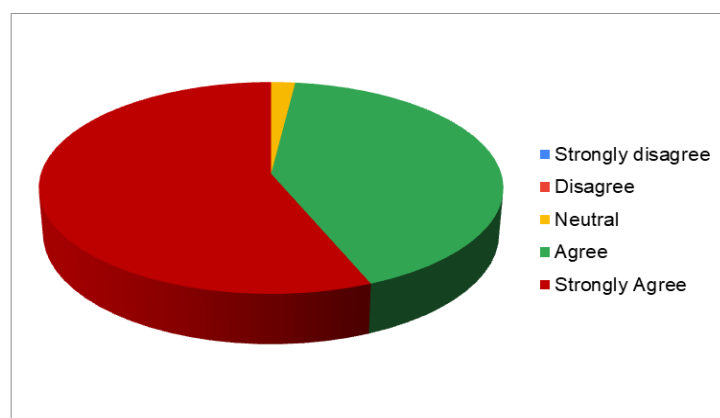


Figure 5. 6 User evaluation result under performance

Based on the above result, the majority of the users give positive feedback for the performance of the online EMS system.

5.5.5 Evaluation results for security

Security of the system was evaluated by using two questions and its summary results were displayed in the following table 5.13. According to the figure 5.6 it shows the graphical representation of the result for better explanation.

	Q18	Q19	Total	%
Strongly disagree	0	0	0	0
Disagree	0	0	0	0
Neutral	0	3	3	10
Agree	1	10	11	37
Strongly Agree	14	2	16	53

Table 5. 13 User evaluation result under security

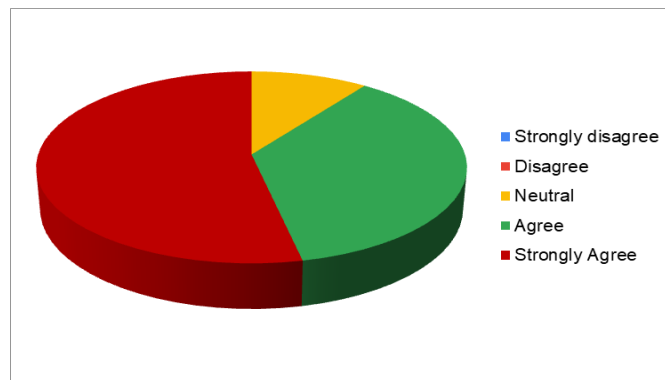


Figure 5. 7 User evaluation result under security

Based on the above result, the majority of the users give positive feedback for the security of the online EMS system.

5.5.6 Final result of the usability evaluation

Table 5.14 displayed the overall responses received in each category. As in the figure 5.7 it shows the graphical representation of the final result of the usability evaluation.

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Appearance	0	0	6	44	25
Usability	0	0	8	33	19
Functionality	0	0	2	21	22
Performance	0	0	1	31	43
Security	0	0	10	37	53

Table 5. 14 Overall usability responses

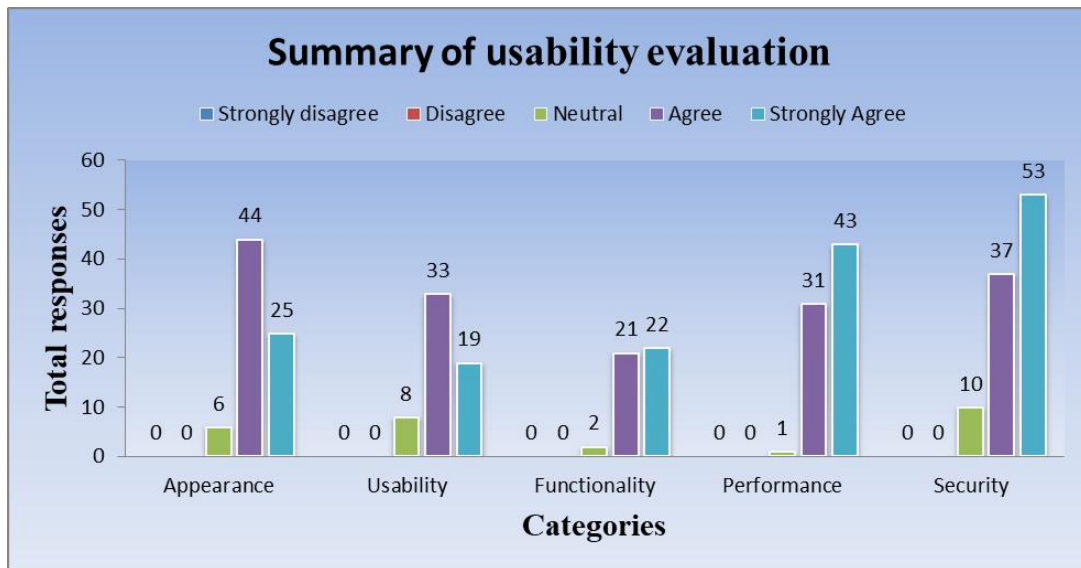


Figure 5. 8 Summary of usability evaluation

5.7 Summary

In this chapter, it was discussed that the different methods which were used to identify the defects of the system and the user experiences of the web based examination management system. This system was tested by login the system and verified the results. After completing those tests and analyzing the user feedback, it was able to produce error-free software.

Chapter 6: Conclusion

6.1 Introduction

This conclusion chapter mainly focused on the achievement of the objectives, lessons learned and give some direction for future development based on the new examination management system development. Further, this chapter will discuss some limitations, challenges faced and ways of overcoming those barriers when developing the system.

6.2 Achievement of the objectives

This web based examination management system was developed for the assessment division of the tertiary and vocational education commission. This system mainly addresses the challenges faced in the manual examination management process, which has found to be tedious, primarily when handling a large number of NVQ candidates in different NVQ courses, and it makes the whole process time-consuming and makes lots of errors. This solution which has been implemented will be much more helpful to both NVQ students and the examination management staff of the TVEC to make their examination process efficiently. This system facilitates registering training centres and their students, creating exam centers and issue admissions, creating examination timetables, recording examination results, and providing an easy way to get reports printed.

In addition to that, it minimized the workload and maximized the efficiency of the examination management process by saving time, effort, resources, money and etc. Then it fulfils the requirement of the assessments division of the TVEC to manage the examination. Newly developed system support to the training providers to register their students and apply for examinations. This system is fully online system then exam management staff able to work from their home as well. Then it will create more flexible working environment for these system users.

This new system facilitates for students to view their basic information by entering their national identity card number into the system.

6.3 Lessons learnt

This whole development helped to gain new knowledge of the technology and software developing experience. When doing the requirements gathering it is essential to handle different types of potential users. It is essential to have good communication with the potential users and work with their level to look through their frame of mind to get the most out of it. In the implementation stage, it was the most complex and most exciting part of this project.

In addition to that, it allowed to use trial and error process when it applies practically and the academic knowledge gained on programming languages such as CodeIgniter, PHP, Java Scripts, CSS, MYSQL and many more development tools and techniques. This project helped to learn about different techniques used for design, coding and try out the many different kinds of patterns to find the solutions. Another important lesson was that developing this kind of new project with the minimum experience should start by making a very simple version. Then extend the solution step by step until it achieves the user requirements. In the testing phase, when the tests fail or a function stops working, it was much easier to find the problem with only changed one thing at a time with some temporary outputs.

6.4 Challenges faced

The proposal development stage had a clear understanding of the examination management manual process and the solution for the manual process. Due to lack of software development experience, it takes more time to search several websites for the most appropriate language and technologies for this project. This initial preparation consumed more time than expected.

When studying similar systems, most of them are commercial products and they were not allowed to access the system. It was limited to read the features of the system without accessing it.

The CodeIgniter PHP framework is used for this development by analyzing the technologies and MYSQL is used as the database application. It took time to learn CodeIgniter and it was affected by the project delivery timeline.

In addition to that, some people were not very much familiar with modern IT technology in the government sector. This lack of knowledge was the barrier to developing and introducing a new IT-based solution and replaces their manual work. To overcome this barrier, it required to find a way to improve their IT-related skills and provide proper system training.

6.5 Future enhancements

In the future, with the technology improvement, this system should be enhanced according to the new technology and give more concern to security factors. In addition to that, when the student did not complete all the modules, the student should have facility to request Record of Achievement (ROA) certificate, and the system should be developed to print ROA certificate. In a further enhancement, it should be considered to give a login facility to students to update their basic profiles. Then it helps to keep student information up-to-date.

In the current system, there is no SMS and online payment facility. In future development, those features should incorporate into the project scope. Using these enhancements by adding more functions to the system, the goal is to develop a more efficient and more reliable system in future.

References

Anand Butani (2020), *5 essential patterns of software architecture* [Online], Available at <https://www.redhat.com/architect/5-essential-patterns-software-architecture> (Access: 10 March 2021)

Applyonlineform.com (2021), *Exam Management System | Online Examination Management Company* [Online], Available at <https://www.applyonlineform.com> (Accessed: 14 January 2021).

Belmonttech.net (2018), *Examination Management Solutions* [Online], Available at <https://belmonttech.net/examination-management-solutions/> (Accessed: 20 May 2021)

CodeIgniter.com (2021), *CodeIgniter Web Framework* [Online], Available at <https://www.CodeIgniter.com> (Accessed: 12 December 2020).

Creatrixcampus.com (2021), *Examination Management Software System* [Online], Available at <https://www.creatrixcampus.com/examination-management-system> (Accessed: 12 January 2021).

Databee.com.au (2021), *Databee Exams Manager* [Online] Available at <https://databee.com.au/examsmanager> (Accessed: 17 January 2021).

Deskera (2008), *Examination Management* [Online], Available at <https://www.deskera.com/lms/examination-management> (Accessed: 6 January 2021).

Didacus Odhiambo (2018), *System Design in Software Development* [Online], Available at <https://medium.com/the-andela-way/system-design-in-software-development-f360ce6fcbb9> (Accessed: 8 May 2021).

Fedena.com (2021), *Exam Management System | Manage Exam & Gradebook* [Online], Available at <https://fedena.com/feature-tour/exam-management-system> (Accessed: 12 January 2021).

Guru99.com (2020), *Cloud Computing Tutorial For Beginners: What Is & Architecture* [Online], available at <https://www.guru99.com/cloud-computing-for-beginners.html> (Accessed: 17 January 2021).

Guru99.com (2021), *UML Class Diagram Tutorial with Examples* [Online], Available at <https://www.guru99.com/uml-class-diagram.html> (Access: 17 February 2021)

Hanna F (2021), *A Comparative Study Of WAMP Vs XAMPP: Which Is The Best Suitable Local Server For Web Development?* [Online], Available at <https://www.temok.com/blog/wamp-vs-xampp> (Accessed: 17 December 2020).

Hostinger Tutorials (2021), *What Is Apache? An In-Depth Overview Of Apache Web Server* [Online], Available at <https://www.hostinger.com/tutorials/what-is-apache> (Accessed: 3 January 2021).

Hosting. S. (2021), *What Is SQL And Mysql* [Online], Available at <https://www.siteground.com/tutorials/php-mysql/mysql> (Accessed: 9 January 2021).

merittrac.com (2021), *End-to-End Examination Management System* [Online], Available at <https://www.merittrac.com/exam-administration> (Accessed: 28 May 2021).

mettl.com (2021), *All-In-One Online Examination Management System* [Online], Available at <https://mettl.com/en/examination-management-system/> (Accessed: 24 May 2021).

Myvirtualx.com (2021), *Assessment Software | Online Examination Tool | Homework Management System* [Online], Available at <https://myvirtualx.com> (Accessed: 16 January 2021).

National Education Commission (2018), *National Policy on Technical and Vocational Education*. 1st edn. Colombo: NEC.

Neha, .T (2020), *Incremental Development Model* [Online], Available at <https://binaryterms.com/incremental-development-model.html> (Accessed: 10 February 2021)

Praxent,(2019), *Why do Usability Testing? 4 Reasons to Make It a Priority* [Online], Available at <https://praxent.com/blog/usability-testing-4-reasons-top-priority> (Accessed: 10 June 2021)

Rajkumar (2021), *What Is Software Testing | Everything You Should Know* [Online], Available at <https://www.softwaretestingmaterial.com/software-testing/> (Accessed: 10 June 2021)

softwareideas.net (2021), *What is Entity-Relationship Diagram (ERD)?* [Online], Available at <https://www.softwareideas.net/what-is-erd-diagram-in-data-modeling> (Accessed: 25 February 2021)

Shreya Bose (2021), *Automation Testing Tutorial: Getting Started* [Online], Available at <https://www.browserstack.com/guide/automation-testing-tutorial> (Accessed: 01 September 2021).

Swifthcm.com (2021), *Exam Management System* [Online], Available at <https://www.swifthcm.com/exam-management-system/> (Accessed: 16 January 2021).

tutorialspoint.com (2021), *UML - Use Case Diagrams*, *tutorialspoint.com* [Online], Available at https://www.tutorialspoint.com/uml/uml_use_case_diagram.htm (Accessed: 17 February 2021)

TVEC (2009), *National Vocational Qualifications Framework of Sri Lanka*. 2nd edn. Colombo: TVEC.

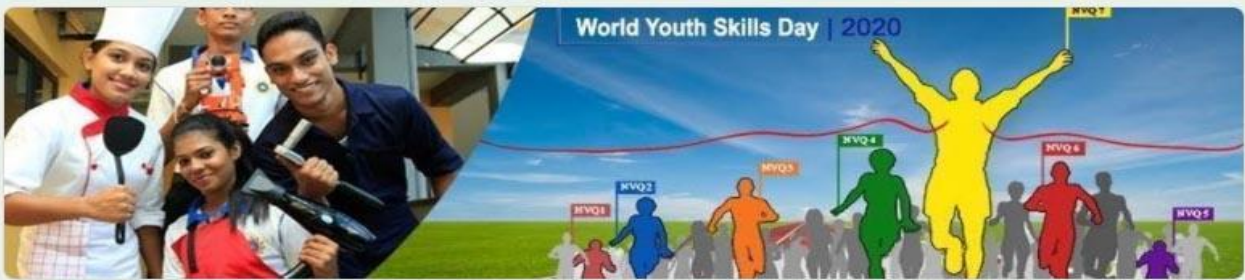
w3computing.com (2021), *Security Concerns for Traditional and Web-Based Systems* [Online], Available at <https://www.w3computing.com/systemsanalysis/security-concerns-traditional-web-based-systems/> (Access: 08 May 2021)

W3schools.in (2020), *What Is MVC Architecture?* [Online], Available at <https://www.w3schools.in/mvc-architecture/> (Accessed: 20 December 2020).

W3.org (2021), *HTML & CSS, W3C* [Online], Available at [https://www.w3.org/standards/web-design/htmlcss.html#:~:text=HTML%20\(the%20Hypertext%20Markup%20Language,for%20a%20variety%20of%20devices](https://www.w3.org/standards/web-design/htmlcss.html#:~:text=HTML%20(the%20Hypertext%20Markup%20Language,for%20a%20variety%20of%20devices) (Accessed: 13 December 2020).

WhatIs.com (2021), *What Is Bootstrap? - Definition From* [Online], Available at <https://whatis.techtarget.com/definition/bootstrap> (Access: 18 January 2021).

Appendix A – Usability evaluation questionnaire



Web based Examination Management System (EMS)

Software Evaluation form. Please fill the following questioner by accessing the EMS

Appearance

Description (optional)

Q1) Interface of this system is pleasant for me *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Q2) It is easy to find the information *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Q3) I like color combination *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Q4 Font size, face and color are readable *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Q5) It is essay to navigate the menu bar *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Usability

Description (optional)

Q6) Interfaces are user-friendly *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Q7) This system is easy to learn *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Q8) I am able to find links easily *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Q9) Clearly display the error messages *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Functionality

Description (optional)

Q10) It is easy to register training institutes *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Q11) It is easy to register Students *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Q12) It is easy to assign students to the examination in module wise *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Performance

Description (optional)

Q13) Index page was load with very short time *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Q14) It is fetch the details quickly on the website *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Q15) It save data without taking too long time. *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Q16) Validate of data is accurate *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Q17) Always display accurate information *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Security

Description (optional)

Q18) I cannot access without my user credentials *

*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Q19) I like auto logout in ideal times *

*

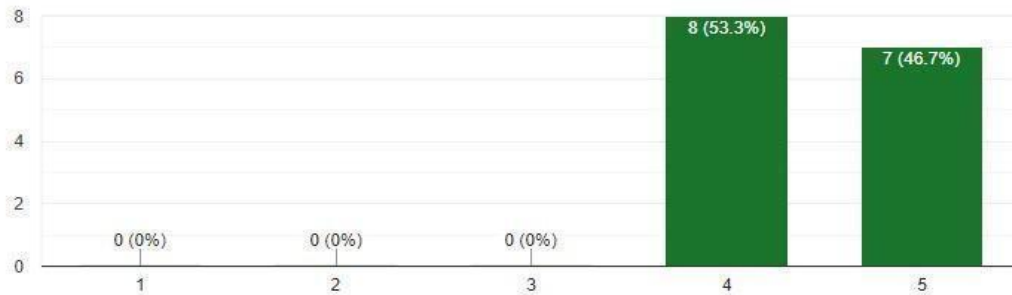
	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Appendix B – Response for questionnaire

Appearance

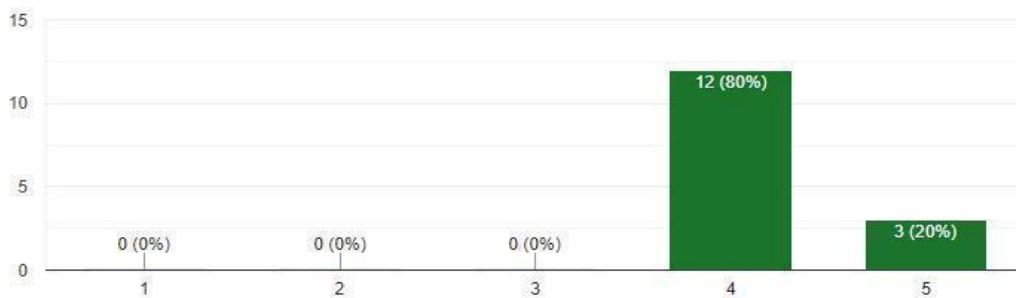
Q1) Interface of this system is pleasant for me

15 responses



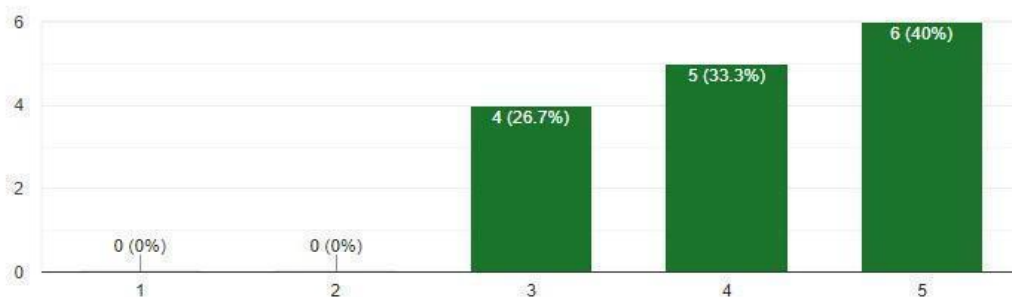
Q2) It is easy to find the information

15 responses



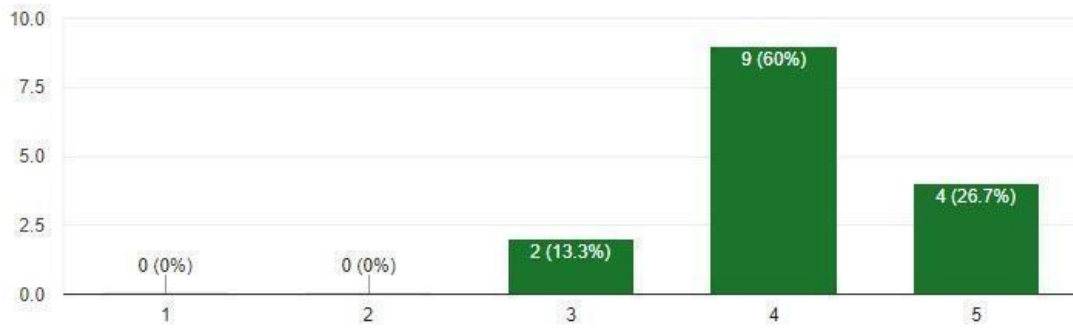
Q3) I like color combination

15 responses



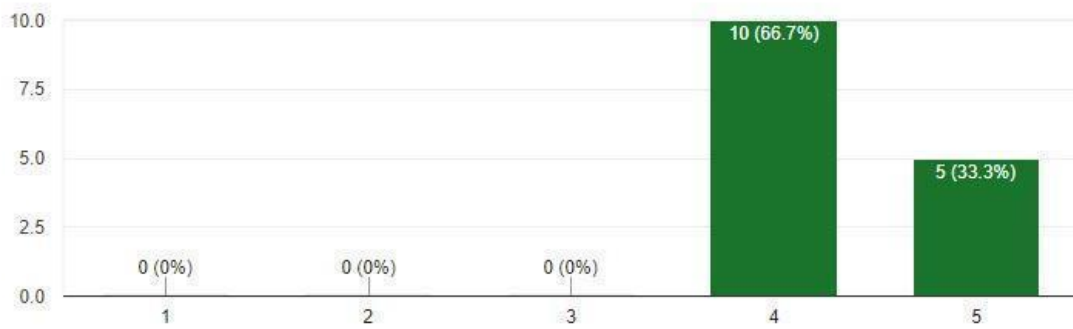
Q4 Font size, face and color are readable

15 responses



Q5) It is essay to navigate the menu bar

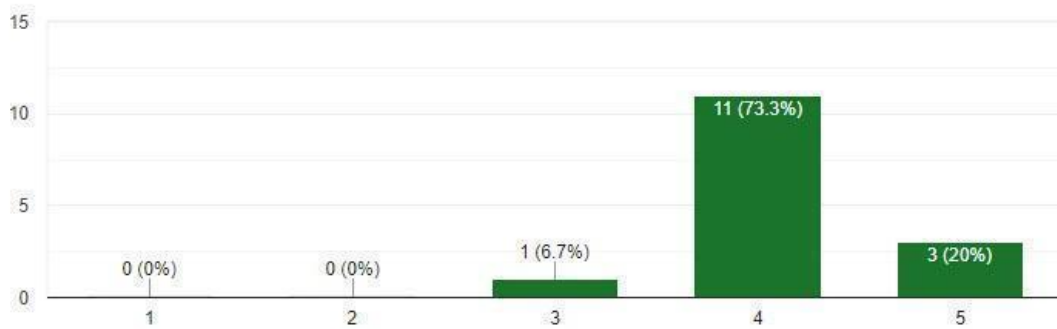
15 responses



Usability

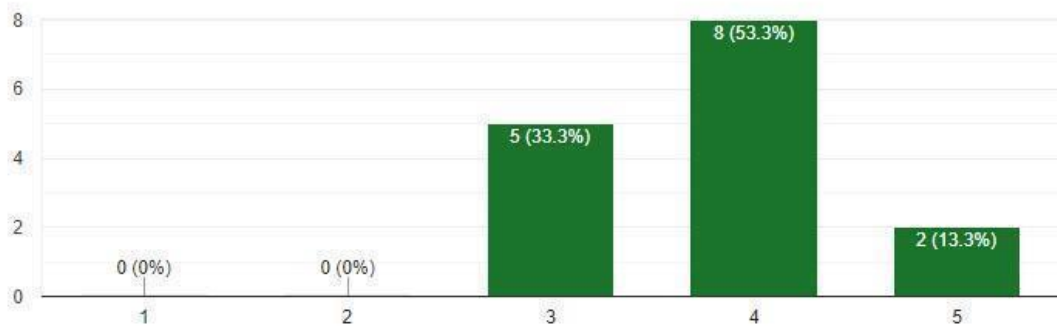
Q6) Interfaces are user-friendly

15 responses



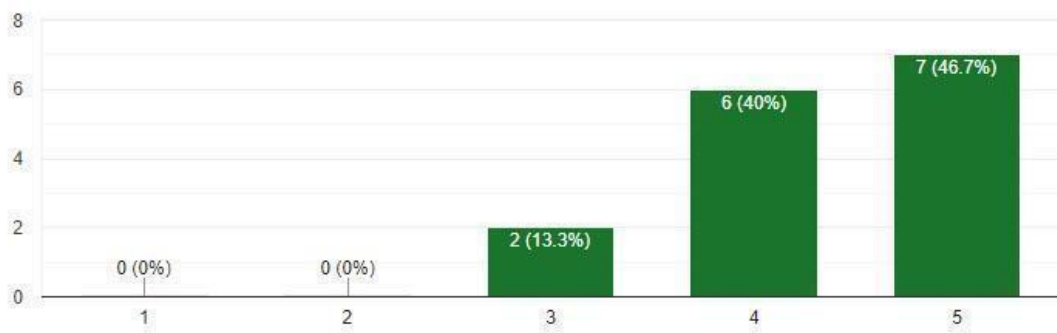
Q7) This system is easy to learn

15 responses



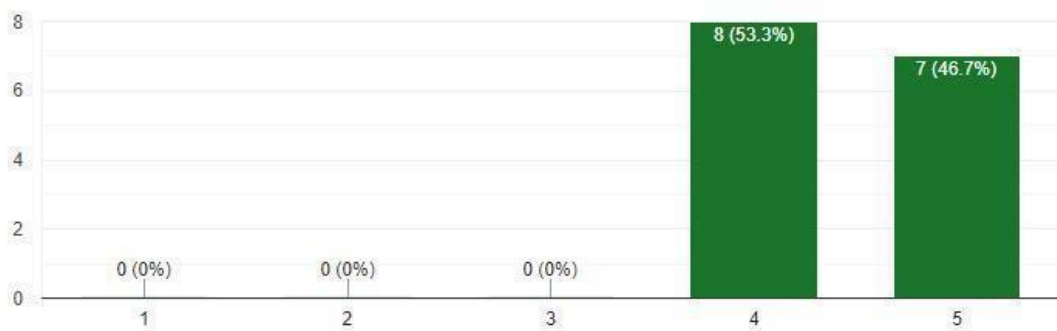
Q8) I am able to find links easily

15 responses



Q9) Clearly display the error messages

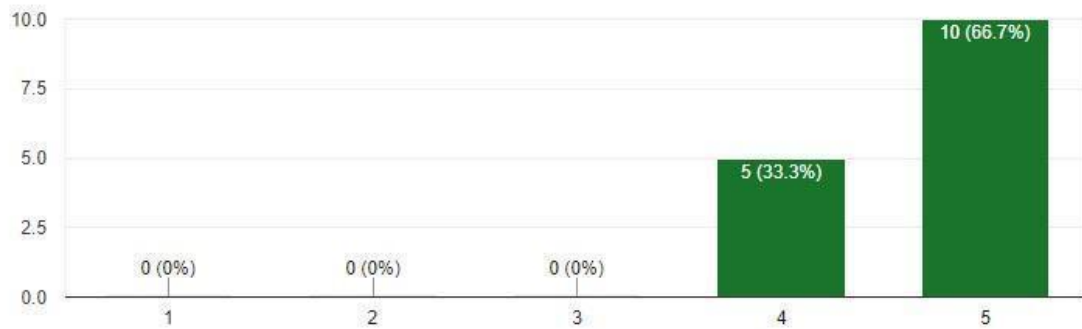
15 responses



Functionality

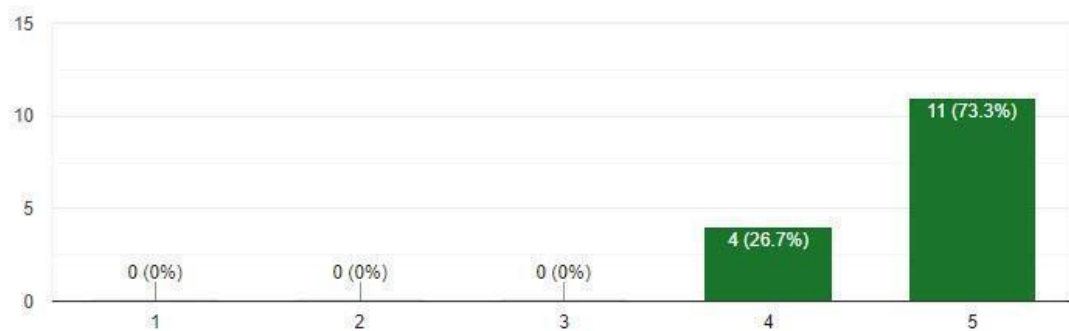
Q10) It is easy to register training institutes

15 responses



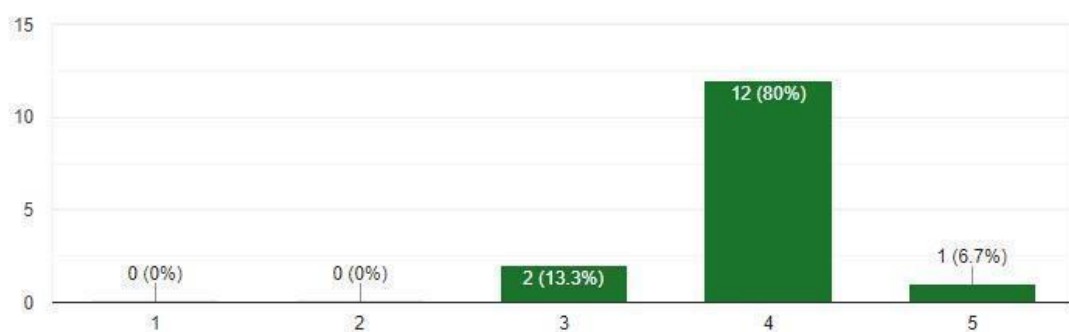
Q11) It is easy to register Students

15 responses



Q12) It is easy to assign students to the examination in module wise

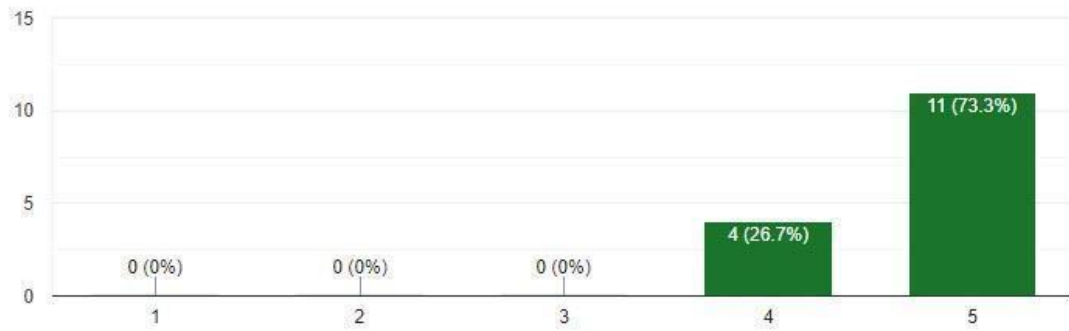
15 responses



Performance

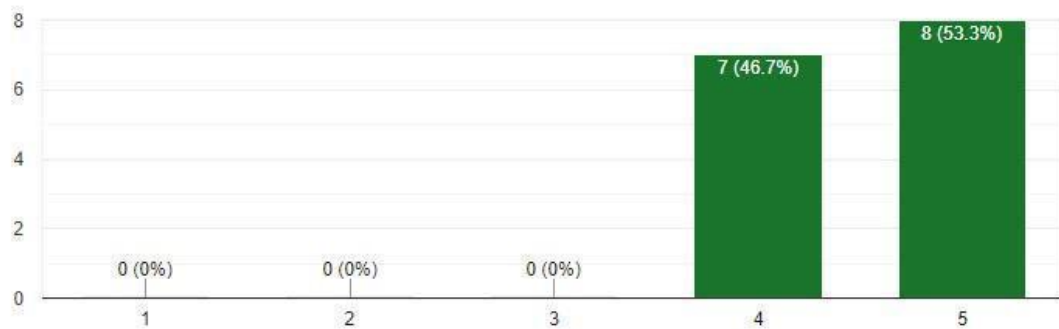
Q13) Index page was load with very short time

15 responses



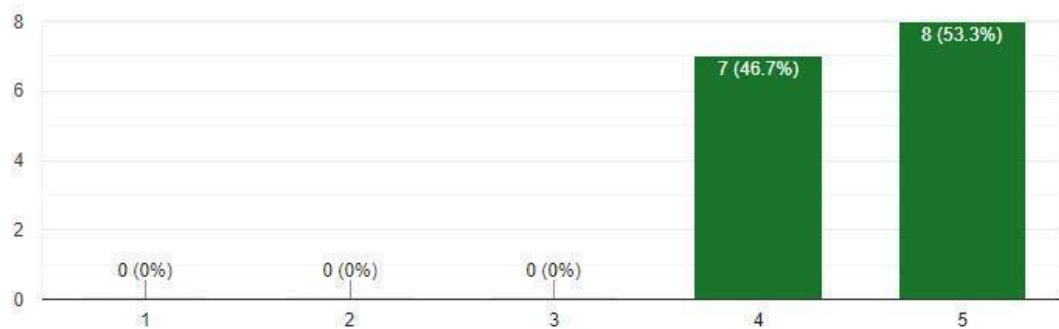
Q14) It is fetch the details quickly on the website

15 responses



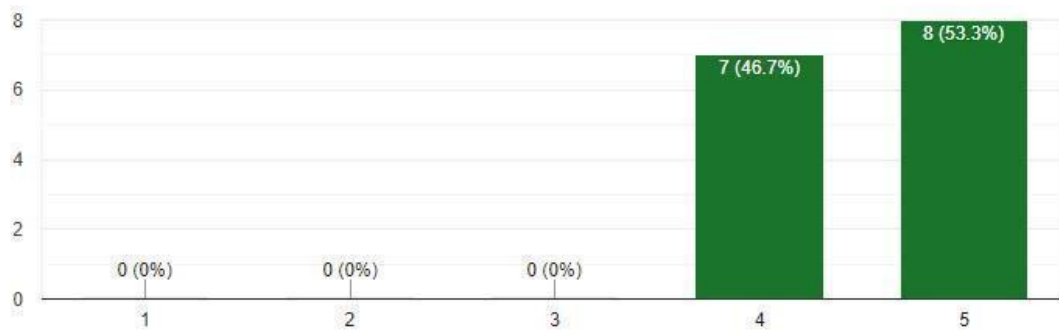
Q15) It save data without taking too long time.

15 responses



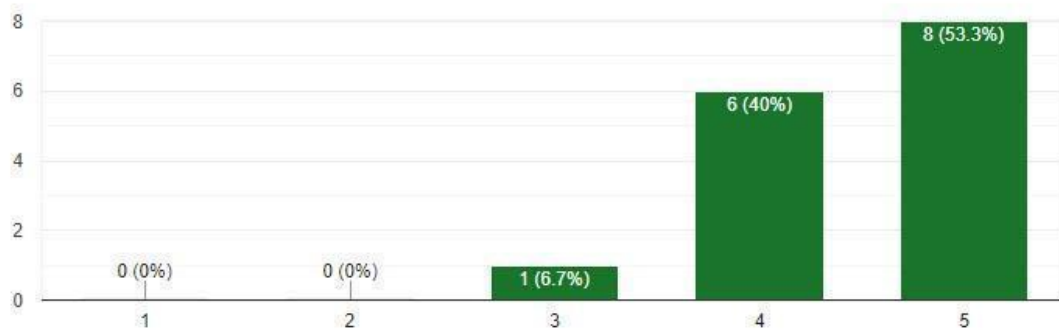
Q16) Validate of data is accurate

15 responses



Q17) Always display accurate information

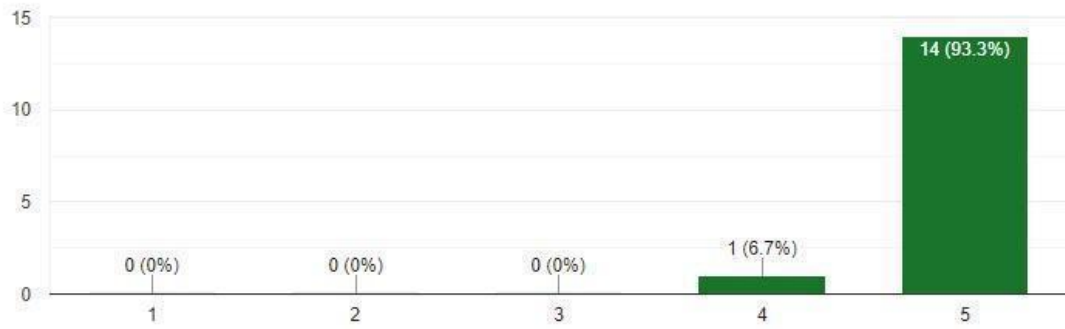
15 responses



Security

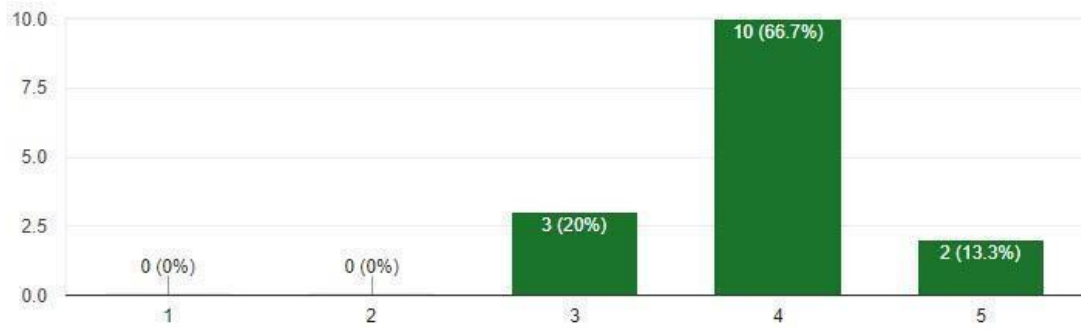
Q18) I cannot access without my user credentials

15 responses



Q19) I like auto logout in ideal times

15 responses



Appendix C - System manual

This examination management system (EMS) was developed based on web technology and used a PHP framework called "CodeIgniter". Therefore it is essential to set up the webserver with other requirements to install the EMS.

Web service requirements

Following software with their supporting versions are used to set up the web service environment.

- Apache/2.4.47
- MySQL 5.0
- PHP Version 7.3.28

For Microsoft Windows, XAMPP Version: 7.3.28 can be used to set up the web environment with all necessary supporting software.

Following figure Appendix C.1, shows the main controlled panel of the active XAMPP software.

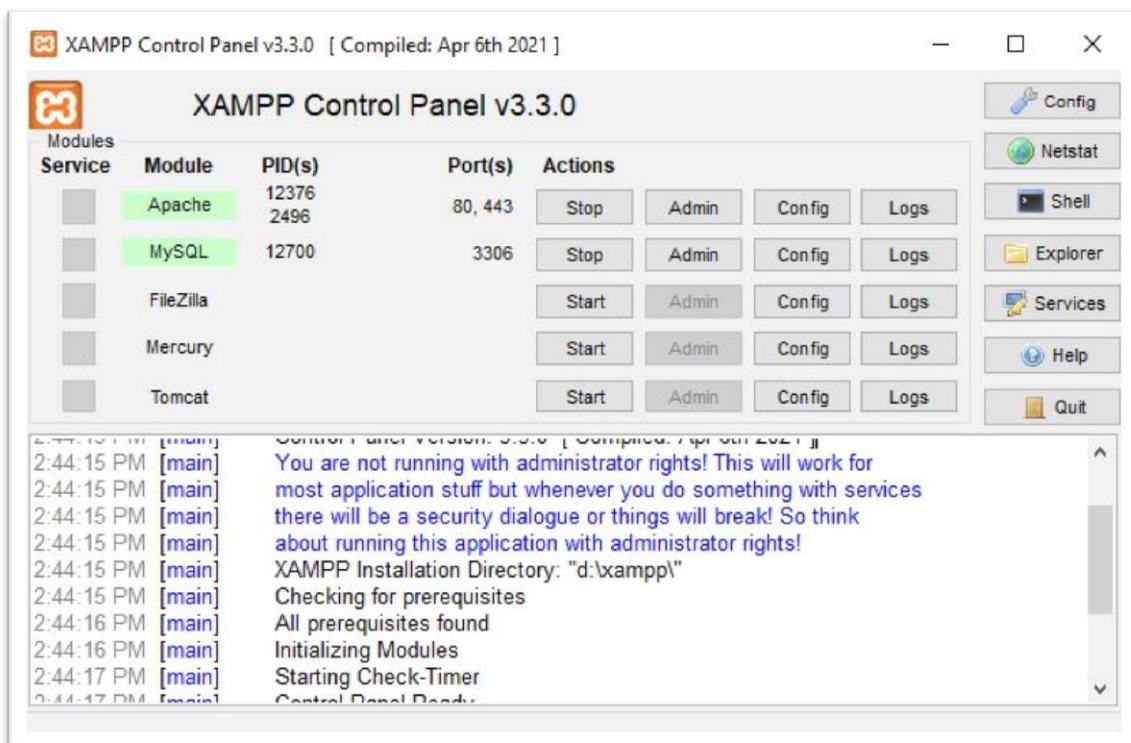
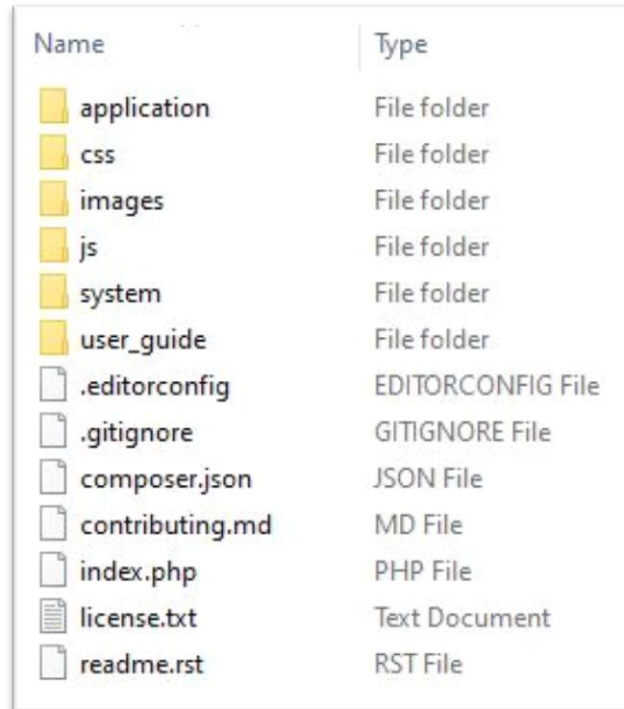


Figure Appendix C.1

Installation steps

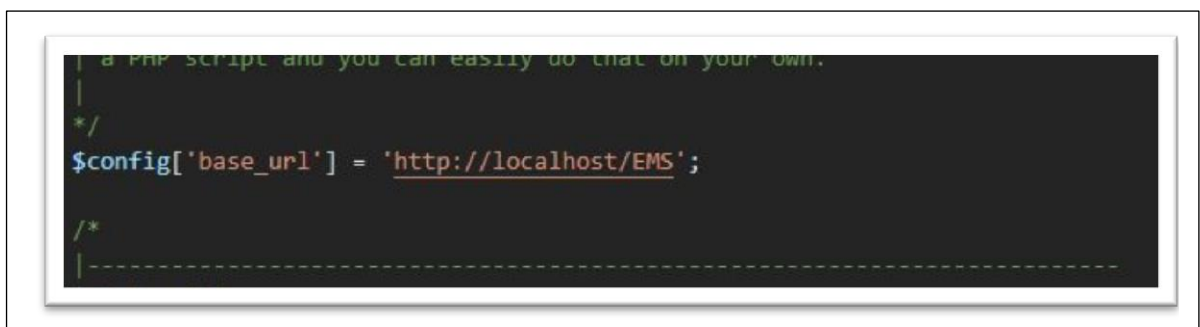
1. After completing the web server setup and should be confirmed that all the required services are up and running. After that create a database with the name of "exam_db" and import the database backup which
2. is required for the EMS.
3. Create the folder name "EMS" under "\xampp\htdocs\". Copy all the files and folders into the EMS folder. Following figure Appendix C.2, shows the folder structure.



Name	Type
application	File folder
css	File folder
images	File folder
js	File folder
system	File folder
user_guide	File folder
.editorconfig	EDITORCONFIG File
.gitignore	GITIGNORE File
composer.json	JSON File
contributing.md	MD File
index.php	PHP File
license.txt	Text Document
readme.rst	RST File

Figure Appendix C.2

4. To change the base URL or the port number, the "config.php" file which is located at "application/config" should change. Following figure Appendix C.3, shows the configuration.



```
/*
 *
 * a PHP script and you can easily do that on your own.
 */
$config['base_url'] = 'http://localhost/EMS';
/*
 *
 */
```

Figure Appendix C.3

5. Once complete all the steps successfully then the system can be accessed through any updated web browser by using the <http://localhost/EMS/> address.

Re-usable codes

1. CodeIgniter 3, a PHP framework is used for this system development.
2. Bootstrap 4.2.1 is used to create device responsive web pages. The following link is used to access the CSS file of Bootstrap.
<https://stackpath.bootstrapcdn.com/bootstrap/4.2.1/css/bootstrap.min.css>
3. The following link is used to get Icons which are for the side menu bar.
<https://unpkg.com/boxicons@2.0.7/css/boxicons.min.css>
4. To create google charts, the following link is used.
<https://www.gstatic.com/charts/loader.js>
5. To generate PDF, TCPDF free software is used. TCPDF is added as the helpers.

To access all these above links, there should have a good internet link. Otherwise, those operations may not be visible.

Appendix D - User manual

1. To access the system, type the link **http://localhost/EMS/** in the web browser and you will see the following main screen shows in figure D.1



Figure D.1: Main page

- Without login registered student can view their basic information by using NIC.
2. To login to the system, click on the "Login" link at the top of the right corner. Then you get the following screen to enter your user credentials.



Figure D.2: Main page

- Once you successfully login to the system, you see the main dashboard with the side menu bar. The side menu bar gives access to the main functions.

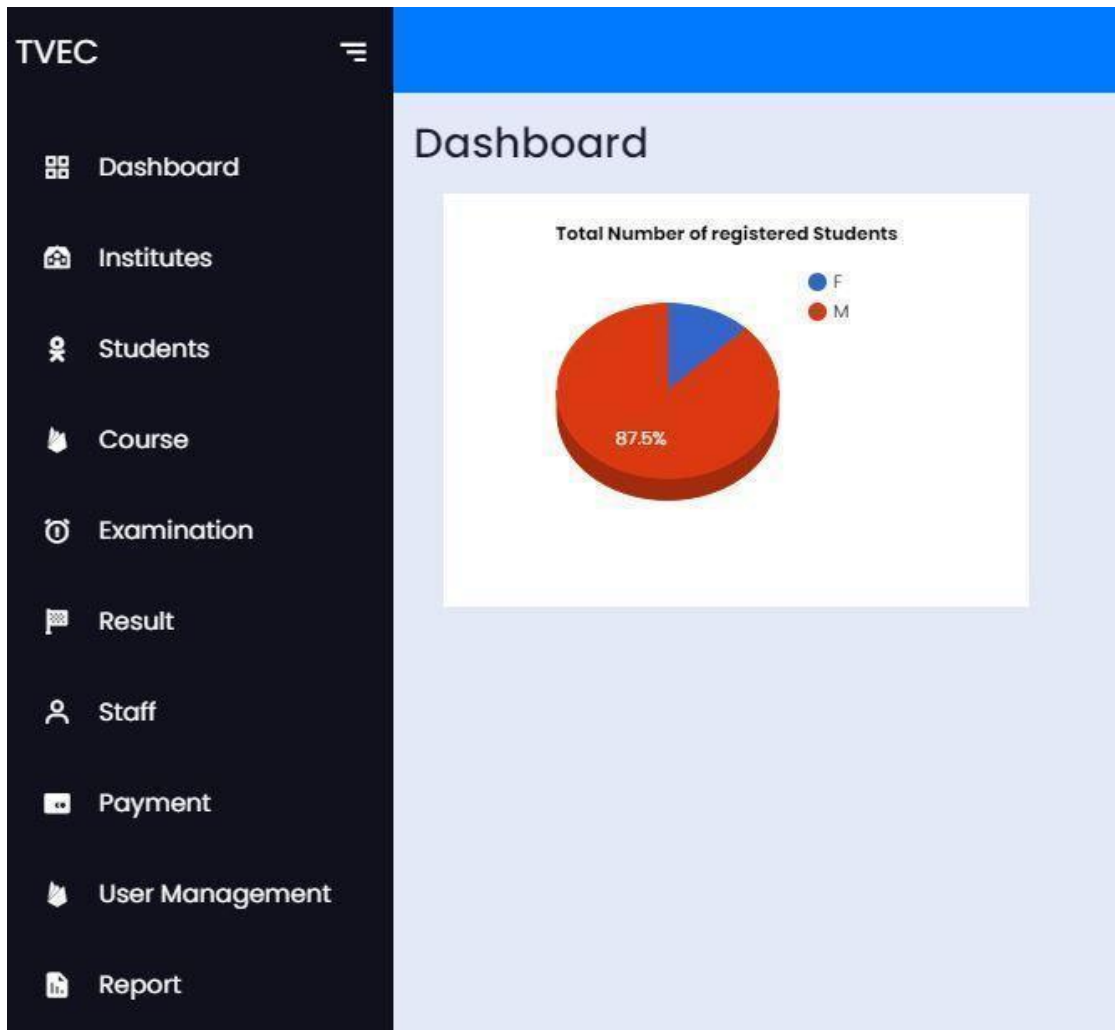


Figure D.2: Main control page

- To manage the training center, click on the link called “Institute”. Then you see the following screen and it allows managing the training centers.

Registration No	Name	Address	District	Email	Contact No	Action
P01/0023	SOFT IT training	354/2, Elvitigala Mw, Narahenpita	Colombo	chammika@tvec.gov.lk	117608008	[Edit] [Delete]
P01/0026	IT center	Kiribathgoda	Gampaha	ICT@gmail.com	76989823	[Edit] [Delete]
P01/0028	Creative Info	Kadawatha	Gampaha	info@ict.lrg	775896325	[Edit] [Delete]
P08/0258	Vocational training center	No.45, Peradeniyay road, Peradeniya	Kandy	vtcKandy@gmail.com	822659869	[Edit] [Delete]

Figure D.3: Manage training centers

- To add the new training center, click on the "Add New Training Center" button. Then you will see the following page to register the new center.

Figure D.4: Register training center

- The second link called "Student" is used to add, update and delete students.
- The "Course" link is used to register the course and add modules to the course. When you click on the "Course" link you will see the following screen.

Manage Courses and modules

[Add Course](#) [Module](#)

Course Code	Course Name	Version	Action
G50T001	Automobile Technology	0	Module  
F45T007	Building Construction Technology	0	Module  
F45T004	Building Service Technology	0	Module  
F45T001	Construction Technology	0	Module  

Figure D.5: Manage course and modules

- Once you complete the training center registration and their student registration. Then you can click on the "Examination" link to create an exam and assign those students to the examination, assign exam centers, add results, download admission, issue index numbers, add time table and download time table. The following page will be displayed when you click on the "Examination" link.

Manage Examination

[Create New Exam](#)
[Exam Center](#)

Level	Sem.	Year	App. Start	App. Closed	Exam Start	Exam Closed	Status
5	2	2021	2021-06-30	2021-07-08	2021-07-31	2021-08-07	Students Index No Timetable Download Timetable
6	2	2019	2021-06-25	2021-07-02	2021-07-09	2021-07-10	Students Index No Timetable Download Timetable

Figure D.6: Manage examination

9. Once you set the exam date and the exam centers, then you can click on the "student" to assign a student to the exam, exam centers, mark attendance and download admissions. The following page will appear when you click on the "Student" link

Manage Examination / Assign Student to Exam

Assign Student to Exam

Select Training Center

No Selected

Select Course

No Selected

[Assign Student](#)
[Assign Exam Center](#)
[Student Attendance](#)
[Download Admission](#)
[Reset](#)
[Close](#)

Figure D.7: Assign student to exam

10. To add the exam timetable, you gave to click the "Timetable" link in figure D.6: manage examinations. Then you will see the following page to add timetables.

[Back](#)

Select Course

No Selected

Select Module

No Selected

Date & Time

mm/dd/yyyy --:-- --

Date & Time

mm/dd/yyyy --:-- --

[Save](#)
[Reset](#)

Course	Module	Date	Start Time	End Time	Action
Cosmetology	Collect requirement, analyse and document the	26-Aug-2021	08:38 PM	01:00 AM	

Figure D.8: Add timetables

11. Once you create the timetables, you can download them as PDF documents by clicking the link "Download Timetable" in figure D.6: manage examinations.
12. After completing the examination, student and module wise results can be entered into the system by using the "Result" link. When you click the result link you will see the following web page.

Examination Result

Level	Semester	Year	Exam Start	Exam Closed	Status
5	2	2021	2021-07-31	2021-08-07	Add Result
6	2	2019	2021-07-09	2021-07-10	Add Result

Figure D.9: Examination results

13. When you click on the "Add Result" button, then you see the following screen to select the training center, course, and module. After that, you can click on the "Student Result" button to enter results.

Examination Result / Manage Results

Manage Results

Select Training Center

No Selected

Select Course

No Selected

Select Module

No Selected

[Student Result](#) [Reset](#) [Close](#)

Figure D.10: Examination Results

14. Staff is used to register staff as invigilators, paper setters, papermakers and others. A payment link is used to add exam centre payments.
15. Link called "User Management" is used to manage system users such as create user id and passwords, add and update user roles.
16. Finally "Report" menu is used to generate different reports.

Appendix E - Management information reports

Following figure E.1 shows the total number of students based on the district and course.



 TERTIARY & VOCATIONAL EDUCATION COMMISSION  COMMON EXAMINATION - NVQ LEVEL 5		
Number of Students in District and Course		
Course Name	District	No. of Student
Cosmetology	Colombo	7
Cosmetology	Kurunegala	11
Information and Communication Technology	Colombo	6
Information and Communication Technology	Gampaha	7

Figure E.1: Total number of students based on district and course

Following figure E.1 shows result sheet based on training center, course and module.





 TERTIARY & VOCATIONAL EDUCATION COMMISSION  COMMON EXAMINATION - NVQ LEVEL 5	
Examination Result	
Training Center : Soft IT training	
Course : Information and Communication Technology	
Module : Database Systems 1	
Student Name	Marks
M. H. M. Shashika Rasanjalee Padmasiri	50
Hamda Haileel	55
A.M.A.L Aththanayake	35

Figure E.1: student result sheet in module wise

Following figure E.1 shows the time table for one course.



TERTIARY & VOCATIONAL EDUCATION COMMISSION



COMMON EXAMINATION - NVQ LEVEL 5

Common Examination - NVQ Level5 - Semester 1 - (2021)

Time Table

Cosmetology

Module Code	Name of the Module	Date	Time
O93C001M01	Introduction to professional cosmetology and ethics	04-Dec-2021	01:00 PM - 03:00 PM
O93C001M02	Health, safety and First aid in cosmetology services	05-Dec-2021	01:00 PM - 04:00 PM
O93C001M03	Nutrition, diet and exercise related to cosmetology	06-Dec-2021	01:00 PM - 04:00 PM
O93C001M05	Cosmetics products for skin, nail and hair services	07-Dec-2021	01:00 PM - 04:00 PM
O93C001M06	Advance skin care	08-Dec-2021	01:00 PM - 04:00 PM

Figure E.1: Cosmetology time table

Appendix F – Automated testing

1. Source code used for login function testing – unit testing

```
public function userLogin(){  
    //Load unit test library in the Codeigniter  
    $this->load->library('unit_test');  
  
    $this->form_validation->set_rules('Username','Username','required');  
    $this->form_validation->set_rules('Password','Password','required');  
  
    if($this->form_validation->run()===FALSE){  
        $this->load->view('login_view');  
    }  
    else{  
        //Set the parameters to the unit test  
        $expected_result=true;  
        $test_name='Login function testing';  
        $note='Unit test using CodeIgniter unit_test library';  
  
        $this->load->model('login_model');  
        $result=$this->login_model->Loginadmin();  
  
        //Run the unit test and print the result  
        echo "<b>CodeIgniter: Unit Testing Class</b>";  
        $this->unit->run($result,$expected_result,$test_name,$note);  
        echo $this->unit->report();  
        die();  
  
        if($result != false){
```

```

$admin_data=array(

    'User_ID '=>$result->User_ID ,
    'TC_ID'=>$result->TC_ID,
    'STF_ID'=>$result->STF_ID,

        'Username'=>$result->Username,
        'Password'=>$result->Password,
        'Availability'=>$result->Availability,

    'loggedin'=>TRUE
);
$this->session->set_userdata($admin_data);
$this->session->set_flashdata('welcome','Welcome to the Admin panel');
redirect ('Admin_Controller/log_admin');

}else{
    $this->session->set_flashdata('error_msg','Username or Password incorrect');
    redirect ('Login_Controller/log_in');
}
}
}

```

2. Source code used for training centre registration form – UI testing

Following Java class is used to implement automated test on training institute registration user interface.

```
package TestAutoRegIns;

import java.util.regex.Pattern;

import java.util.concurrent.TimeUnit;

import org.testng.annotations.*;

import static org.testng.Assert.*;

import org.openqa.selenium.*;

import org.openqa.selenium.chrome.ChromeDriver;

import org.openqa.selenium.support.ui.Select;

public class autoTestInsRegistration {

    private WebDriver driver;

    private String baseUrl;

    private boolean acceptNextAlert = true;

    private StringBuffer verificationErrors = new StringBuffer();

    @BeforeClass(alwaysRun = true)

    public void setUp() throws Exception {

        System.setProperty("webdriver.chrome.driver",

"D:\\JavaProjects\\TestAutoInstRegister\\Libraries\\chromedriver.exe");

        driver = new ChromeDriver();

        baseUrl = "https://www.google.com/";

        driver.manage().timeouts().implicitlyWait(30, TimeUnit.SECONDS);

    }

    @Test

    public void AutoTestInsReg() throws Exception {
```

```

driver.get("http://localhost/EMS/");
driver.findElement(By.xpath("/html/body/div[1]/div[1]/nav/div/ul/li/a")).click();
driver.findElement(By.id("Username")).clear();
driver.findElement(By.id("Username")).sendKeys("admin");
driver.findElement(By.id("Password")).clear();
driver.findElement(By.id("Password")).sendKeys("admin");
driver.findElement(By.xpath("//button[@type='submit']")).click();
driver.findElement(By.xpath("//li[2]/a/i")).click();
driver.findElement(By.xpath("(./*[normalize-space(text()) and normalize-space(.)='Manage
Training institute'])[1]/following::button[1]")).click();
driver.findElement(By.id("Reg_No")).click();
driver.findElement(By.id("Reg_No")).clear();
driver.findElement(By.id("Reg_No")).sendKeys("P09/0137");
driver.findElement(By.id("CenterName")).click();
driver.findElement(By.id("CenterName")).clear();
driver.findElement(By.id("CenterName")).sendKeys("Excel College");
driver.findElement(By.id("PermanentAddress")).click();
driver.findElement(By.id("PermanentAddress")).clear();
driver.findElement(By.id("PermanentAddress")).sendKeys("Excel college, 669, Peradeniya
Road, Kandy");
driver.findElement(By.id("District")).click();
new Select(driver.findElement(By.id("District"))).selectByVisibleText("Kandy");
driver.findElement(By.id("Email")).click();
driver.findElement(By.id("Email")).clear();
driver.findElement(By.id("Email")).sendKeys("scillapperuma@gmail.com");
driver.findElement(By.id("Mobile")).click();
driver.findElement(By.id("Mobile")).clear();
driver.findElement(By.id("Mobile")).sendKeys("8115634206");

```



```

driver.findElement(By.xpath("//button/i")).click();
driver.findElement(By.xpath("//button[3]/i")).click();
}

@AfterClass(alwaysRun = true)
public void tearDown() throws Exception {
    driver.quit();

    String verificationErrorString = verificationErrors.toString();
    if (!"".equals(verificationErrorString)) {
        fail(verificationErrorString);
    }
}

private boolean isElementPresent(By by) {
    try {
        driver.findElement(by);
        return true;
    } catch (NoSuchElementException e) {
        return false;
    }
}

private boolean isAlertPresent() {
    try {
        driver.switchTo().alert();
        return true;
    } catch (NoAlertPresentException e) {
        return false;
    }
}

```

```
    }  
}  
  
private String closeAlertAndGetItsText() {  
    try {  
        Alert alert = driver.switchTo().alert();  
        String alertText = alert.getText();  
        if (acceptNextAlert) {  
            alert.accept();  
        } else {  
            alert.dismiss();  
        }  
        return alertText;  
    } finally {  
        acceptNextAlert = true;  
    }  
}  
}
```