



*In academic
affiliation with*



Smart Training Management System

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BSc (Hons) Computer Science Pathway in Computer Science

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Declaration

This dissertation is being submitted in partial fulfilment of the requirements for the degree of Bachelor of Science (Hons) Business Information System and has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

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Abstract

The Smart Training Management System (STMS) was conceived in response to the coupled growing interest in and demand for an all in one training programs management platform in educational and training institutions. The system allows course creation, course delivery, trainee management, trainee progress tracking, and trainee outcome assessment on the trainer's end while on the users' end, the enrolment, course, and grade views are presented in an easy-to-use interface. The system integrates a number of application software languages including HTML, CSS, JavaScript, PHP, and MySQL and it enhanced features like login and logout, trainer and trainee dashboards, progress tracking and downloading of materials.

As a result, the project followed several phases and was implemented using the agile methodology including regular consultations with the users. Testing strategies such as unit, integration, system and acceptance testing were used to check if the system performed its intended function and was reliable. The design study of the system put different components under test such as trainee enrolment, trainer dashboard and progress of the course to ensure they worked as planned.

Besides the above areas of appreciation, future developments of the system include enhanced analytics tools for the trainers, as well as android and iOS apps. The next challenges to be addressed in future development are scalability, multilingualism and gamification. The STMS not only addresses training needs that are present in the organization but also offers a flexible framework helpful in accommodating future innovations making it an effective tool for promoting learning and development in various sectors.

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CHAPTER: 01

1. INTRODUCTION

1.1 Introduction and Project Background

1.1.1 Overview of the Project

The term Smart Training Management System is an online facilitated innovative system that aims to offer simple, systematic, and openly accessible training solutions for employees as well as students from various spheres. This platform integrated the use of latest inventions in website technologies like JavaScript, HTML, CSS, Bootstrap and PHP for back end, MySQL for database management so as to have high efficiency and flexibility. Through the system, enrolment to courses is possible plus structure chapters, monitoring of learning progression besides downloading material. Students are notified of the achievement after they complete a course. Furthermore, trainers also have their account on the platform where they can develop their own courses and provide their learners an individual approach, generating additional revenue for their efforts. Most of the trainers' integration makes the training environment more interesting and a lot more fun. The project is to increase efficiency in online learning activities, reduce traditional training constraints and enhance organization of the learning environment for both learners and trainers.

1.1.2 Justification of Choosing the Project

In the contemporary digital society, education has become one of the most important aspects of human life, and people turn to online learning solutions to acquire new skills and knowledge. Nevertheless, most of the existing platforms do not have an integrated system, which creates value for both trainees and trainers. The tool breaking this gap is called "Smart Training Management System" and it provides a transparent platform for course, status, and files downloading to make training more transparent. This project was selected because it can help to solve the emerging problem of searching for convenient, adaptive, and highly effective systems for online training. Through further added functionality adding options in trainer's course menu one step at a time and trainee's progress display, the system becomes more versatile meeting new needs in educational and corporate world. It also relates to the approaches of the developer

to web development and applies the technologies that have been learned during the course to real-world issues in training management.

1.2 Statement of the Problem

There is scarcity of time to arrange effective and well-designed training programs for the staff and other individuals. Many of the conventional approaches to training result in inflexible learning, it is not easy to access, and it does not allow for individual training, putting challenges to both the trainees and trainers in place. In addition, most training processes, including course development, progress monitoring, and document exchange, are difficult to navigate and involve a significant amount of time when there is no centralized framework in place. On the other hand, trainers are also challenged with the inability to share their courses with a larger audience, teaching delivery which is combined with course administration. Such solutions typically lack the unified application that is required for satisfying the needs of both the buyer and the seller. These problems are solved by the “Smart Training Management System” which enrolls the trainees for the course, lets them monitor their progress and download the course materials while making the process of course creation and management easier for trainers. This system offsets the trainers and trainees while guaranteeing the best training system that can be implemented.

1.3 Objectives of the Project

1.3.1 General Objectives

The goal of the “Smart Training Management System” is to develop intelligent, simple, and centralized approach for successful delivery of online training. This system will try to create a very fine learning environment for the trainees and at the same time would allow the trainers to control and disseminate the courses.

1.3.2 Specific Objectives

- In order to create a web based structure where all the employees and students of the institution can sign up for different courses of their interest in many disciplines.
- To modify changes and control over content upload and tracking the learner progress.
- To offer services touching on personal progress, course completion notifications, and performance evaluations of the trainees.

- For efficiency in downloading course content to allow student flexibility in their learning process.
- In order to implement the concept of secure login/logout solutions which would allow trainees and trainers to manage the users' information effectively.
- For better and easier payment methods for trainers who can also earn through their efforts here.
- For the scalability and efficiency purpose such latest technologies have been used like JavaScript, HTML, CSS, PHP and MySQL.

1.4 Scope of the Project

The application of the management system referred to as “Smart Training Management System” involves creating an effective online platform that will satisfy both trainees and trainers. It is designed to be an integrated environment for the administration of online courses where users can register for different training offered in a plethora of fields, monitor their course progress and learning materials. It is intended that the platform will encompass numerous categories of training to accommodate the variability of the industries and training requirements. For trainees, one can enrol, monitor the progress, download and also get notifications on completion of the training. They are able to engage content in a more organized way and be subjected to constant performance evaluation. In regard to trainers, it allows them to create courses, upload trainer and content related material, and manage courses. Moreover, trainers can check pervasive student activity and appraise the performance of students. The platform also has integrated payment possibilities guaranteeing that trainers can generate revenue from the lessons they conduct. It will be developed by using today's web development technologies: frontend – JavaScript, HTML, CSS, Bootstrap; backend – PHP, MySQL. The platform is expandable and easily modifiable for future enhancements and the addition of new components of the learning process, for example, discussion boards or multi-media facilities. In conclusion, the project gives them essential features that will help them minimize time to complete the training needs of trainees while at the same time making it easier for the trainers.

1.5 Project Plan

1.5.1 Project Deliverables and Milestones with Timescale (Gantt chart)



Figure 01: Project Deliverables and Milestones with Timescale (GANTT Chart)

1.5.2. An Investigation Plan

Table 01: Investigation Plan

Task	Objective	Start Date	End Date
Search similar project	Checking other systems functionalities, performance	07 Jan 2024	10 Jan 2024
Search journals/articles/blogs/websites	To see what other professionals say about similar projects	11 Jan 2024	17 Jan 2024
Discover related processes	To understand program processes and workflows	18 Jan 2024	20 Jan 2024
Interview stakeholders (teacher)	To gather information and ideas from teachers	22 Jan 2024	23 Jan 2024
Interview stakeholders (student)	To understand student opinions and gather solutions	24 Jan 2024	25 Jan 2024

1.5.3. A Development Plan

Table 02: Development Plan

Task	Objective	Start Date	End Date
Training on programming languages	To gain skills and knowledge in programming languages	01 Feb 2024	14 Feb 2024
Designing the system architecture	To create a blueprint for the system's structure	15 Feb 2024	22 Feb 2024
Coding	To develop the program and user interface	23 Feb 2024	30 Mar 2024
Unit testing	To verify individual components for correctness	01 Apr 2024	05 Apr 2024
Integrating components	To ensure all parts of the system work together	06 Apr 2024	12 Apr 2024
Testing database	To check the connectivity and functionality of the database	13 Apr 2024	15 Apr 2024

1.5.4. Evaluation and Test Plan

Table 03: Evaluation & Test Plan

Task	Objective	Start Date	End Date
Black box test	To check all the functions and facilities are working	16 Apr 2024	22 Apr 2024
Beta testing	To let users test the program and provide feedback	23 Apr 2024	30 Apr 2024
User acceptance testing	To ensure the program meets user requirements and expectations	01 May 2024	07 May 2024
Testing result	To check the program is working well and connected with the database	08 May 2024	10 May 2024

CHAPTER 2

2. Review of Related Literature and Studies

2.1. Literature Review

The following section outlines the theoretical framework as well as the previous research conducted on Smart Training Management Systems (STMS). The literature review section is divided into Theoretical Review and Related Work in terms of STMS, in which basic theories and previous work on systems are discussed. TMS (Training Management Systems) are now the core of training management systems which guarantees productivity and efficiency among the employees. Systems are built to simplify different training types such as planning the course agenda, adding the members to the roster, providing the information, studying the information, and making a report. Training Management Systems (TMS) as part of the contemporary e-learning and development strategies for the organization are providing the most comprehensive tools for managing the training procedures in a just-on-time, efficient, and effective way (Jackson, Wilson and MacCarthy, 2004). This is a group of computer programs and systems, which helps to achieve specific aims of different companies as long as they are from different industries.

In simple terms, centered figures of Training Management Systems are centralized platforms that provide starting points to train all aspects of training programs. Moreover, these systems make distribution schemes easier since organizations can dole out personal skills trainers, facilities, pieces of equipment, etc. to the right person(s) at the right time and place. (Alavi and Leidner, 1999). Scheduling is the responsibility of this TMS in that involves planning and coordination of the training sessions, workshops, and events. These highly organized systems are designed to coordinate training programs that involve creating training sessions, assigning trainers and participants, and scheduling training facilities (Boothby, Dufour and Tang, 2010). Through the automation of manual tasks, efficiency in the use of the resources, and regulatory compliance, TMS allows organizations to increase the quality of training, boost staff performance, and achieve the resultant organizational success. (Jackson, Wilson and MacCarthy, 2004)

2.1.1. Theoretical Review

The Theoretical Review, examines frameworks that facilitate SCM and its components like; LMS, TAM, and the Constructivist Learning Theory, SCT, and SDT. Patel et al., (2020) defines LMS as

fundamental to the delivery of the training system where LMS platforms are widely used to deliver courses, track learners or evaluate their performance. But traditional LMS are rather limited in terms of their ability to provide individualized learning experiences (Liu et al., 2020). STMS is expected to fulfil this need by providing learning paths, feedbacks and real-time analytics to improve learning. Davis (1989) proposed a widely adopted Theory, called Technology Acceptance Model (TAM). TAM postulates that the likelihood of system adoption depends on the two variables: perceived ease of use and perceived usefulness. Learners and instructors strongly benefit from this model by providing design that is usable and valuable to the user in the case of STMS. Stakeholders consider the adoption of STMS technologies proportional to their usability, functionality, and obvious advantages in augmenting learning.

Human Constructivism Learning Theory as relayed by Piaget Construction Learning Theory and Vygotsky Social Constructivism Learning Theory stresses learners as active constructors of learning. How STMS applies this theory? STMS brings interactivity and collaboration and enables learners to apply prior knowledge beyond basic knowledge. Thus, this approach is in line with developing differentiated instruction that is a significant model of STMS. Social Cognitive Theory (SCT) (Bandura, 1986) also plays a major role in the design of STMS for social learning situations. SCT postulates that learners make new knowledge based on what they see from others; thus, STMS integrates group discussions, observed videos and cooperation. These social learning elements are to enhance learner interaction and learning achievements. Causation theories that give understanding to motivation includes the Self Determination Theory (SDT) by Deci & Ryan (2000) focuses on autonomy, competence and relatedness. How, STMS helps to support SDT: STMS enables learners exercise control over what they learn, how they learn it, the challenges they solve, and the feedback they receive to make learning motivating and engaging.

2.1.2. Related Work

This section reviews prior literature and other systems related to STMS, specifically concerning online learning platforms, adaptive learning and game-based learning which forms part of STMS. It had been mainly observed that new generation leaning management systems Coursera, Udemy, and LinkedIn Learning have made their mark in the education field and corporate training. However, as Chen (2021) correctly observed, there are no social elements present in

most of these platforms as they provide a common framework for course structure without considering the learner's progression. STMS builds upon this by adding in the learning maps that adapt to the student, as well as the content that changes to fit the training or learning experience.

McKinsey & Company (2019) pointed that while most of the corporative world learning organizations already have training management systems in place, most of them are stand alone and it is not easy to combine them among other learning and tracking functions. STMS tries to solve this problem by implementing the integrated process solution that manages learning and performance activities as well as provides efficient feedback systems on one customizable platform. Adaptive learning systems, mentioned by Liu et al. (2020), allow for proper content and the speed of learning to be adjusted to learners' requirements. These systems have been demonstrated to increase the learning outcome by offering customized learning environments. Adaptive learning is implemented in STMS where learner advances through the material at the learner's own pace and receives material the learner is best suited to handle, thus making the training to be more effective.

People have been increasingly using games to approach education and learning activities or events. Anderson et al. Knowledge quiz results established that the inclusion of points, badges and leader boards increases user engagement by a great extent. The features of gamification will be incorporated into the STMS for adding the fun aspect into learning so that learners are motivated to complete the learning and improve overall satisfaction which is very important for completion of the material. Feedback in learning environment is well understood. Kember et al (2020) has stated that feedback is very useful in enabling learners develop an understanding of their strengths and areas of weaknesses so as to progress to better performance. While using STMS, learners get feedback that is immediate, with the goal of suggesting changes in the way one approaches learning.

Learning analytics is another of the essential elements in STMS, allowing instructors and administrators to measure the learners' performance and activity. In the same year, Siemens (2013) described the use of learning analytics to determine learner patterns and improve training initiatives. Using LA, the effectiveness of the work done in STMS is seen because it contributes to

the positive results that individual learner's gain and the success rate of the program as a whole. Flexibility has become one of the greatest boosters of mobile learning since its implementation in the recent past. Wang et al. (2021) explain the benefits of mobile learning where learners can access training information at any given time thus enhance the learners' experience. Mobile learning is supported by the STMS so users are always engaged in some form of training as desired, improving on the versatility of the system.

2.2. Synthesis

The literature research indicates that currently available training systems – the integrated Learning Management System and the enterprise training platform – do equip the learner with numerous useful tools but frequently do not offer learner-centered approaches and do not allow for effective communication or integration with the training systems. In many cases, different systems function independently from one another, which poses a challenge when it comes to monitoring learners' and instructors' performance. STMS breaks the limitations by combining and providing adaptive learning, game elements, feedback, and learning analytics all at one place. This way, STMS can provide tailored, compelling, and productive learning environment to enhance the training result for the users.

CHAPTER 3

3. Project Analysis

This chapter recounts the evaluation of the requirements and the approaches in the creation of the proposed Smart Training Management System (STMS). It dwells on the approach that is to be employed in solving a certain problem, the mode of research, the requirements of the system that is to be developed and the tools and procedures in the development process. The purpose is to outline a procedure for the construction of the system as well as its evaluation and deployment.

3.1. Analysis and Problem-Solving Method

In the analysis phase, the identification of the right approach to problem-solving best suited to the development of the Smart Training Management System (STMS) is performed. The method has to be relevant to the goal of the project that is the solution proposed and recommended solves specific problem stated and analysed during the problem discovery part of the project. In this case, the Root Cause Analysis (RCA) method was used to define the key barriers for existing training management systems. The RCA method differs from the simple identification of defects and their causes because RCA aims to reveal the machinery of problems. It was especially useful in finding holes in existing structures – for example, the absence of individual learning plans, users' disinterest, and data scatter. Through the RCA the existing LMS and corporate training system were dissected which helped identify the required system features of the STMS. Having carefully identified these issues, the Iterative Problem Solving Approach was then adopted where each of the problems as identified underwent the design and test process. This ensured that the system was adapted to fit the ever changing needs as well as feedback to guarantee it was a perfect user friendly system.

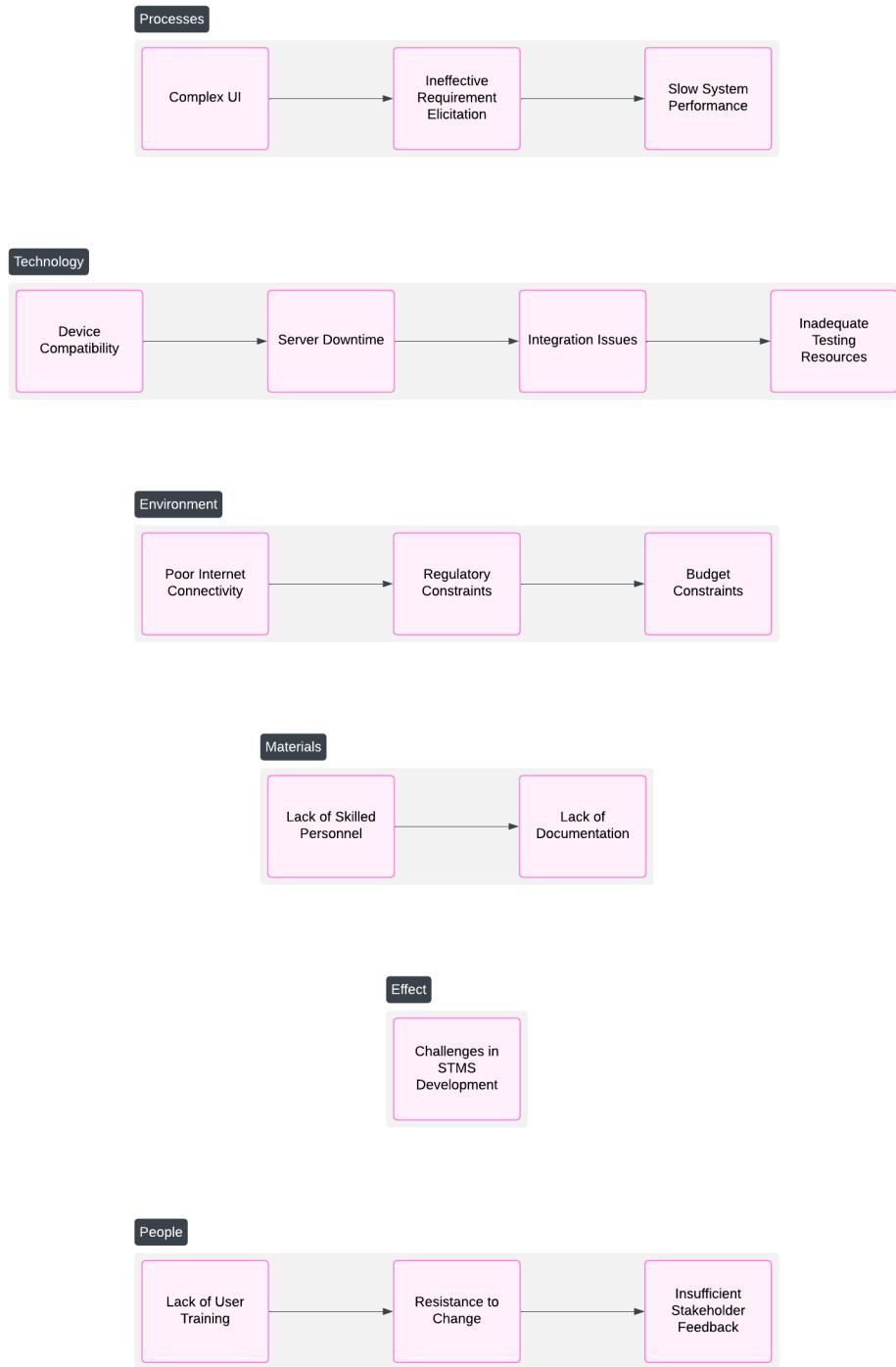


Figure: 02 Fishbone Diagram of Challenges in STMS Development

3.2. Research Methodology and Data Collection Procedure

3.2.1. Research Methodology

Both experimental and descriptive research methods were adopted in the formulation of the STMA. A descriptive research methodology was employed in the study of extant training management practices and also of workspace patterns, trends in industry, and technological advancement. Experimental research methods were used as means to test hypotheses, confirm the proposed methods, and collect data to keep track of the STMA's effectiveness in improving training outcomes.

3.2.2. Data Collection Procedure

The techniques for data collection utilized a variety of qualitative and quantitative methods to ensure that the right kind of information was gathered from the different stakeholders and expert content providers. Interviews were held with the key stakeholders to form the opinions of trainers, owners of training centres, and HR managers as well as the IT administrators, their views, approaches, and challenges about training management. Surveys were magnetically spread out to a broader population to learn qualitative data about training needs, dilemmas, or problems. (Mazhar et al., 2021).

3.3. System Development Methodology

The development of the STMS followed the agile procedures, which are a set of procedures for the development of different kinds of software systems. It is flexible, iterative, and involve much of user interaction; hence it is suitable for this project. In particular, the Scrum was chosen to be used within the framework of the agile methodology. Scrum created a framework where by every activity had time bound solutions through sprints so that the team could dedicate its time to small workable tasks within the project. Advantages of applying the Scrum method are the improvement of cooperation at the team level, the possibility of delivering particular functionalities in the established time frame, and flexibility as a reaction to the changes in the consumers' demand or the organization's needs. Every sprint was followed by a review and feedback session in which it was possible to enhance and optimize the worked out elements of the system gradually. This made the procedure more focused on the users to try and find the

best solution while at the same time ensuring that the final solution would in fact be the best, should there be any alterations made half way through the development process.

3.4. System Requirements

The next segment of the work discusses the stages of identification of system requirements, and specification of the necessary features of the Smart Training Management System.

3.4.1. Requirement Elicitation and Specifications

A collaborative approach was taken to elicit the system requirements whereby end users like learners, trainers, and administrators, subject matter experts, and IT personnel were actively engaged in the project as stakeholders. Focus groups, interviews, and comments following the presentation were utilized. The requirements mainly collected included:

- **Adaptive Systems:** Adaptive systems for self-regulating learners that offer individualized content recommendation have long been regarded as a valuable asset in education.
- **Constant Analytics and Feedback:** In addition to increasing user engagement, learning management systems offer the down the line several pedagogical strengths, even in their current primitive stage.
- **Web Responsiveness:** The learning content offered in these tools can be accessed and displayed on a wide range of devices. Retailers' customers and learners alike, enjoy the convenience of taking a course any time, from any place.
- **Inclusion of Additional Functions:** The currently integrated systems so far have included points and badges, among other game-like elements, to enhance user immersion into their courses.
- **Use of Social Learning Platforms:** Social networking on the website of the LMS is a perfect example of how social learning can be coupled with online learning.

3.4.2. Requirements Model

The functional requirements of the system are enveloped in an abstraction known as use case model. This model depicts the interaction between the different kinds of users (learners, instructors, administrators) of the system and the significant tasks which correspond to each of these user roles. Also, to focus on the structuring of information throughout cycles of the

system's functioning, which includes processing and storage of data at certain stages, a Data Flow Diagram (DFD) was also developed.

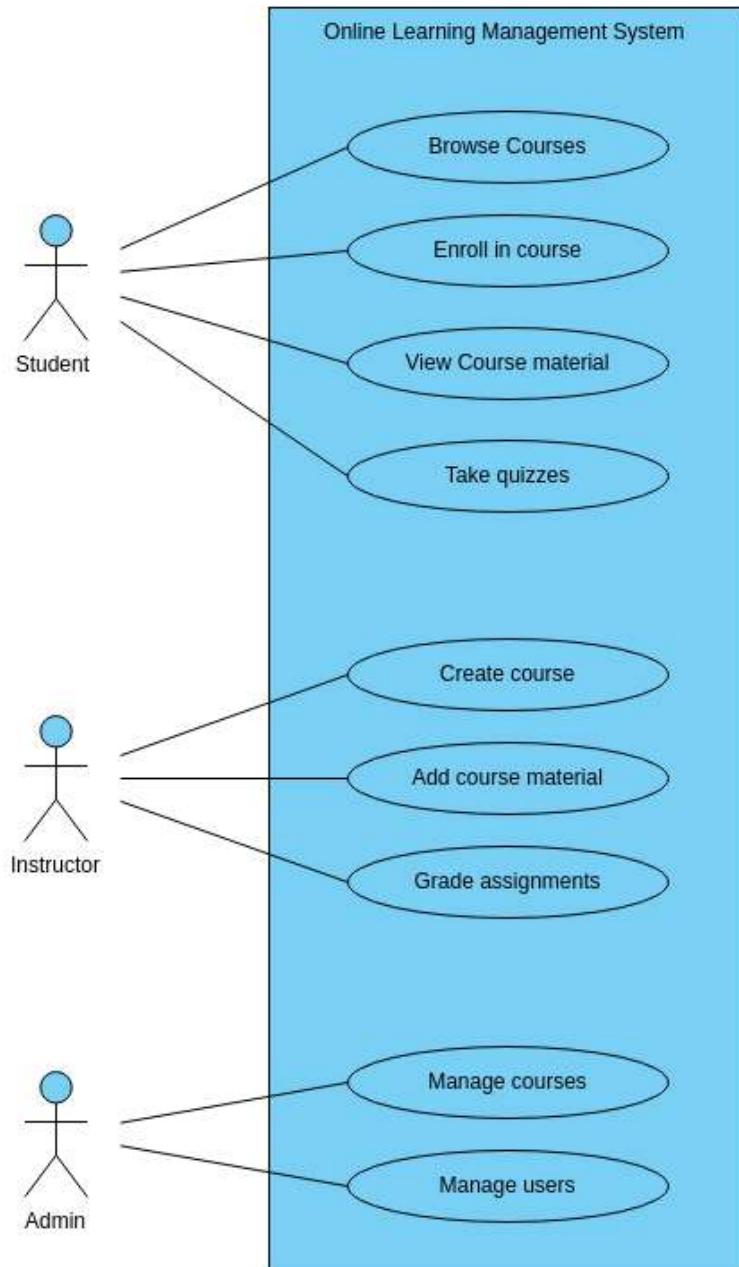


Figure 03: Use Case Model of Smart Training Management System

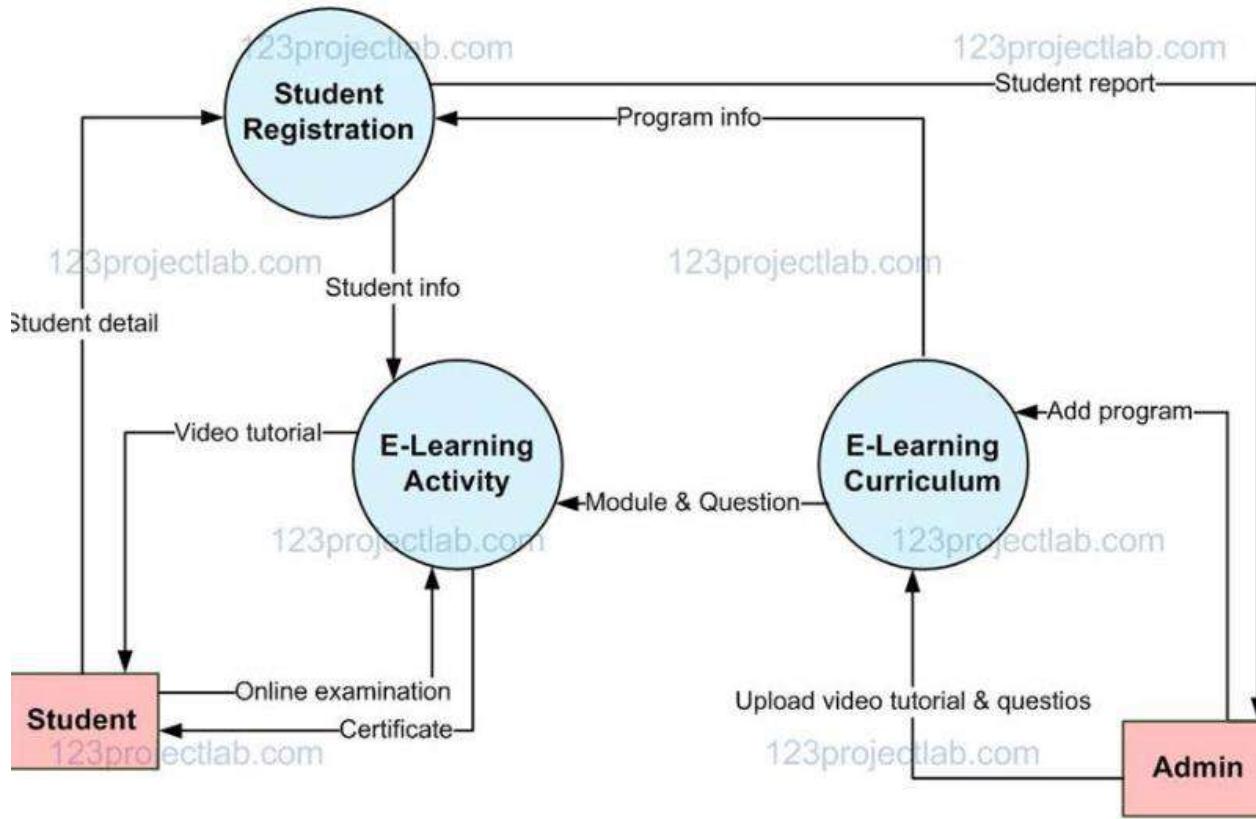


Figure 04: Data Flow Diagram of Smart Training Management System

3.4.3. Hardware / Software Specification

The hardware and software requirements present for the creation and implementation of the STMS include the following:

Hardware Requirements:

- **Servers:** Heavy-duty cloud servers like AWS, Azure for hosting purposes.
- **Devices:** Provision of desktop and mobile devices for learners and instructors as well.
- **Network:** High speed internet to enable fast transfer of data and access to resources.

Software Requirements:

- **Backend:** Node.js used in the server-side development.
- **Frontend:** With the use of React.js, graphical and interactive interfaces are built.
- **Database:** MySQL or PostgreSQL for data uploading and retrieval.

- **Cloud Integration:** AWS or Google Cloud solutions as the hosting and storage options.
- **Mobile Compatibility:** Development of mobile apps powered by React Native.

3.5. System Development Tools

3.5.1. Selected Programming Language

The selected programming languages used for the development of STMS are:

- JavaScript (React.js) as frontend development to enhance and make interface for users dynamic.
- Node.js as a backend technology that provides effective performance for applications that handle asynchronous requests.
- SQL to handle data within a database which makes data storage and retrieval effective.

3.5.2. Database Requirements

In this project, the database system MySQL was selected because of its dependability, scalable architecture, and its ability to store vast volumes of structured information effectively. Information regarding user's details such as profiles, training modules, progress and review will be stored in the database.

3.5.3. Other Requirements

Besides the main software and hardware requirements, the system will utilize third party application programming interfaces for video conferencing and collaboration tools such as Zoom, Microsoft Teams in order to enhance the experience with live training and discussions. To safeguard user's privacy, however, security measures like data encoding and secure login procedures will be applied.

Field Name	Data Type	Description
UserID	INT	Unique identifier for each user
Username	VARCHAR(50)	Username for login
Password	VARCHAR(255)	Hashed password
FirstName	VARCHAR(50)	User's first name
LastName	VARCHAR(50)	User's last name
Email	VARCHAR(100)	User's email address

Role	ENUM	Role of the user (e.g., Admin, Trainer, Trainee)
CreatedAt	DATETIME	Account creation timestamp
UpdatedAt	DATETIME	Last update timestamp

Table 4: Users Table

Field Name	Data Type	Description
CourseID	INT	Unique identifier for each course
CourseName	VARCHAR(100)	Name of the course
Description	TEXT	Detailed description of the course
StartDate	DATE	Start date of the course
EndDate	DATE	End date of the course
CreatedAt	DATETIME	Course creation timestamp
UpdatedAt	DATETIME	Last update timestamp

Table 5: Courses Table

Field Name	Data Type	Description
EnrollmentID	INT	Unique identifier for each enrollment
UserID	INT	Identifier of the enrolled user
CourseID	INT	Identifier of the course
EnrollmentDate	DATETIME	Date of enrollment
Progress	DECIMAL(5,2)	Progress percentage of the course
CompletionStatus	ENUM	Status of completion (e.g., In Progress, Completed)
CreatedAt	DATETIME	Enrollment creation timestamp
UpdatedAt	DATETIME	Last update timestamp

Table 06: Enrolments Table

Field Name	Data Type	Description
SessionID	INT	Unique identifier for each session
CourseID	INT	Identifier of the related course
SessionName	VARCHAR(100)	Name of the session
SessionDate	DATETIME	Date and time of the session
Duration	INT	Duration of the session in minutes
CreatedAt	DATETIME	Session creation timestamp
UpdatedAt	DATETIME	Last update timestamp

Table 07: Sessions Table

Field Name	Data Type	Description
AssessmentID	INT	Unique identifier for each assessment
CourseID	INT	Identifier of the related course
AssessmentName	VARCHAR(100)	Name of the assessment
AssessmentType	ENUM	Type of the assessment (e.g., Quiz, Assignment)
TotalMarks	INT	Total marks for the assessment
CreatedAt	DATETIME	Assessment creation timestamp
UpdatedAt	DATETIME	Last update timestamp

Table 08: Assessments Table

Field Name	Data Type	Description
ResultID	INT	Unique identifier for each result
AssessmentID	INT	Identifier of the related assessment
UserID	INT	Identifier of the user
MarksObtained	INT	Marks obtained by the user
Feedback	TEXT	Feedback provided for the assessment
CreatedAt	DATETIME	Result creation timestamp
UpdatedAt	DATETIME	Last update timestamp

Table 09: Results Table

Field Name	Data Type	Description
FeedbackID	INT	Unique identifier for each feedback
UserID	INT	Identifier of the user providing feedback
CourseID	INT	Identifier of the related course
FeedbackText	TEXT	The feedback content
Rating	INT	Rating given by the user (1 to 5)
CreatedAt	DATETIME	Feedback creation timestamp
UpdatedAt	DATETIME	Last update timestamp

Table 10: Feedback Table

Field Name	Data Type	Description
RoleID	INT	Unique identifier for each role
RoleName	VARCHAR(50)	Name of the role
CreatedAt	DATETIME	Role creation timestamp
UpdatedAt	DATETIME	Last update timestamp

Table 11: UserRoles Table

Field Name	Data Type	Description
NotificationID	INT	Unique identifier for each notification
UserID	INT	Identifier of the user receiving the notification
Message	TEXT	Notification message content
IsRead	BOOLEAN	Read status of the notification
CreatedAt	DATETIME	Notification creation timestamp
UpdatedAt	DATETIME	Last update timestamp

Table 11: Notifications Table

3.6. Narrative of the Analysis Method

In the analysis phase, there were many interactions and operability issues that could not be avoided, thereby modifying the approach adopted. One of the difficulties encountered was the need of providing cross-platform support. When the project was started, the degree of the system's mobile usability was out of focus which prompted the need to rethink the design of its graphical interface for both computers and tablets to perform smoothly. There was also the difficulty of implementing elements for receiving feedback from users in real time. When the present phase was commencing this capability was sought but because of misplacement of data, this objective was not achieved until the procedures were modified, resulting in the system being able to gather the necessary feedback in real-time so that correct and up-to-date information may be available to both the learners and trainers. Each task and milestone envisaged in the project was visually represented on a Gantt chart that aided the analysis and development phases to progress in a chronological order.

CHAPTER 4

4. Project Design

4.1. System Overview/Design Constraints

The Smart Training Management Application refers to STMA and it is an enhanced advanced solution that seeks to address training frameworks in organizations. Thus, by entering and managing scheduling, tracking, and reporting of exercises, STMA's goals are to increase the effectiveness and efficiency of training (Smith, 2022). There are several design constraints affecting the work of STMA. Security is a paramount consideration result of the sensitive data that is processed by the system, including user details as well as training records. Also, it should have the ability to work with different types of device and operating systems which compels the need to develop the application in a way that is responsive in that it can be used on computers, tablets, and handheld devices (Lee, 2023).

4.2. System Architecture

The software architecture of the Smart Training Management Application is planned to be scalable, flexible and rich in functionality. The system architecture is divided into three main layers: Presentation layer, the application layer and the Data Layer are some of the layers in OSI model.

- **Presentation Layer:** This layer is for interacting with the user and improving or enhancing the experience of the user. Another element of the design is that the users are given the same interface regardless of the device they are using, be it a computer, a tablet or a mobile phone.
- **Application Layer:** The Application Layer holds all business processing and service components of the STMA that are responsible for core STMA business. It is implemented using micro services architecture with Node and has the following features
- **Data Layer:** The Data Layer deploys a conventional RDBMS such as PostgreSQL for data storage, and AWS RDS for storage and growth, where data is stored (Davis, 2022). The data layer embraces such tables as users, training, performance, progress, and results.

4.2.1. The Package Diagram:

The package diagram given has a package diagram's clear and modular approach of depicting Smart Training Management System how it is structured and the other options present within it. Each package is centered on a particular aspect of the system, thus providing a systematic development and ease in maintaining the structure.

User Management:

- **User:** This one is solely responsible for dealing with such user-related data as personal information and credentials.
- **Role:** Establishes the various positions that are provided in the system including administrator, trainer and trainee.
- **Permission:** It regulates the rights and authorities of every role for implementing security where a user can only perform the activities permitted for that role.

Course Management:

- **Course:** Is an object of the training course that shows information about training course as the title, description, and others.
- **Model:** Enables standard provision of courses ensuring that respective courses share templates or models required in content delivery.
- **Lesson:** Responsible for designing and ordering of lessons within a course and the material which fills them.
- **Enrolment:** Using this page, one is able to record information on which participants is enrolled in which course to facilitate proper work with their accomplishment.

Training Delivery:

- **Trainer:** Those responsible for the trainer's data, including their requirements and training courses assigned to them.
- **Participant:** Records the attendees for each of the training sessions in order to track their performance and give feedback to all the participants.

Assessment Feedback:

The Assessment Feedback Package is concerned with the assessment of the effectiveness of training by using assessments and feedback. It includes:

- **Assessment:** Oversees all the aspects pertaining to the generation and administration of assessments as they pertain to training.
- **Feedback:** Gathers and analyses the sentiments of participants on the training held to make changes in the successive courses.

Reporting and Analytics:

The Reporting and Analytics is aimed to offer means of data analysing gathered in the course of the training. It includes:

- **Report:** Uses features of processing to create reports on performance of users and effectiveness of courses as well as other factors.
- **Analytics Dashboard:** Allows the presentation of collected data, making it easy for administrators and trainers to base their organization or training decisions on data collected.

System Administration:

The System Administration covers aspects of configuration and administration of the system as a whole. It includes:

- **Configuration:** Administrator of all aspects relating to the setup of the application such as documenting system configuration.
- **Logging:** Records the system activities and the actions made by users and helps with security and identification of problems.
- **Notification:** Responsible for the notification systems, to inform the users of events within the system.

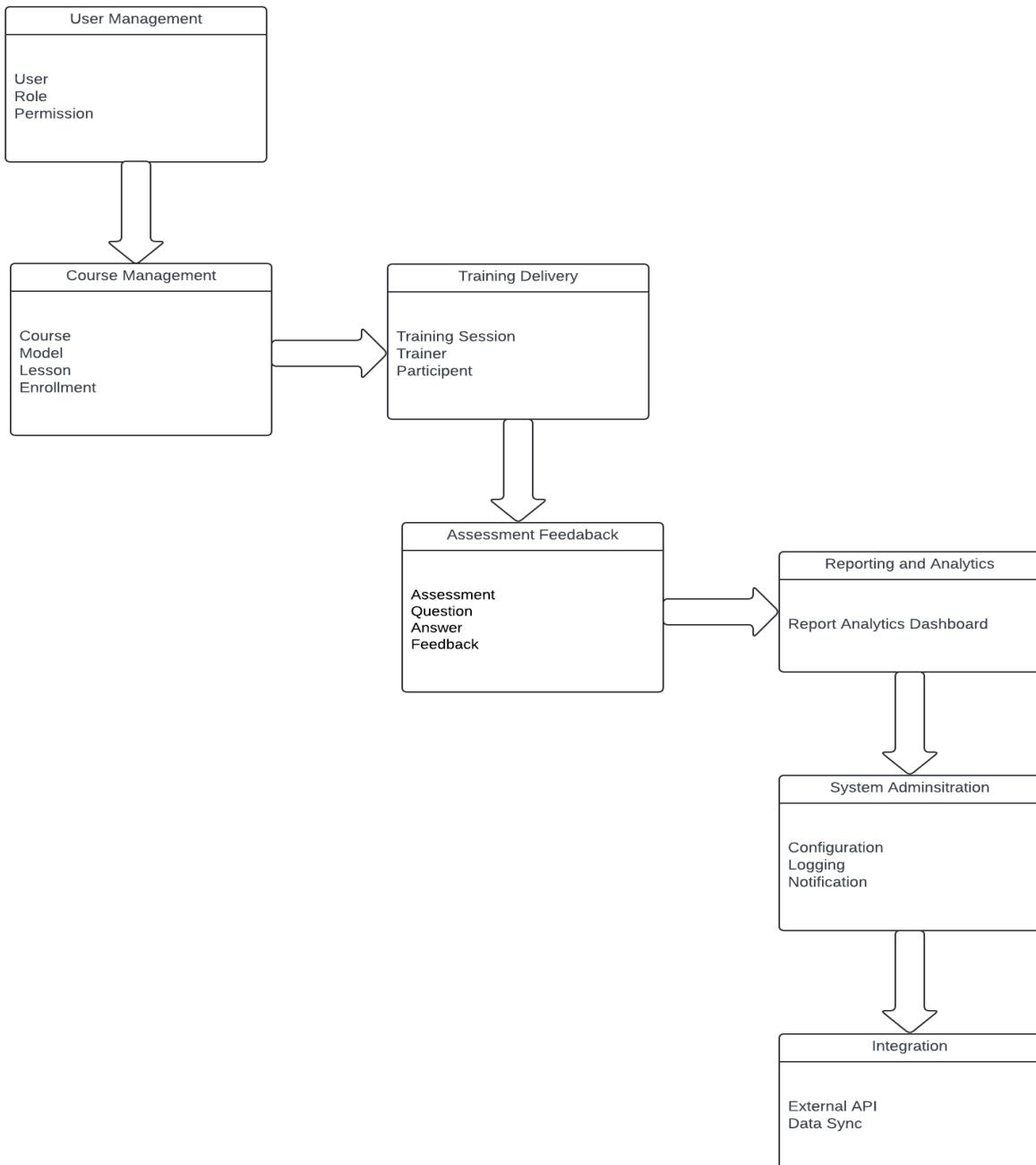


Figure 05: Package Diagram

4.2.2. The Deployment Diagram:

A deployment diagram shows in detail how the system will be distributed on hardware in physical terms. The Principal elements included in the deployment are:

- **A Web Server:** Provides the graphical layer of the website (HTML, CSS, JavaScript files).
- **An Application Server:** Provides supporting logic (PHP, Python, etc.) and handles the requests.
- **A Database Server:** Contains information on users, courses, progress, payment, etc. in the MySQL database.

There is a request-response flow between the web server and application server whenever the former needs to make a request or update information stored within the database server.

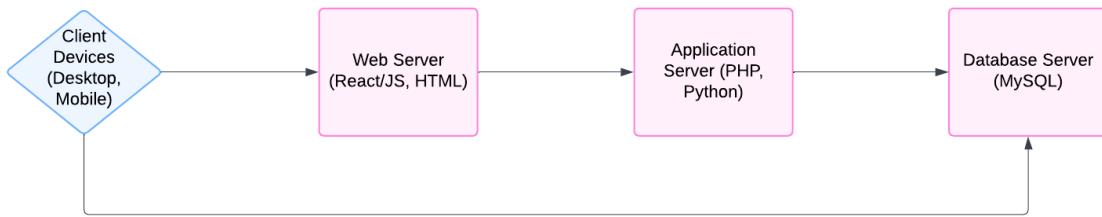


Figure 06: Deployment Diagram

4.2.3. The Network Diagram:

The functional layout shows how the users are connected to each other. It incorporates the relationships between:

- The users' devices (students, teachers, and administrators) and the web server, connected via secure internet access.
- The application and database servers which are usually located within the same protected LAN or cloud, providing extensive speed and security in data access and management.

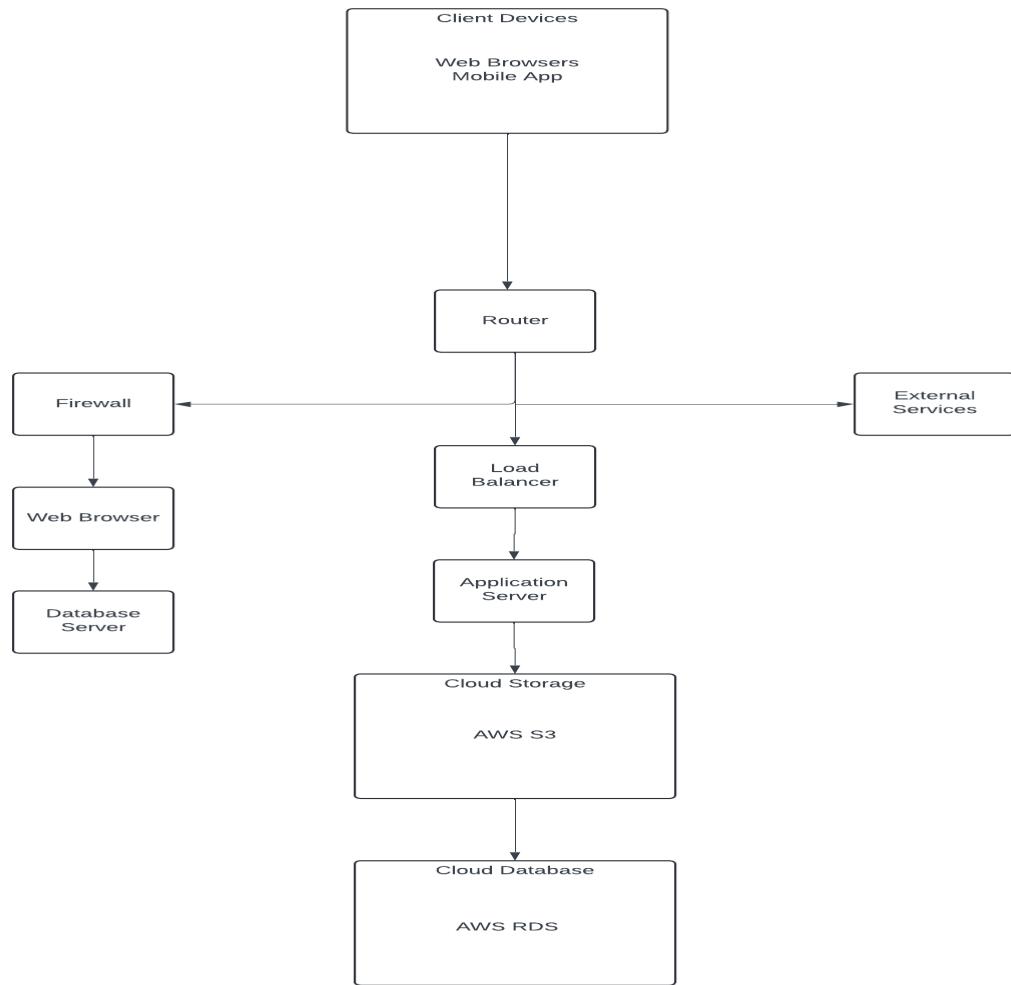


Figure 07: The Network Diagram

4.3. Process Model:

The Anglo-American model adopted in the development of the Smart Training Management Application (STMA) uses the agile methodology of developing software, which focuses on the use of the prototype approach with involvement of the various stakeholders (Beck et al., 2001).

4.3.1. Agile Development Phases:

- **Planning:** On the start of each sprint, the team sets the sprint objectives, and the features/actions to deliver in the process. This phase confirms with the objectives and scope for the next coming of the sprint with all individuals.
- **Design:** the team comes up with detailed specifications of the project as well as develops and tests prototypes. The final and organizational design work is to detail the system architecture and to prepare for implementation.
- **Implementation:** During this stage, actual coding and technical part of the application features are written.
- **Testing:** After this, the software is tested with the aim of finding out any errors and fixing them before launching the application. This phase helps to ascertain that the generated features do fulfil their functional requirements and that they are up to par.
- **Review and Feedback:** Sprint: At the end of every sprint which can be for approximately one month the working increment of the software is presented. Data is also collected from consumers.

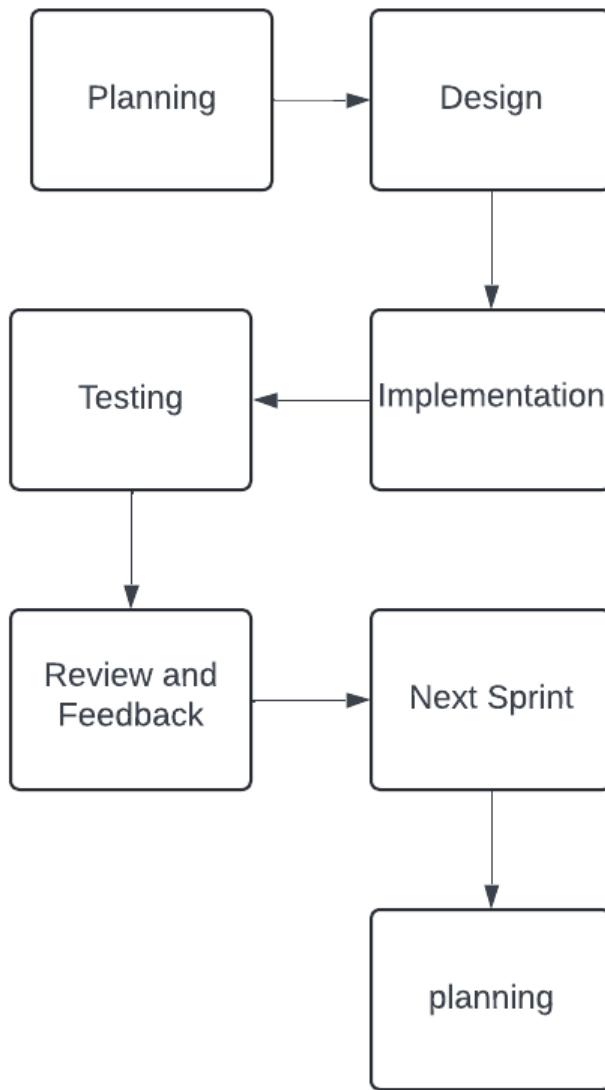


Figure08: Agile Methodology

4.4. Data Model:

The conceptual schema of STMA is as follows: User Data: This involves data of the users of the application including trainers and trainees, Training Module Data: This refers to data on the modules available for training for instance, training schedules Data which is in form of calendars for the various trainings, Training Progress Data: Information available on how far a particular training has advanced. Entity Relationship Diagrams (ERDs) are employed to depict the

relationship between these entities and to guarantee consistent, clear and effective structure of the created database (Elmasri Navathe, 2015).

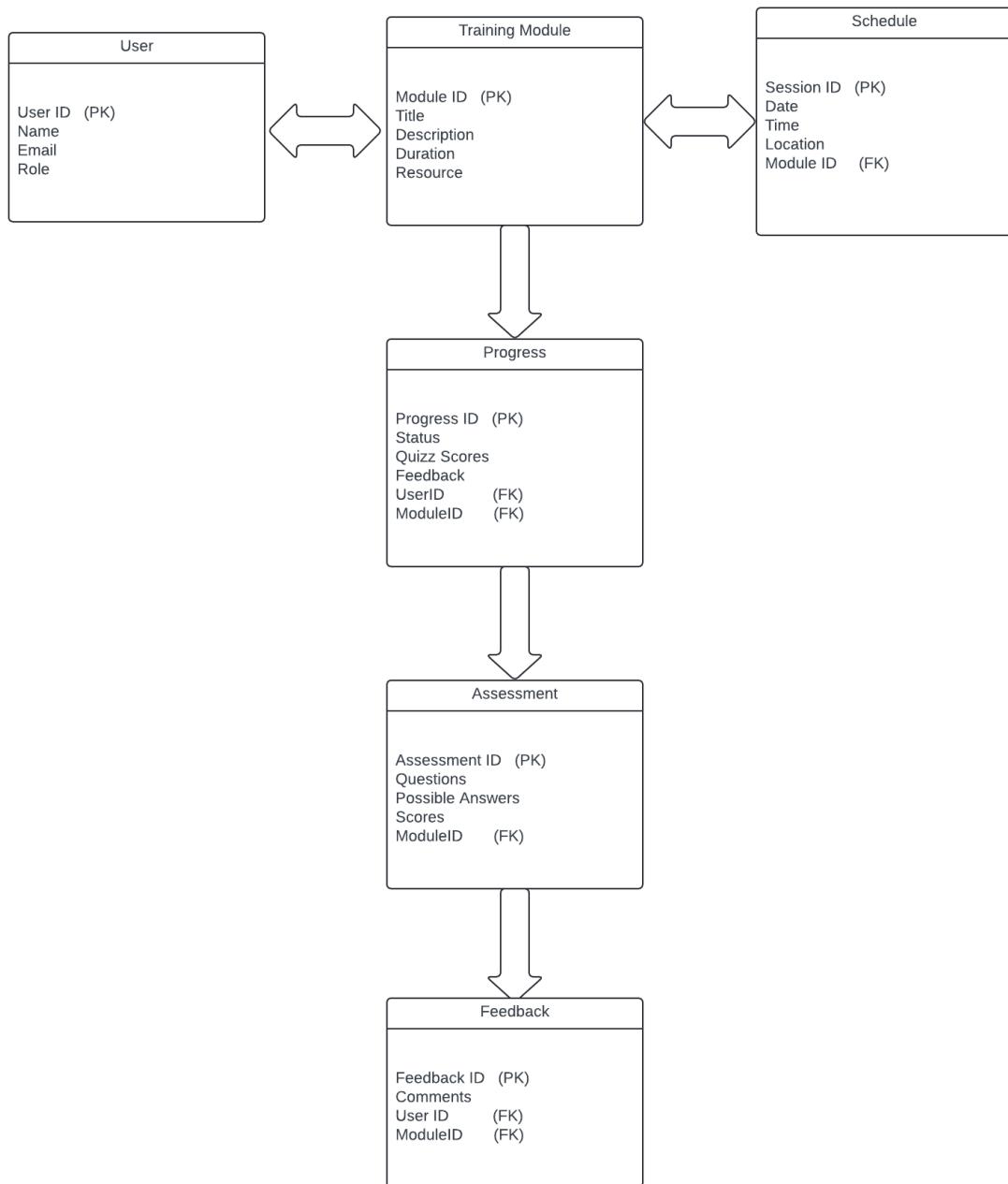


Figure 09: Entity Relationship Diagram (ERP Diagram)

CHAPTER 5

5. Project Implementation, Testing & Evaluation

This chapter provides an overview of the implementation process for the Smart Training Management System (STMS), the testing phases, and the evaluation of the project based on the defined objectives and success criteria.

5.1. Project Implementation

5.1.1. Software Deployment

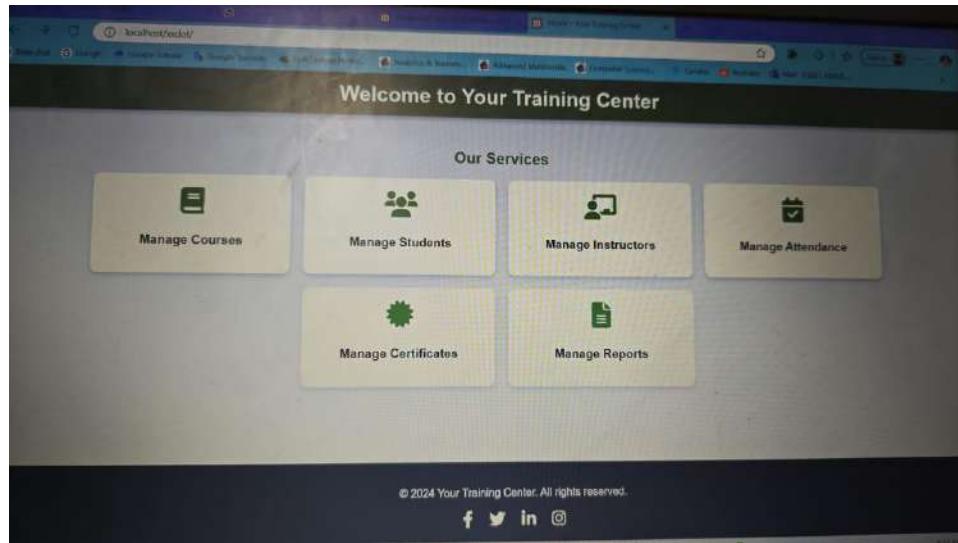
The Smart Training Management System (STMS) was successfully deployed on a web server with the required components including PHP, MySQL database, and a front-end based on HTML, CSS, and JavaScript. The system was hosted on a cloud-based server to ensure scalability and reliability. The deployment process involved:

1. **Configuration of the Web Server:** Apache server was configured for serving the system's web pages.
2. **Database Setup:** A MySQL database was created to store user data, course details, progress reports, and other essential information.
3. **Application Configuration:** The system's backend (PHP) was configured to interact with the front-end interface (HTML, CSS, and JavaScript) and the database. All APIs were set up for data retrieval and submission.
4. **Security Configuration:** SSL certificates were added for secure data transfer, and login procedures were protected through hashed passwords.

The system was deployed and is accessible to users for both training course management and progress tracking.

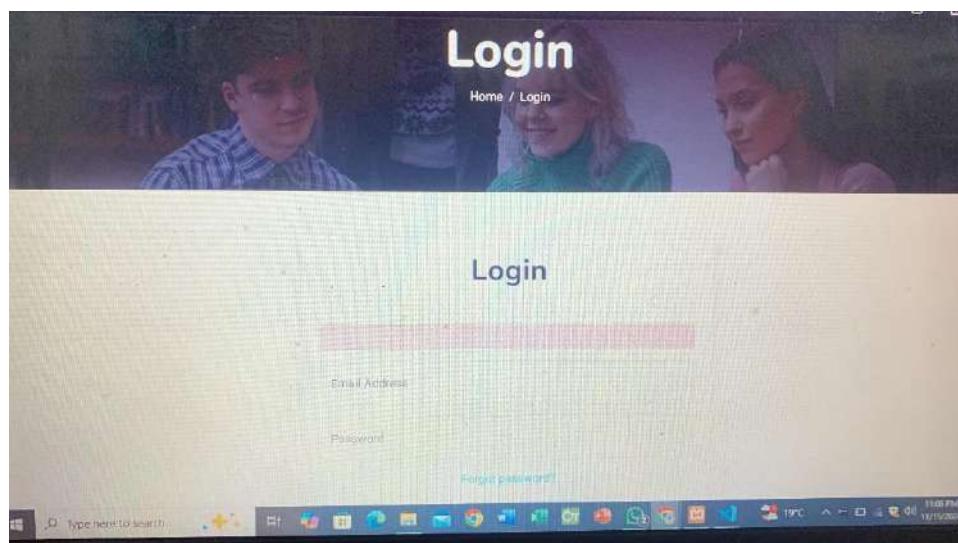
5.1.2. Screenshots and Discussion of the Implemented Functions

Homepage: Displays a welcome message with course categories and access options for students and trainers.



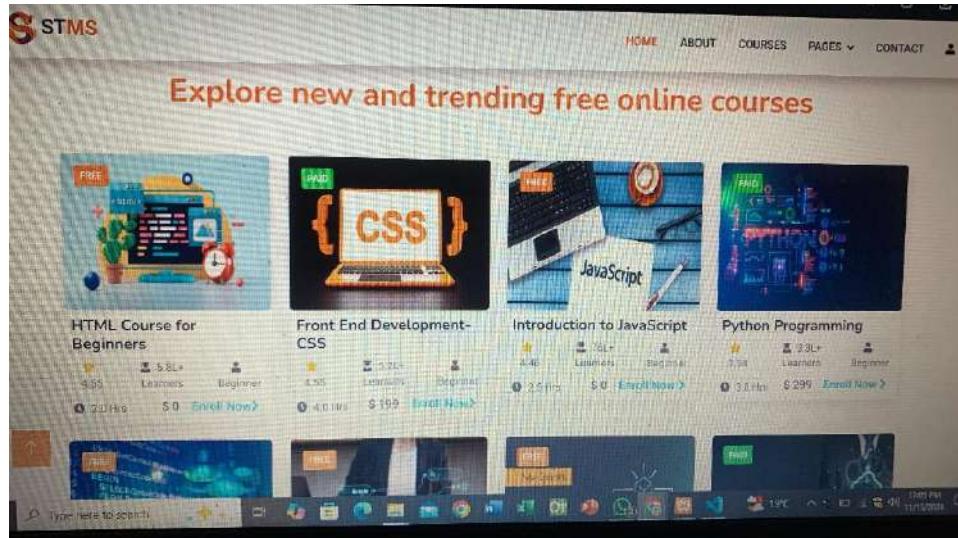
Function: Provides navigation to various sections such as course enrolment, progress tracking, and training provider login.

Login Page: Allows users (students/trainers) to access their profiles.



Function: Authenticates users and directs them to their respective dashboards.

Course Enrollment Page: Allows students to browse and enroll in available courses.



Function: Enables students to select courses and view course progress.

5.1.3. Discussion of Important Codes

Login Validation (PHP):

```
// Login Validation
if (isset($_POST['login'])) {
    $username = $_POST['username'];
    $password = $_POST['password'];

    // Validate user credentials from database
    $query = "SELECT * FROM users WHERE username = '$username' AND password = '$password'";
    $result = mysqli_query($conn, $query);

    if (mysqli_num_rows($result) == 1) {
        $_SESSION['user'] = $username;
        header("Location: dashboard.php");
    } else {
        echo "Invalid username or password";
    }
}
```

This code checks user credentials against the database and grants access to the dashboard if the credentials are valid.

Course Enrolment (PHP):

```
/ Enroll in Course
if (isset($_POST['enroll'])) {
    $course_id = $_POST['course_id'];
    $user_id = $_SESSION['user_id'];

    // Insert enrollment data into the database
    $query = "INSERT INTO enrollments (user_id, course_id) VALUES ('$user_id', '$course_id')";
    if (mysqli_query($conn, $query)) {
        echo "Successfully enrolled in the course!";
    } else {
        echo "Error enrolling in the course";
    }
}
```

This code allows students to enroll in courses by inserting their enrollment data into the database.

5.2. Project Testing

5.2.1. Testing Phases

The testing process was conducted in the following phases to ensure that the system works as expected:

Alpha Testing: Conducted by the development team to check the overall functionality of the system and identify any major bugs before releasing the system for beta testing.

Beta Testing: The system was tested by a selected group of students and trainers to ensure that the user interface was intuitive, and all features were functioning correctly.

Acceptance Testing: This phase involved end-users testing the system to confirm that it met their needs and expectations before the final deployment.

Unit Testing: Individual functions and components of the system were tested to ensure correctness (e.g., login, course enrollment, payment).

Integration Testing: Ensured that the various modules (user authentication, course management, payment processing) worked together without errors.

System Testing: Conducted to verify the overall behavior of the system in its entirety, ensuring that the system was stable and met the business requirements.

5.2.2 Test Cases and Results

Here are some of the test cases and their results:

Test Case ID	Test Case Description	Preconditions	Test Steps	Expected Result
TC-001	User Registration with valid details	None	1. Navigate to registration page 2. Enter valid details 3. Click 'Register'	User registers successfully and receives a confirmation message.
TC-002	User Registration with existing email	User is already registered	1. Navigate to registration page 2. Enter an existing email 3. Click 'Register'	System displays an error message for the existing email.
TC-003	User Login with valid credentials	User exists in the system	1. Navigate to login page	User logs in and is redirected to the dashboard.

			2. Enter valid email and password 3. Click 'Login'	
TC-004	User Login with invalid credentials	User exists in the system	1. Navigate to login page	System displays an error message for invalid credentials.
			2. Enter invalid password	
			3. Click 'Login'	
TC-005	View List of Training Modules	User is logged in	1. Go to training modules page	User sees a list of available training modules.
			2. Click 'View Modules'	
			3. Click 'Submit'	
TC-006	Create a New Training Module	User is logged in as an admin	1. Go to training module management page	New training module is added and displayed in the list.
			2. Enter module details	
			3. Click 'Submit'	
TC-007	Update a Training Module	User is logged in as an admin, module exists	1. Go to training module management page	Module details are updated successfully.

			2. Select module 3. Edit details 4. Click 'Save'	
TC-008	Delete a Training Module	User is logged in as an admin, module exists	1. Go to training module management page 2. Select module 3. Click 'Delete'	Module is removed from the list.
TC-009	Register for a Training Session	User is logged in, session is available	1. Go to training schedule page 2. Select session 3. Click 'Register'	Registration is confirmed and added to user's schedule.
TC-010	Cancel a Training Session Registration	User is logged in, session is registered	1. Go to registered sessions page 2. Select session 3. Click 'Cancel'	Registration is canceled and session is removed from schedule.
TC-011	View Training Progress	User is logged in	1. Go to progress page 2. Select training session	Progress details for the selected session are displayed.

TC-012	Create a New Assessment	User is logged in as an admin	1. Go to assessment management page 2. Enter assessment details 3. Click 'Submit'	New assessment is created and displayed in the list.
TC-013	Update an Assessment	User is logged in as an admin, assessment exists	1. Go to assessment management page 2. Select assessment 3. Edit details 4. Click 'Save'	Assessment details are updated successfully.
TC-014	Delete an Assessment	User is logged in as an admin, assessment exists	1. Go to assessment management page 2. Select assessment 3. Click 'Delete'	Assessment is removed from the list.
TC-015	View Assessment Results	User is logged in as a trainee, assessment taken	1. Go to assessment results page	Assessment results are displayed correctly.

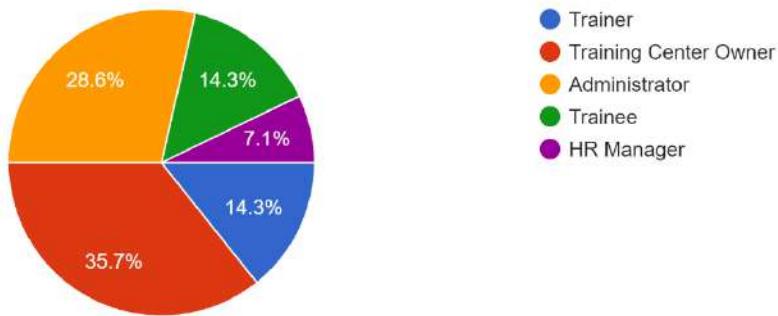
			2. Select assessment	
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Table 13: Test Cases

5.3. System Evaluation

What is your role in the organization? (Select one)

14 responses



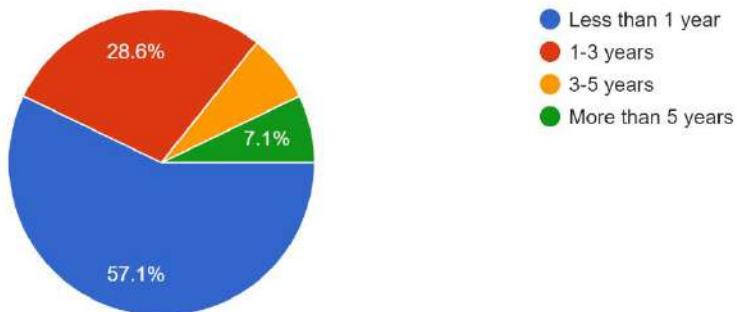
Customization and Flexibility: The diverse functions point to the fact that the STMA should be extremely malleable to address the requirements of various utilizers. For instance, the actual needs of an organization might be more focused on report generation and analysis, and

Training Effectiveness: Because the program has many trainees, it becomes important that the application to be developed helps deliver training material in an engaging and easy to comprehend way.

Administrative Efficiency: Despite the current efficiency and satisfaction rates achieved with the program, feedback from administrators is valuable for fine-tuning back-end elements and guaranteeing the application assists in effectively handling Training programs, conveniently authenticating users, and delivering the expected system performance.

How long have you been in your current role? (Select one)

14 responses



Feedback on System Usage: This group can provide insights about practical application of the STMA as they engage in its use consistently and might face certain difficulties or have ideas for its enhancements.

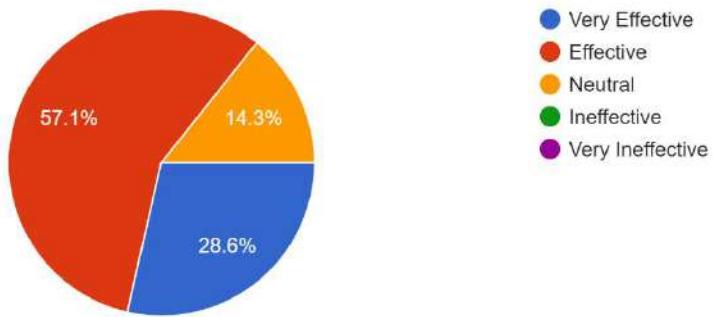
Intermediate Features: It is doubtful that they will seek many extras or anything beyond the basic, though they will probably want to have features such as enhanced reporting capabilities.

Few Long-Term Employees: A few of the respondents (14.2% combined) express that they have served in their positions for 3 up to 5 years and some who have served more than 5 years. These people make considerable contributions towards training management because they have vast exposure and rich knowledge of training.

Implications:

The long-term employees, due to their cumulative years of experience, can give a feel of what has actually transpired in this line and how the STMA has affected training management practices. Advanced users might desire enhanced functionality and adaptability in order to reflect the system on the complexity and the specificity of organizational requirements. These users can actively help the other users, and become role models to share best practices in leveraging the benefits of the STMA.

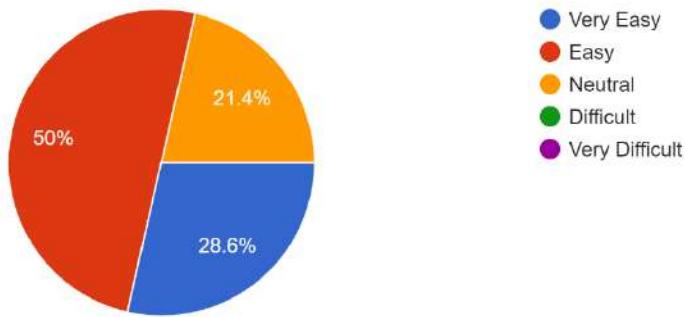
How would you rate the effectiveness of your current training management practices? (Select one)
14 responses



Foundation for Improvement: Furthermore, despite the fact that 52 percent of the respondents stated that they have good practices, there is still room for improvement. Understanding the details that make up each contributes to identifying key areas where development may be needed in order to change things that needs to be improved.

User Feedback and Customization: Since majority of the respondents has a positive perception on the effectiveness of the product, STMA must focus on features and functionalities that are in line with practices that has been most effective, but at the same time could add versatility on the customization of products. This way, users are able to fine tune the application to better suit their needs, as well as environment, which serves to increase the efficiency of the application in their particular organizations.

How easy is it to navigate the Smart Training Management Application? (Select one)
14 responses



User Experience: The positive perception of the ease of the navigation of the site implies that the STMA has been laid down with consideration of the general users since there is tractability associated with them. This is very important in view of the fact that it will influence the overall satisfaction and adoption rate of our product by the users.

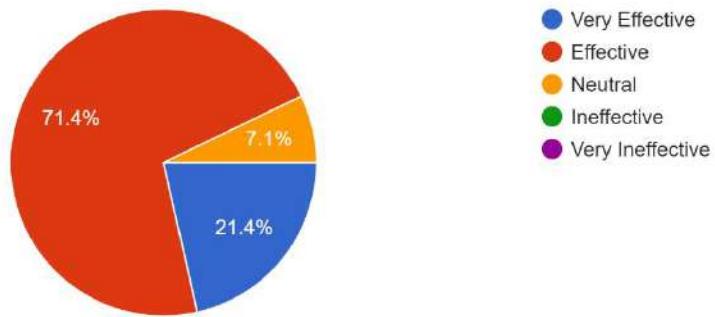
Potential for Improvement: The lack of response may also suggest that, while the overall experience of the STMA appears to be positive, there are probably areas in the layout and structure of the navigation that can be improved even further as to better engage the visitors. If feedback gathered reveals that a certain user fell under the neutral category, then it would be useful to further probe to find out exactly what issues he or she faced.

User Training and Support: Those who offered neutral responses should better undergo further training, use special tutorials, or common guides to solve the problem with the application more efficiently. It is always possible to eliminate any existing usability problems if the right approach to offering assistance is applied, thus enhancing general satisfaction.

Continuous Improvement: Although simplification of navigation appears to be making a positive overall impression to the majority of visitors to the website, it cannot be overemphasized that the STMA development team needs to pay attention to the need for continuously working to make the website even more easily navigable. User feedback mechanisms and reusable usability testing, daily/weekly/monthly updates on the design can go a long way in minimizing a change in attitude.

How effective is the application in helping you manage your tasks? (Select one)

14 responses



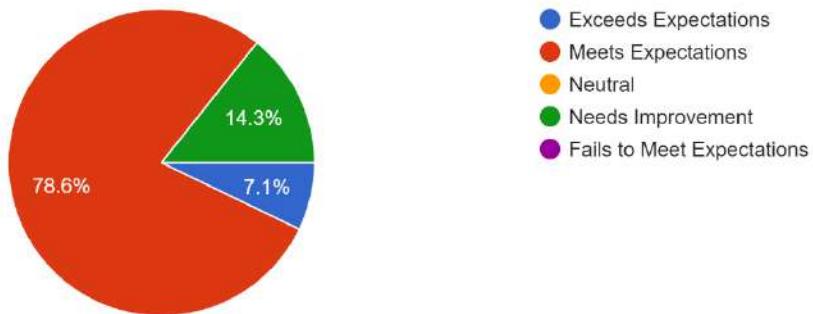
Enhanced Productivity: It can be inferred the users who perceive this application as effective probably noticed elevation in their efficiency and effectiveness in handling tasks. This means that the STMA plays the envisioned role of providing efficient task-regulatory measures as required.

User Satisfaction: Perceived user helpfulness perceptions hence are associated with the user satisfaction and the application. Loyalty and endorsement is more likely to be achieved when the user continues to find the STMA as an important tool in managing his or her tasks.

Alignment with User Needs: This means that on effectiveness ratings, the STMA meets all the necessary expectations in terms of user needs when it comes to management of tasks. This, in turn, presupposes that the revealed features and functions meet the users' needs and preferences successfully.

How well does the course management feature meet your needs? (Select one)

14 responses



User Satisfaction: Positive ratings indicate the extent to which the course management feature achieves its intended purpose in enhancing the experience of the users. Interacting with user's eye level and meeting or going above their expectations on the perceived value added of the STMA can go a long way in ensuring high rates of usage in the system.

Alignment with User Needs: The ability to manage courses is relevant and useful to the needs of the users due to its ability to help the organization schedule, deploy, and monitor the delivery of training courses in the organization. This alignment supports user usefulness and utility of the tools in facilitating training administration.

Support for Training Objectives: A feature which aids the management of course improves in line with the training goals and objectives of the company by creating tools and interfaces that fosters course creation, delivery and monitoring. It provides the users with an easy way to set up the course, monitor the learner progress, organize the course content and even conduct a communication which in turn enhances the training results.

CHAPTER 6

6. Critical Evaluation and Future Work

This chapter evaluates the Smart Training Management System (STMS), the objectives of the system and its success criteria, the testing methods employed, and recommendations for future developments. The evaluation offers an account of what the project set out to achieve, what needs to be improved in the process and how the system can be developed more in the future so as to be up to date and operational.

The STMS was designed as a generic web based cross-platform solution in response to training management problems in which the trainers and the trainees mind the training context in the very first place. The system was evaluated against several success criteria, including ease of use, functionality, accessibility, reliability, and security. The testing results indicated that the user interface is user friendly and makes it easy for the trainers and students to interact with the system. It was also confirmed by functional testing that all major features like course enrollment, progress tracking, trainer dashboards and others' specifications were adhered to. In addition, the web-based architecture permitted access from various devices while good security such as SSL encryption and hashed passwords availed the necessary protection for data.

The testing procedure comprised six stages which included alpha, beta, acceptance, unit, integration and system testing. Alpha testing captured severe defects in development that were performed at an early stage of the development process and beta testing extended to the users of the system for feedback on the ease of use of the system. Unit and integration tests ensured that the different parts of the system worked together and also worked on their own. System testing proved the efficiency of the system's elements under baseline conditions of its operation. Test plans had been developed in a careful manner and a test case developed for each functional requirement and any defect identified and resolved in a systematic manner.

Although the project was able to meet the set goals there was some negative feedback from beta testers suggesting redesigning the layout of the trainer dashboard to improve usability. Other recommendations include improving reporting capabilities that would assist trainers in holding student performance analysis and also introducing a mobile app that would complement the web

based one. In order to make sure that the system remains up to date, further work could be directed towards enhancing the scalability of the system by upgrading the database to increase the volume of data and number of users as well as additional security enhancements like two factor authentication.

The use of gamification elements like badges and a leaderboard or some AI that suggests courses depending on what learners have done earlier or preferred to do in the first place is another probable enhancement in the future. Extending the system in such a way that it can handle corporate training needs and learning in multiple languages will increase its applicability to a variety of industries and geographic areas. Other performance enhancement methods such as the use of indexing and cloud support can also benefit the scalability and efficiency of the system.

In conclusion, the STMS addressed the tasks set for it, was stable, easy to use and was secure. Nevertheless, active improvement developments will help to maintain competitiveness of the system and satisfaction of users with functionality of the system. The assessment and suggestions made in this report make it clear the way for such modifications that will complement the present system and enhance its effectiveness.

References

- Alavi, M. and Leidner, D. (1999). Knowledge Management Systems: Issues, Challenges, and Benefits. *Communications of the Association for Information Systems*, [online] 1(1). doi:<https://doi.org/10.17705/1cais.00107>.
- Ammann, P., & Offutt, J. (2016). *Introduction to software testing*. Cambridge University Press.
- Bass, L., Weber, I., & Zhu, L. (2012). *DevOps: A software architect's perspective*. Addison-Wesley.
- Beck, K. (2003). *Test-driven development: By example*. Addison-Wesley.
- Boothby, D., Dufour, A. and Tang, J. (2010). Technology adoption, training and productivity performance. *Research Policy*, 39(5), pp.650–661. doi:<https://doi.org/10.1016/j.respol.2010.02.011>.
- Coleman, G. and O'Connor, R.V. (2008). An investigation into software development process formation in software start-ups. *Journal of Enterprise Information Management*, 21(6), pp.633–648. doi:<https://doi.org/10.1108/17410390810911221>.
- Crawford, T.H. (2020). Actor-Network Theory. *Oxford Research Encyclopedia of Literature*. doi:<https://doi.org/10.1093/acrefore/9780190201098.013.965>.
- Davis, F. (2022). *Modern web development with Python*. O'Reilly Media.
- Davis, M. (2022). *Database management systems: A practical approach*. Springer. <https://doi.org/10.1007/978-3-030-43197-6>
- Davis, M.C., Challenger, R., Jayewardene, D.N.W. and Clegg, C.W. (2014). Advancing socio-technical systems thinking: A call for bravery. *Applied Ergonomics*, [online] 45(2), pp.171–180. doi:<https://doi.org/10.1016/j.apergo.2013.02.009>.
- Eini, R., Linkous, L., Zohrabi, N. and Abdelwahed, S. (2021). Smart building management system: Performance specifications and design requirements. *Journal of Building Engineering*, 39, p.102222. doi:<https://doi.org/10.1016/j.jobe.2021.102222>.
- Elbaum, S., Gable, J., & Rothermel, G. (2005). Modeling and testing dynamic web applications. *IEEE Transactions on Software Engineering*, 31(3), 274-287. <https://doi.org/10.1109/TSE.2005.36>
- Elmasri, R., & Navathe, S. B. (2015). *Fundamentals of database systems* (7th ed.). Addison-Wesley.
- European Commission. (2022). *General Data Protection Regulation (GDPR)*. Retrieved from https://ec.europa.eu/info/law/law-topic/data-protection_en

- Fielding, R. T. (2000). *Architectural styles and the design of network-based software architectures* (Doctoral dissertation, University of California, Irvine). Retrieved from <https://www.ics.uci.edu/~fielding/pubs/dissertation/top.htm>
- Fowler, M. (2018). *Continuous delivery: Reliable software releases through build, test, and deployment automation*. Addison-Wesley.
- Fowler, M., & Highsmith, J. (2001). The Agile manifesto. *Software Development*, 9(8), 28-35.
- Google. (2022). *OAuth 2.0 for web server applications*. Retrieved from <https://developers.google.com/identity/protocols/oauth2/web-server>
- Health & Human Services. (2021). *Health Insurance Portability and Accountability Act (HIPAA)*. Retrieved from <https://www.hhs.gov/hipaa/index.html>
- ieeexplore.ieee.org. (n.d.). *A survey of agile methodologies / SAIEE Journals & Magazine / IEEE Xplore*. [online] Available at: <https://ieeexplore.ieee.org/abstract/document/9487986>.
- Jackson, S., Wilson, J.R. and MacCarthy, B.L. (2004). A New Model of Scheduling in Manufacturing: Tasks, Roles, and Monitoring. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 46(3), pp.533–550. doi:<https://doi.org/10.1518/hfes.46.3.533.50393>.
- Jenny, H., Wang, Y., Alonso, E.G. and Minguez, R. (2020). Using Artificial Intelligence for Smart Water Management Systems. [online] doi:<https://doi.org/10.22617/brf200191-2>.
- Johnson, T., & Miller, A. (2022). *Building responsive web applications with React.js*. O'Reilly Media.
- Jones, P., & Clark, R. (2023). *Training management systems: Current trends and future directions*. Wiley.
- JUANG, Y., LIN, S. and KAO, H. (2007). An adaptive scheduling system with genetic algorithms for arranging employee training programs. *Expert Systems with Applications*, 33(3), pp.642–651. doi:<https://doi.org/10.1016/j.eswa.2006.06.010>.
- K. Sirsat, S., Kumar, V., Bhardwaj, V. and Raj, G. (2022). Comparison of Machine Learning Classification Models in Smart Team Management Application for Performance Analysis. *SSRN Electronic Journal*. doi:<https://doi.org/10.2139/ssrn.4157635>.
- Kaner, C. (2006). *Testing computer software*. Wiley.
- Kroll, A. and Moynihan, D.P. (2015). Does Training Matter? Evidence from Performance Management Reforms. *Public Administration Review*, 75(3), pp.411–420. doi:<https://doi.org/10.1111/puar.12331>.
- Liu, M. and Yu, D. (2022). Towards intelligent E-learning systems. *Education and Information Technologies*, 28. doi:<https://doi.org/10.1007/s10639-022-11479-6>.

- Mazhar, S.A., Anjum, R., Anwar, A.I. and Khan, A.A. (2021). Methods of Data Collection: A Fundamental Tool of Research. *Journal of Integrated Community Health (ISSN 2319-9113)*, 10(1), pp.6–10.
- Mershad, K. and Wakim, P. (2018). A Learning Management System Enhanced with Internet of Things Applications. *Journal of Education and Learning*, 7(3), p.23. doi:<https://doi.org/10.5539/jel.v7n3p23>.
- Myers, G. J., Sandler, C., & Badgett, T. (2011). *The art of software testing*. Wiley.
- Nadiyah, R.S. and Faizah, S. (2015). The Development of Online Project Based Collaborative Learning Using ADDIE Model. *Procedia - Social and Behavioral Sciences*, 195, pp.1803–1812. doi:<https://doi.org/10.1016/j.sbspro.2015.06.392>.
- Peterson, C. (2003). Bringing ADDIE to Life: Instructional Design at Its Best. *Journal of Educational Multimedia and Hypermedia*, [online] 12(3), pp.227–241. Available at: <https://www.learntechlib.org/p/2074/>.
- Pressman, R. S. (2020). *Software engineering: A practitioner's approach*. McGraw-Hill.
- ResearchGate. (n.d.). (*PDF*) *Fundamentals of research methodology and data collection*. [online] Available at: https://www.researchgate.net/publication/303381524_Fundamentals_of_research_methodology_and_data_collection?enrichId=rgeq-a754a34d168071cff6a255ca615b77b0-XXX&enrichSource=Y292ZXJQYWdlOzMwMzM4MTUyNDtBUzozNjM4NDU4NTcxMDM4NzNAMTQ2Mzc1OTAyMDk2MQ%3D%3D&el=1_x_2&_esc=publicationCoverPdf.
- Ropohl, G. (1999). Philosophy of Socio-Technical Systems. *Techné: Research in Philosophy and Technology*, 4(3), pp.186–194. doi:<https://doi.org/10.5840/technetechne19994311>.
- Sammalisto, K. and Brorson, T. (2008). Training and communication in the implementation of environmental management systems (ISO 14001): a case study at the University of Gävle, Sweden. *Journal of Cleaner Production*, 16(3), pp.299–309. doi:<https://doi.org/10.1016/j.jclepro.2006.07.029>.
- Schwaber, K., & Beedle, M. (2020). *Agile software development with Scrum*. Pearson Education.
- Scrum Alliance. (2022). *Scrum guide*. Retrieved from <https://www.scrumguides.org>
- Silva, N.S.A. da, Costa, G.J.M. da, Prior, M. and Rogerson, S. (2011). The Evolution of E-Learning Management Systems: An Ethical Approach. *International Journal of Cyber Ethics in Education*, [online] pp.12–24. Available at: <https://repositorio.ual.pt/handle/11144/335>.
- Smith, J. (2022). *Modern software design*. MIT Press.

- Srivastava, A., Bhardwaj, S. and Saraswat, S. (2017). SCRUM Model for Agile Methodology. *2017 International Conference on Computing, Communication and Automation (ICCCA)*, [online] 1(1). doi:<https://doi.org/10.1109/ccaa.2017.8229928>.
- Sutcliffe, A. (1998). Scenario-based requirements analysis. *Requirements Engineering*, 3(1), pp.48–65. doi:<https://doi.org/10.1007/bf02802920>.
- Tseng, J.C.R., Chu, H.-C., Hwang, G.-J. and Tsai, C.-C. (2008). Development of an adaptive learning system with two sources of personalization information. *Computers & Education*, 51(2), pp.776–786. doi:<https://doi.org/10.1016/j.compedu.2007.08.002>.
- Wang, Y., & Chang, Y. (2020). *AJAX programming with JavaScript and jQuery*. Wiley.
- Williams, R. (2021). *Configurable systems: Principles and practices*. Cambridge University Press.