



## School of Computer Sciences

### CAT400 Undergraduate Major Project

#### Final Report

*SC21220141: University Strategic Partnership Customer  
Relationship Management (CRM) System*

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**Academic Session**

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## DECLARATION

"I declare that the following is my own work and does not contain any ***unacknowledged*** work from any other sources. This report was undertaken to fulfill the requirements of the Undergraduate Major Project for the Bachelor of Science in Computer Science (Honors) program at Universiti Sains Malaysia".

Signature : 

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Date : 29<sup>th</sup> June 2022

## **ABSTRAK**

University Strategic Partnership Customer Relationship Management (CRM) System merupakan sebuah sistem yang dibangunkan bertujuan untuk mengukuhkan perhubungan akademik antara penggunanya, iaitu pensyarah universiti dan industri. Sistem ini membolehkan pensyarah, khususnya pensyarah Sains Komputer dan pihak berkepentingan dalam industri untuk mempromosikan projek mereka kepada pengguna, sama ada berkaitan penyelidikan dan pembangunan atau pengajaran dan pembelajaran. Sistem ini menyediakan platform perbincangan buat pengguna untuk membincangkan projek mereka dan mengemaskini perkembangan projek mereka. Pengguna juga boleh mendapatkan cadangan (rekomendasi) projek berdasarkan minat mereka. Projek ini dibangunkan untuk pensyarah universiti dan industri untuk menghubungkan kedua-dua belah pihak dengan lebih berkesan. Selain itu, pelajar universiti juga diharapkan dapat memperoleh pengalaman dalam praktikum yang dapat memanfaatkan masa depan mereka. Sistem ini berbentuk papan pemuka yang boleh digunakan pengguna untuk berkomunikasi antara satu sama lain mengenai kolaborasi projek. Ia juga diharapkan dapat membantu pengguna mengenalpasti sebarang projek berdasarkan rekomendasi yang disediakan oleh sistem.

Kata kunci: universiti, pihak berkepentingan industri, penyelidikan dan pembangunan, pengajaran dan pembelajaran

## **ABSTRACT**

The University Strategic Partnership Customer Relationship Management (CRM) System is a dashboard system that seeks to improve the academic relation between the main users, university lecturers and industries. The system allows university lecturers, specifically Computer Science lecturers and industry representatives to promote their projects, either research and development or teaching and learning projects. The system provides a discussion platform for users to discuss these projects in detail and keep track of their progress. Users can get project recommendations which are tailored based on their liking for an enhanced experience. The project is developed for both university lecturer and industries to connect with each other in a more efficient way. Other than that, university students can get a hands-on experience of how the industry works, which is beneficial for their future. The system should be a dashboard application that can be used by university and industries to communicate with each other for project collaboration purposes. This should also be able to help users identify any projects of their interest based on the recommendations of the system.

Keywords: university, industry representatives, research and development, teaching and learning, dashboard

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## **LIST OF ABBREVIATIONS AND SYMBOLS**

CRM	- Customer Relationship Management
CSS	- Cascading Style Sheets
FYP	- Final Year Project
GB	- GigaByte
GLC	- Government-Linked Company
HTML	- HyperText Markup Language
IDE	- Integrated Development Environment
JRE	- Java Runtime Environment
MNC	- Multinational Corporation
NGO	- Non-Governmental Organization
R&D	- Research & Development
SME	- Small and Medium-sized Enterprises
SOP	- Standard Operating Procedure
SSD	- System Sequence Diagram
SWOT	- Strength, Weakness, Opportunity, Threat
T&L	- Teaching & Learning
WBS	- Work Breakdown Structure

# 1 INTRODUCTION

## 1.1. Background

Customer Relationship Management (CRM) is generally defined as any approach or practice by businesses nowadays to manage connections with their consumers [1]. These strategies vary according to the business, such as compiling customer data using media like e-mail or phone, and customers' personal information.

In the past few years, research and development (R&D) have always been pivotal to the science and technology industry to ensure the industry keeps evolving [2]. Continuous R&D helps create new knowledge and find solutions to certain problem. In university level, collaboration between companies and university are one of the important mechanisms for continuous R&D. This collaboration is also important to ensure education for university students are at their best through multiple teaching and learning (T&L) provided. However, to date, there has not been a proper platform for easier communication between the two sides. Besides, the current traditional ways like through emails are not suitable for proper documentation, as there is no repository to store important documents related to the project such as participants' certificates.

In education, specifically higher institutes, the use of CRM is existent, but very limited [3]. CRM in university mostly focused on the university-student interaction including university admissions and connecting with alumni. No CRM for the use of R&D and T&L has been developed for higher institutions so far in the market. Therefore, the University Strategic Partnership CRM System is a system that aims to minimize these problems by offering a platform for university lecturers and industry representatives to collaborate with each other easier. Instead of doing it the traditional ways, both parties can do it through this system. The system consists of three users, admin, university lecturers and industry representatives. This system uses CRM practice to nurture connection between industry and university by improving the collaboration process to make it more efficient. The system also analyzes users' data to identify their preferences, thus enhancing the academic relationship between the university and representatives.

## 1.2. Problem Statements

When it comes to collaborations between university and industry representatives, there needs to be proper two-ways communication. However, the current ways such as e-mailing, or sending WhatsApp messages are not good enough platforms so both sides cannot communicate properly regarding collaboration. Emails or messages sent may have been buried under a pile of other messages when discussing for collaboration, which may lead to lost or misleading information. Other than that, most CRM systems in the market are developed only for business. To date, there has not been a good CRM system for university-industry collaboration.

With the current Covid-19 pandemic still happening in Malaysia, many universities also missed out the opportunities to handle face-to-face events related to working life such as industrial visit. Even though the situation is recovering, it is still hard for university to do such event due to Standard Operating Procedure (SOP) restrictions. Hence, many opt for virtual events, e.g virtual site visit. However, it may be hard for university to look for potential companies for collaborations due to many of them cutting down their resources or ceasing operations because of the pandemic.

There is also no proper archive to store records for the project, including draft agreements. University and industry mostly use traditional ways of storing their documents in either their local repositories or other cloud platforms such as Google Drive.

## 1.3. Motivation

The first motivation of implementing this project comes from the lack of CRM systems available in the market for university-industry partnerships. Most CRM systems nowadays are centered around business. The needs of developing a proper system for university-industry collaboration is supported by the Malaysian government, stating that more platforms for lecturers to exchange idea would be beneficial especially for R&D innovation [4].

Next, Computer Science has been known as a field with many branches as the field grows more over the years. Compared to the other fields, Computer Science graduates have been in demand more than ever, with The Bureau of Labor Statistics expecting

that the employment rate will increase by 15% from 2019 to 2029 [5]. For higher institutions, establishing partnerships with industry when the field is continuously developing can be a tedious work. Therefore, this project is developed in order to lessen the problem of looking for a suitable partner by providing recommendation based on the needs of both university academic staff and industrial partner.

Another motivation of proposing this project is to enable both academic staff and industrial partner to keep documents of the projects in the system. As there is no exact place to store the documents, they can treat the system as an archive to store these documents.

## 1.4. System Objectives

The objectives of the system are:

- To provide a dashboard system that allows academic staff and industrial representatives communicate with each other for collaboration purposes. Through this platform, both sides can reach out to each other easier.
- To develop a suitable recommendation system based on similarities and differences of the industrial representative and academic staff.
- To serve as a centralized repository to keep documents related to discussed projects. In this way, proper documentation can be made for the projects.

## 1.5. Proposed Solutions

The University Strategic Partnership CRM System is a dashboard application for university lecturers and industry representatives for research, development and education purposes. Through this, lecturer can keep in touch with industry representatives for collaboration. The system contains five modules, as shown in Figure 1.1 below:

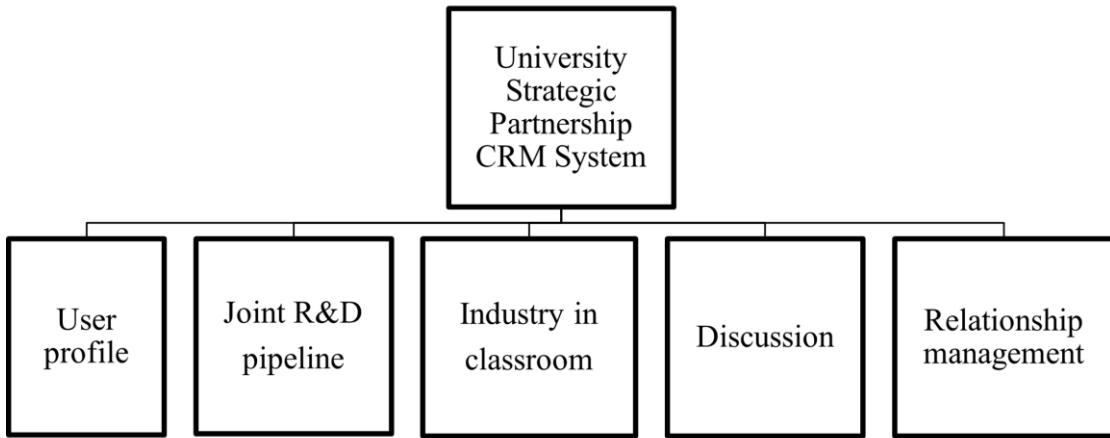


Figure 1.1. Overall module diagram of the system

The first module is **User profile** module. All users can update their profile and view other users' profile. Admin monitors and sets user access to the system.

Next, the **Joint R&D pipeline** is the first core module that provides users the opportunity to post any project related to R&D. This is where user, either university lecturer or industry can look for potential collaborators to work on an R&D project together. This module covers final year project (FYP) project offering by industry partners. It also covers potential research project offering between academic staff and industry partners. Project admin can edit the project while interested collaborators can reach out to the admin. This will be discussed further in the Discussion module. User can also track their R&D project progress by adding project activity. Both parties can update the project with more information as they progress. There will be a repository to store important documents related to the project such as draft agreements and project description. User also has the options to search projects based on their name.

The third module, **Industry in classroom** module is the second core module. T&L projects are allowed to be posted such as industrial talk or site visit. This module covers subjects for Computer Science from first year until final year. There is also an option to track the project's progress by updating the details of the project, including activity and adding important documents to the repository. User is also able to search for a specific T&L project.

Fourth module, **Discussion** module stems from R&D and T&L projects posted by the admin. For every project user posted, there will be a discussion board for further

discussion by admin and potential collaborators. There are two kinds of discussions, pre and post project participation discussion. For pre-project participation discussion, collaborators can comment under a project's post for a project they are interested with. The discussion will be public where project owner can reach out to collaborators that commented. After choosing one they are interested with, there will be a private discussion between the two parties for further content planning, such as discussing the topic in detail. Post-project participation discussion still involves both sides, however it only happens after they have done the project. This is where they can discuss issues such as certificates to participants or agreements.

The last module, **Relationship management** module provides enhanced experience for users, where they can view project recommendation based on their preferences and domain of interest. This recommender system will use the *cosine similarity* technique for comparing the preferences and projects to determine the correct recommendation for users. The steps will be explained more in Section 2.5, Introduction of proposed work and Section 4.2.2, Algorithm implementation.

## 1.6. Benefits and Uniqueness of the Proposed Solutions

The benefits of the project are:

- University and industry representatives can reach out to each other more easily for collaboration purposes.
- The system can promote healthy idea exchange between university and industry representatives through the projects.
- Industry representatives can identify and hire talents from university for job training early.
- University students can be exposed to the industry, preparing them for working life earlier.

The uniqueness of the proposed solutions is:

- Recommender system based on user preferences to help users discover new projects.

## 1.7. Organization of the Report

The final report starts with abstract which contains the overall description of the project. The rest of the report is divided into six main parts: Introduction, Background & Related Work, System Analysis / Requirements, System Design & Implementation, System Testing & Evaluation, and Conclusion & Future Work.

The first part, Introduction contains brief introduction to the system, including background, problem statements that lead to the development of the project and motivation. It also contains system objectives, proposed solutions with module diagram and benefits/uniqueness of the project.

The second part, Background & Related Work consists of status of the project whether it is new or continuation of previous project, existing systems review, existing algorithms/theories/models, comparison of strengths and weaknesses of existing systems and a brief introduction to the proposed work.

Third part, System Requirements / Analysis are further split into several parts. Firstly, the project scope, capabilities and limitations are provided. Next, the part consists of Work Breakdown Structure (WBS), Gantt chart, milestone timeline and SWOT analysis. Other than that, the development methodology and detailed requirements of new system are also mentioned in this part. Furthermore, the analysis of the new system using diagrams such as use case diagram, UML class diagram and flowcharts are also provided. The last section of this part contains the technology deployed for the project, including hardware and software.

The fourth part, System Design & Implementation comprises four smaller sections. The first section contains the detailed system sequence diagram (SSD) of important use cases. The second section explains in deeper the implementation of cosine similarity algorithm in the system. The third one, User Interface Design has the screenshots of the web application's user interface. The last section, Implementation Strategy describes the implementation strategy used to build the system and the reasons for choosing the technique.

Fifth part, System Testing & Evaluation involves the testing done to the system after the complete construction. Other than the usual type of testing done and the test case list, this part also contains a discussion on whether the system meets the requirement or not. Other than that, is system evaluation, where the system is evaluated in terms of its strengths and weaknesses.

The last part, Conclusion & Future Work presents my conclusion and thought on my future work for this project.

## 2 BACKGROUND & RELATED WORK

### 2.1. Status of project development

This is a newly developed project and not a continuation of any other project. The system may take inspiration from other existing CRM systems; however, it is unique.

### 2.2. Existing system

#### 2.2.1. Zoho CRM

Released in November 2005 [6], Zoho CRM is a cloud-based software solution for users managing their businesses. It is now one of the most popular CRM systems with more than one million users worldwide. Zoho offers a variety of solutions depending on their customers' needs, including features for marketing and sales purposes. Not only is it available web based, Zoho also has a mobile application for Android and Apple users. Figure 2.1 shows an example of Zoho CRM web dashboard when user first logged in. The dashboard can be customized with different components, including adding analytics for reviewing business performance.

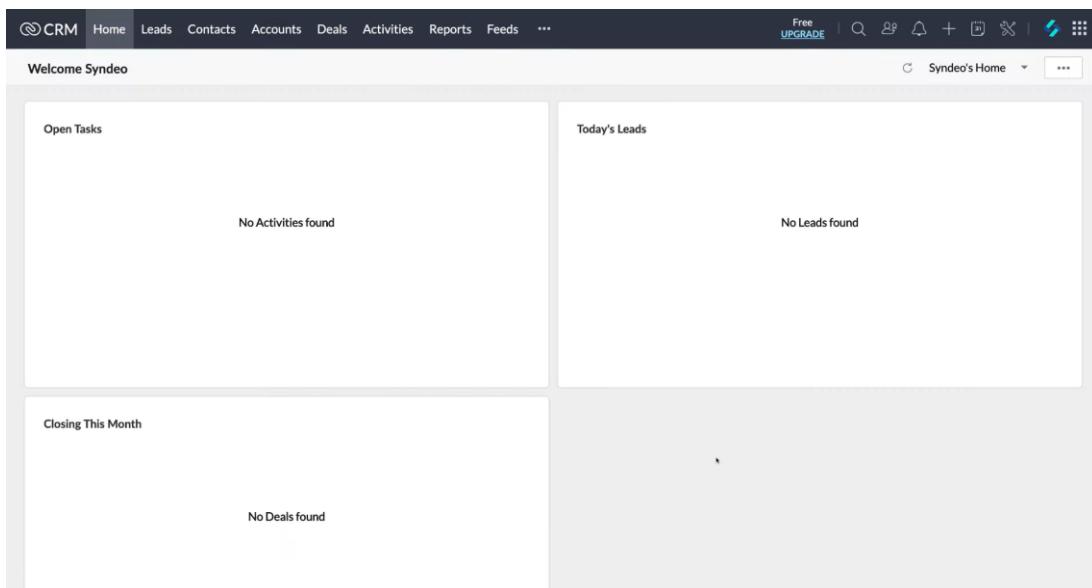


Figure 2.1 Dashboard of Zoho CRM

The functionalities offered by Zoho CRM [7] are as explained below:

- Add and import contacts of customers. Leads are used to add possible customers' contact to the business, such as people the business have potential to deal with. Supposed the business has locked a deal with a potential customer, their contact information will be moved to Contacts. Contacts are reserved for existing customers, customers who are currently or have done dealing with the business. This is useful for business to keep in touch with their customers always. User can also import contacts from their local files or other CRM systems. Figure 2.2 shows an example of a Leads contact.

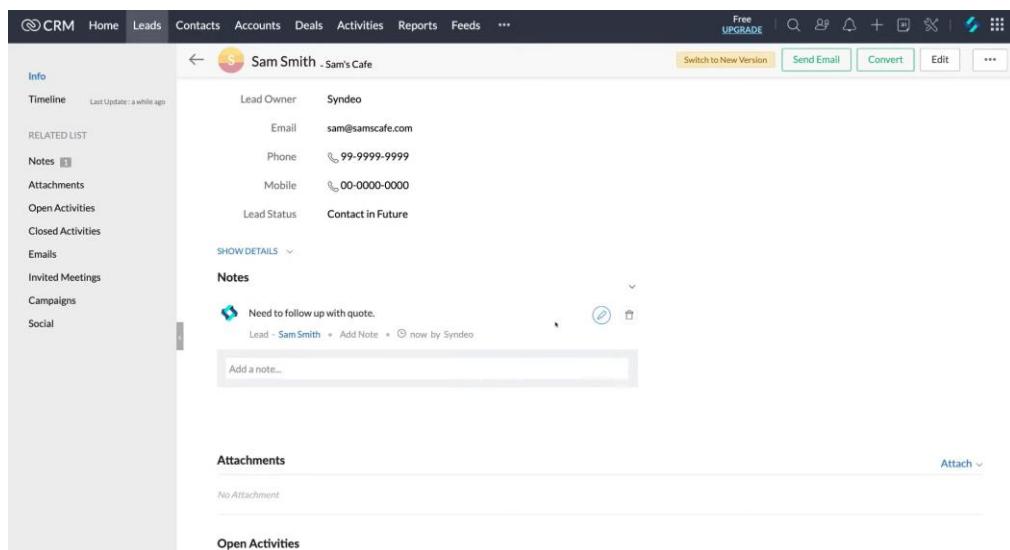


Figure 2.2 Example of Leads contact in Zoho CRM

- Add and import organization. While Leads and Contacts are for storing people within the organization, Accounts is solely for adding the information of the organization or department the user is dealing with. Figure 2.3 shows an Account example.

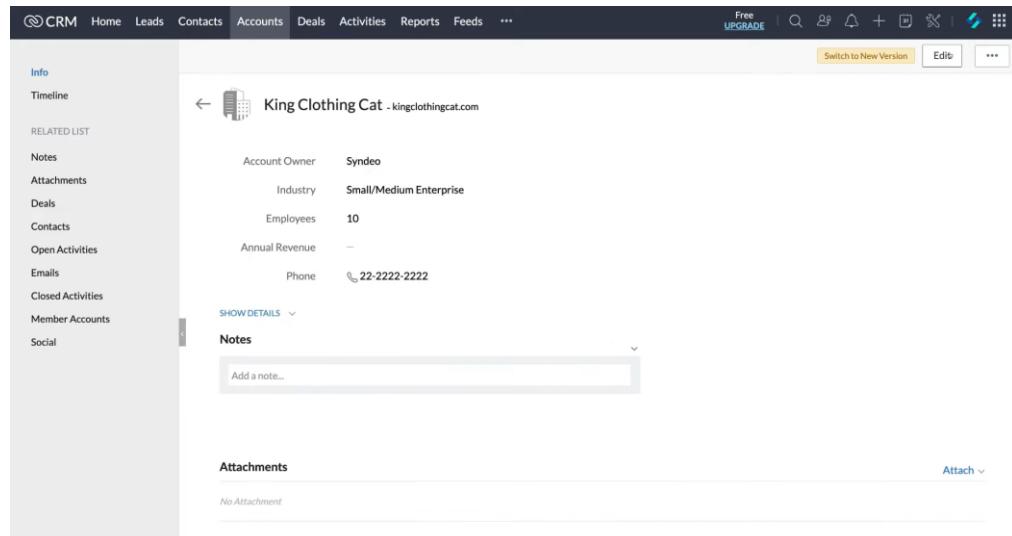


Figure 2.3 Example of organization Account in Zoho CRM

- Add and update business deals. User can create a new deal under the Deals tab. Here, user could update the deal information, track the deal progress, add notes, attachment, competitors, activities like meeting, task and call, contacts and send emails. This feature helps business to monitor their sales cycle and track the sales pipeline. Figure 2.4 and 2.5 show the example of a deal created.

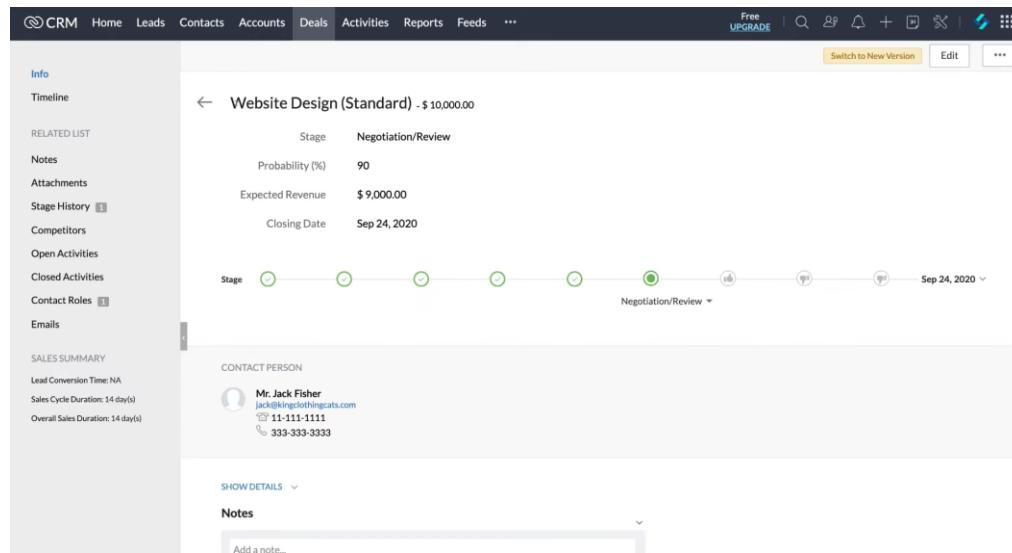


Figure 2.4 Example of deal in Zoho CRM (1)

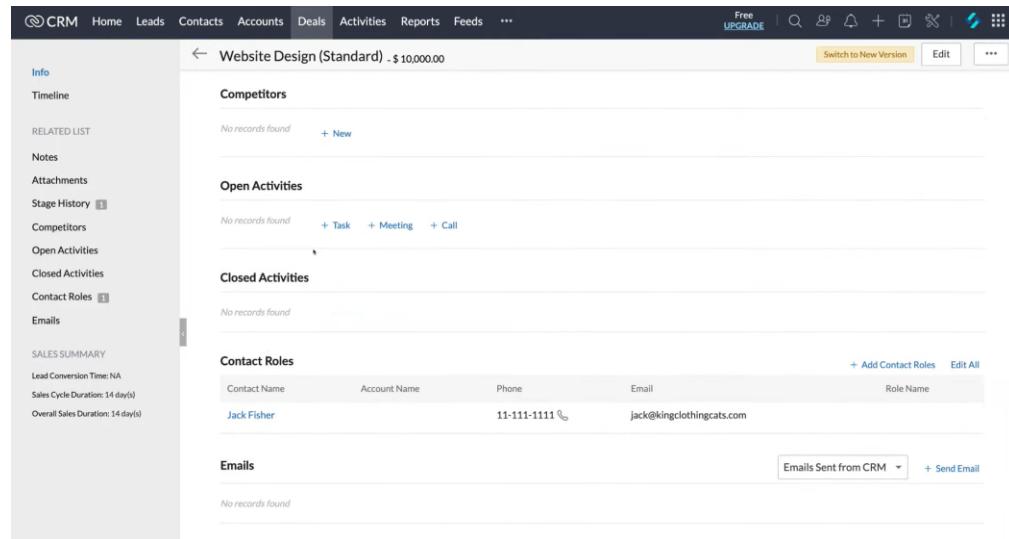


Figure 2.5 Example of deal in Zoho CRM (2)

- Add activities. User can either schedule a task, meeting or call with customers, as shown in Figure 2.6.

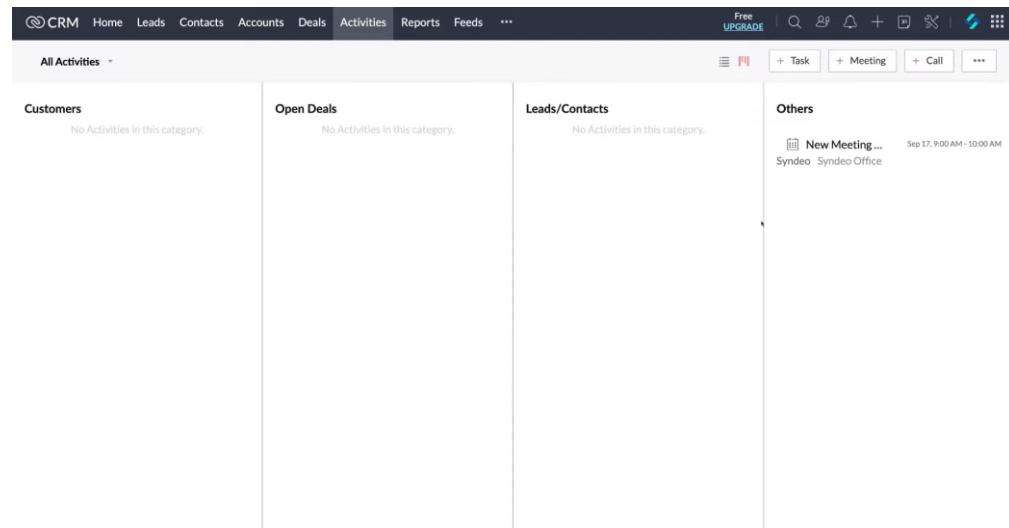


Figure 2.6 Activities feature in Zoho CRM

- Generate report. Zoho Analytics lets user review their business performance by generating various reports for the record as displayed in Figure 2.7.

The screenshot shows the 'Reports' section of the Zoho CRM interface. On the left, a sidebar lists various report categories: Favorite Reports, Recent Reports, Reports Created by Me, Account and Contact Reports, Deal Reports, Lead Reports, Activity Reports, Sales Metrics Reports, and Meeting Reports. The main area is titled 'All Reports' and contains a table with columns for 'Report Name', 'Description', and 'Last Run Date'. The table lists 16 different reports, each with a small icon and a brief description.

Report Name	Description	Last Run Date
Check-Ins for Leads	Get check-in details for each Lead	-
Key Accounts	Accounts with more Deals	-
Pipeline by Probability	Deals by Probability	-
Leads by Ownership	Leads by Owner	-
Lead Conversion Count across Owners	Total number of Lead converted for the past 6 months, by all owners	-
Contact Mailing List	Contact Address details	-
Open Deals	Deals Pending	-
Todays Leads	Leads obtained today	-
Lead Conversion Across Owners	Average Lead conversion time for the past 6 months, by owner	-
Check-Ins for Accounts	Get check-in details for each Account	-
Deals by Type	Deals by Type	-
Leads by Status	Leads and their statuses	-
Sales Cycle Duration Across Owners	Average time taken for Potentials won, by Owner Deal	-
Overall Sales Duration Across Deal Type	Average time taken for Lead to be converted to Deal of different type	-
Lost Deals	Deals Lost	-

Figure 2.7 Example of reports in Zoho CRM

- Post feeds. Feeds are simply for updating followers on what the business is up to. User can post anything related to their business and followers can write their comments. Figure 2.8 depicts the use of Feed in Zoho CRM.

The screenshot shows the 'Feeds' section of the Zoho CRM interface. The left sidebar includes 'Followed by me', 'Dormant Records', 'Auto-Follow Rules' (with 'Manage' and 'Create' options), and 'Feeds Preference'. The main area displays a feed post from a user named 'Syndeo' at 4:59 PM. The post content is: 'Website Design (Standard) \$ 10,000.00 Stage changed from 'Closed Lost' to 'Negotiation/Review' Expected Revenue changed from '\$ 0.00' to '\$ 9,000.00 Probability (%) updated to 90'. Below the post is a text input field labeled 'Write a comment.'

Figure 2.8 Feeds feature in Zoho CRM

There is a limitation of Zoho CRM system which will be discussed in Section 2.4, Strengths and Weaknesses of existing system.

### 2.2.2. Salesforce Education Cloud

Salesforce is also a cloud-based platform offering CRM solutions. Like any other CRM systems in the market, Salesforce allows proper communication and engagement between businesses and their clients. However, unlike any other CRM systems, Salesforce has Education Cloud, a solution for higher institutions to better manage their students, staffs and alumni. Figure 2.9 depicts a dashboard of an account in Salesforce Education Cloud. The dashboard is also customizable, depending on the data user wants to display.

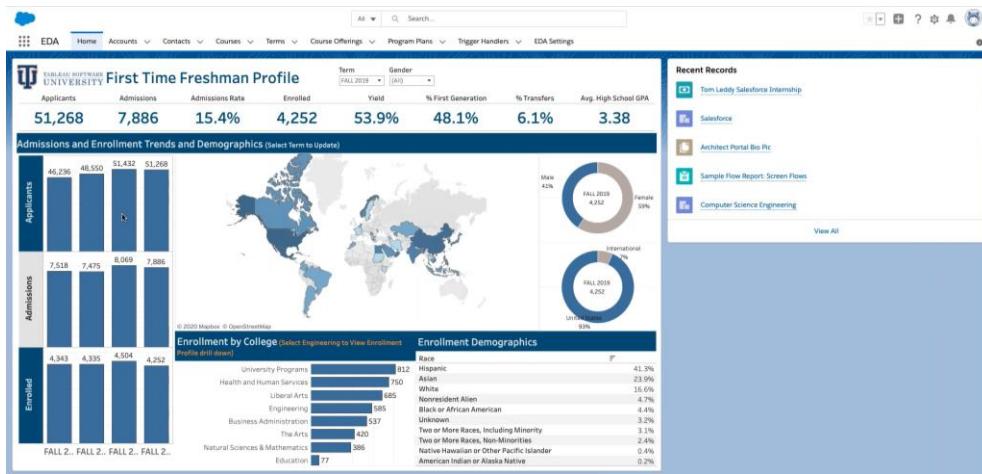


Figure 2.9 Dashboard of Salesforce Education Cloud

Salesforce Education Cloud is a CRM for managing university's connection with their students, potential applicants and alumni. Some of the functionalities [8] offered by Salesforce Education Cloud are:

- Add and import individual contact. For Salesforce, Contacts is used to store an individual within the organization's contact information. In this case, Contacts contain the details of the institute's faculties/staffs, students and alumni. User can also import the contacts from their local files. Figure 2.10 is an example of a student's contact information.

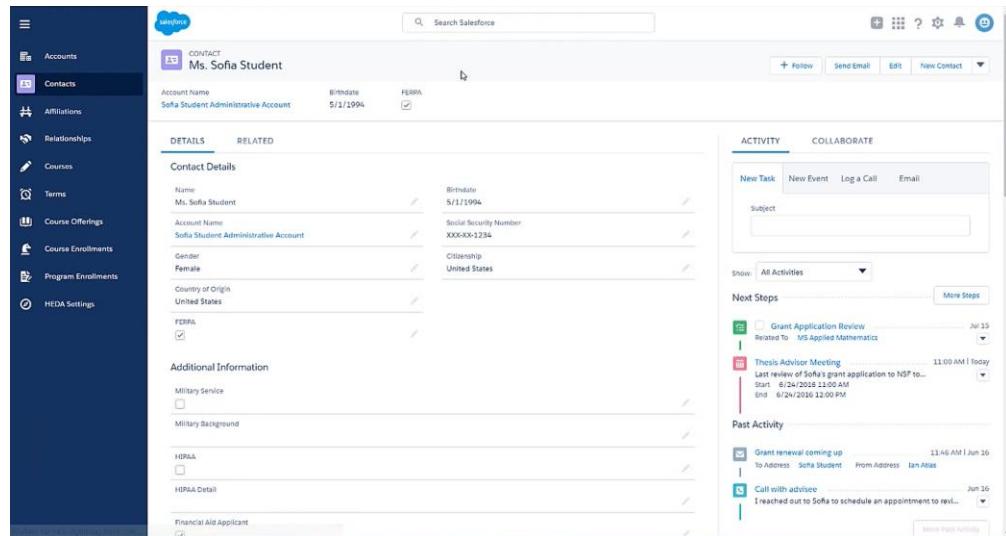


Figure 2.10 Example of Contact in Salesforce Education Cloud

Not only it stores the details of the student, but Salesforce CRM also lets user to add task, call, event and send email to the students. Apart from that, Salesforce also stores other related information to the student, such as their courses and affiliate contacts as displayed in Figure 2.11.

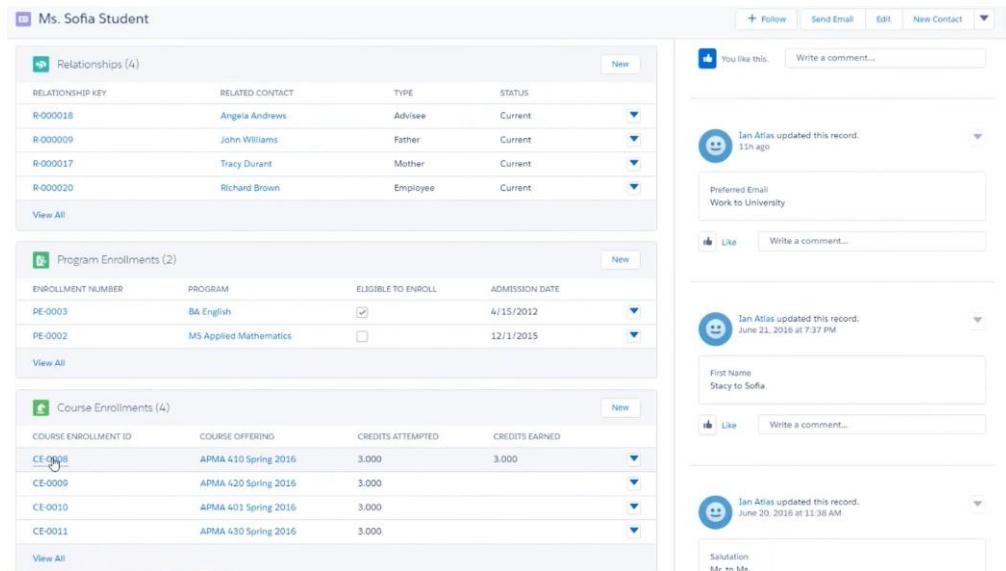


Figure 2.11 Example of Contact information in Salesforce Education Cloud

- Add and import account. Account is any organization or household the institutions have a relationship with. They consist of academic department, career recruiter, alumni household and current student household. Figure 2.12 shows an example of an account information.

The screenshot shows the Salesforce Education Cloud interface for an account named 'Math Department'. The top navigation bar includes 'Follow', 'Edit', 'New Contact', and 'New'. Below the header, there are tabs for 'RELATED' and 'DETAILS'. Under 'RELATED', there are sections for 'Contacts (0)', 'Affiliated Contacts (3)', 'Addresses (0)', and 'Courses (4)'. The 'Courses' section displays two entries:

COURSE NAME	COURSE ID	CREDIT HOURS	DESCRIPTION
Applied functional analysis	APMA 420	3.000	
Introduction to dynamical systems	APMA 410	3.000	In mathematics, a dynamical system is a syste...

Figure 2.12 Example of Account in Salesforce Education Cloud

- Add opportunity. Opportunity in this context is defined as any process or activity involving the institutions and other stakeholders want to track. The first one is recruiting and admissions. User can store and track prospective students' application progress. The second one is known as 'student experience'. This feature lets user track students' application progress for a research grant or studying abroad. Other than that, opportunity also allows institutions to connect with their alumni through gift donation. Figure 2.13 shows an example of tracking the progress of a prospective student's application.

The screenshot shows the Salesforce Education Cloud interface for an opportunity named 'S.Applicant/UG/CompSci/Fall'18'. The top navigation bar includes 'Admissions', 'Home', 'Leads', 'Contacts', 'Opportunities', 'Campaigns', 'Financial Aid', 'Applications', 'Notes', 'Reports', and 'Dashboards'. The opportunity details include:

- Type: Undergraduate Application
- Program of Interest: BS Computer Science
- Stage: Reviews In Progress
- Primary Campaign Source: College Fairs

The 'Contact Roles' section lists 'Sofia Applicant' (Applicant) and 'Betty Applicant' (Mother). The 'Opportunity Team' section lists 'Rachel Recruiter' (Admissions Counselor), 'Dean Cloudly' (Program-Specific Faculty Reviewer), and 'Casey Sponseller' (Program-Specific Staff Reviewer). The 'Activity Timeline' shows recent interactions:

- 2nd Review/UG/CompSci/S.Applicant/F18 (Today)
- 1st Review/UG/CompSci/S.Applicant/F18 (Today)
- You're all signed up for the campus tour!... (3:00 AM | Dec 11)
- Rachel Recruiter sent an email to Sofia Applicant (2:54 AM | Dec 11)
- Join us for a campus tour! (2:54 AM | Dec 11)

Figure 2.13 Example of Opportunity in Salesforce Education Cloud

Salesforce CRM permits the stakeholders (in this case, enrollment staffs) to review the applicants. Staffs can add calls, tasks and events related to the applicants.

- Add case. Case is any feedback, issue or question institution gets from the stakeholders and users could follow up on the questions. User can set up and automate cases. For example, any cases raised by stakeholders can be set up to receive an auto-reply email. Rules can also be added to the cases for restrictions, as illustrated in Figure 2.14.

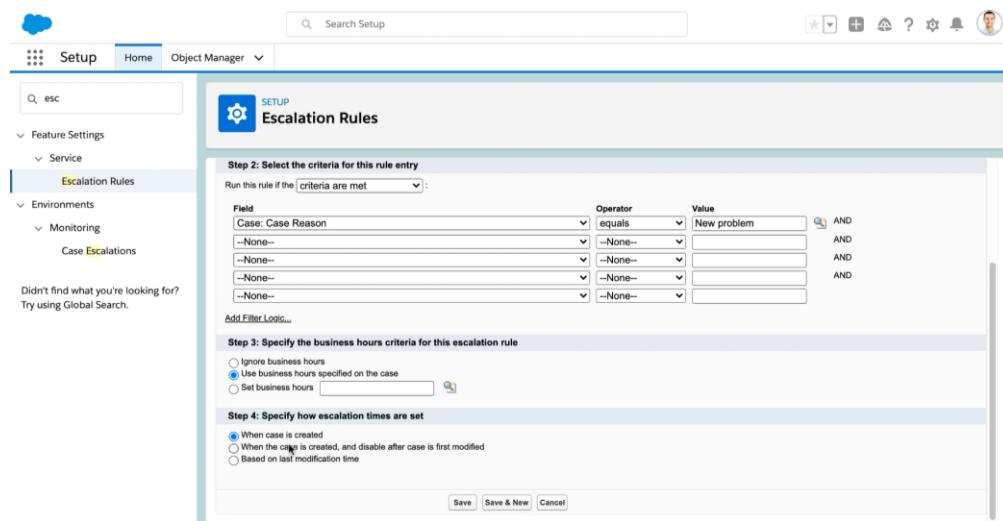


Figure 2.14 Example of adding Case rule in Salesforce Education Cloud

- Add and import leads. Similar to Zoho CRM, Leads in Salesforce CRM are also potential stakeholders to the institution. They might not be related to the institution yet, but in the future they might be. Leads could be a future student who attended seminar in the institution or someone who raised a case.

Salesforce CRM has more unique features for an enhanced user experience, however the ones listed are some of their most important features. These features help improve academic relation between students, potential stakeholders and alumni.

### 2.2.3. Mautic for Higher Education CRM

Mautic CRM is another cloud-based CRM platform that can cater to higher education. Figure 2.15 is a dashboard example of Mautic CRM.

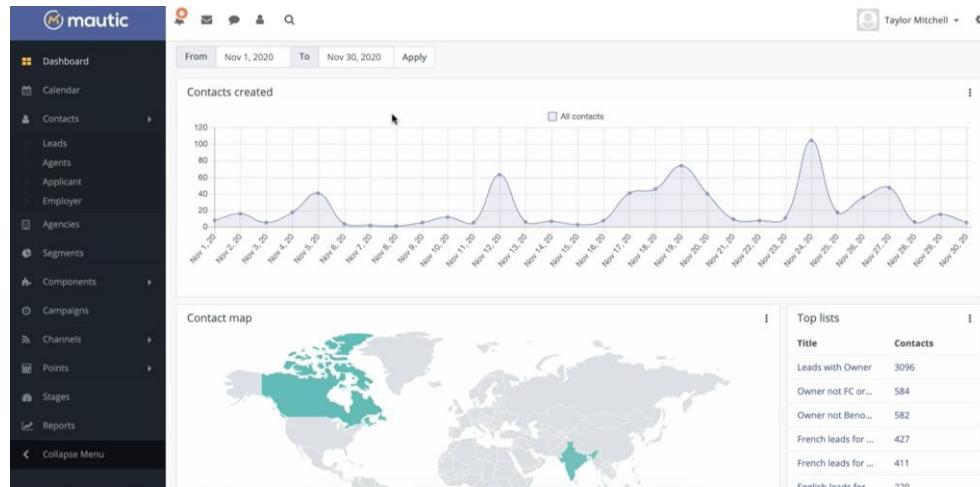


Figure 2.15 Dashboard example of Mautic for Higher Education CRM

Mautic CRM can be divided into several sections [9] as presented in Figure 2.16 below.

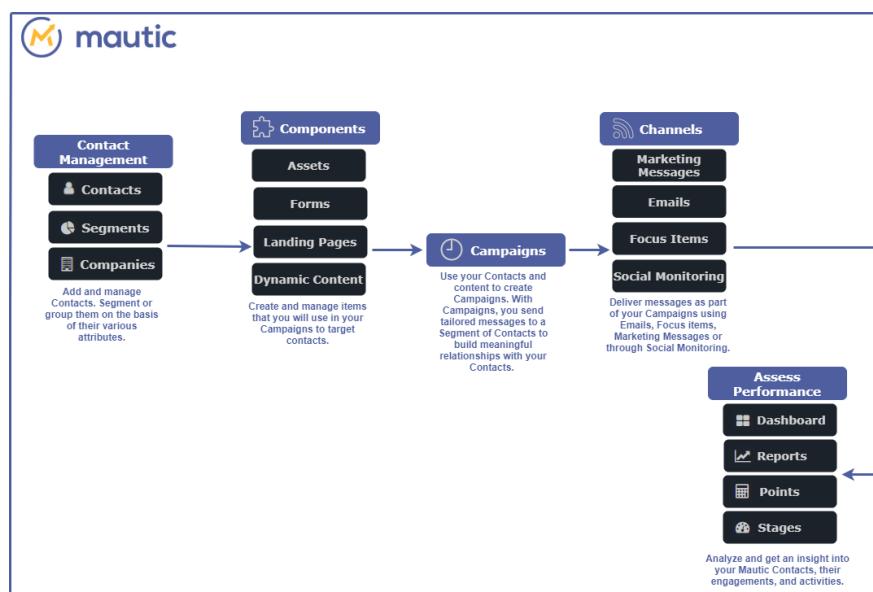


Figure 2.16 Components of Mautic for Higher Education CRM

- Add and import contacts. Contacts are used to store students, potential students and alumni contact information. These contacts can be grouped

according to their categories using Segments. Figure 2.17 shows the example of a contact information.

Field	Value
First Name	HEMTEST
Last Name	ELIE
Company	Test agency 3
Email	mynameiselle@hotmail.com
Country	Canada
Contact Type	Lead
Lead Status	Warm
Contacted	No

**Lead**

Field	Value
Lead Status	Warm
Stage	New Inquiry
Contact owner	HEM Admin
Channel	Empty
Address	Canada
Email	mynameiselle@hotmail.com
Phone - home	Empty
Phone - mobile	Empty

Figure 2.17 Example of Contact in Mautic for Higher Education CRM

As displayed in Figure 2.17 above, user can add more details of the student including program and emergency contact. New tasks, notes and calls can also be added.

- Add and manage components. Components can be assets, forms, landing pages or any dynamic content. These components are useful for marketing purposes for prospective students which will be discussed in the next point.
- Add and manage channels. This is where institution can use components for their marketing such as sending brochures and emails. Figure 2.18 is an example of asset; a brochure being used to send marketing email to prospective students.

**Higher Education Marketing**

**A Truly International Agency**

Based in Montreal, Canada, we have regional representatives living and working in the UK, Europe and North America. Our company includes professionals from all over the world working in several different languages. Each team member brings their own unique background and skills to our operation, including many with several years of experience working directly for education institutions.

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Drag the type to the desired position.

**Customize Slot**

```
<p>Based in Montreal, Canada, we have regional representatives living and working in the UK, Europe and North America. Our company includes professionals from all over the world working in several different languages. Each team member brings their own unique background and skills to our operation, including many with several years of experience working directly for education institutions.</p>
```

Based in Montreal, Canada, we have regional representatives living and working in the UK, Europe and North America. Our company includes professionals from all over the world working in several different languages. Each team member brings their own unique background and skills to our operation, including many with several years of experience working directly for education institutions.

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Padding Top: px

Padding Bottom: px

**Customize Section**

Content Background Color:

Figure 2.18 Example of brochure being sent to channel in Mautic for Higher Education CRM

- Generate report. Mautic CRM lets user customize their dashboard with various reports such as displaying statistics of visits and student enrollment for the past few months. Figure 2.19 shows an example of a dashboard with reports.

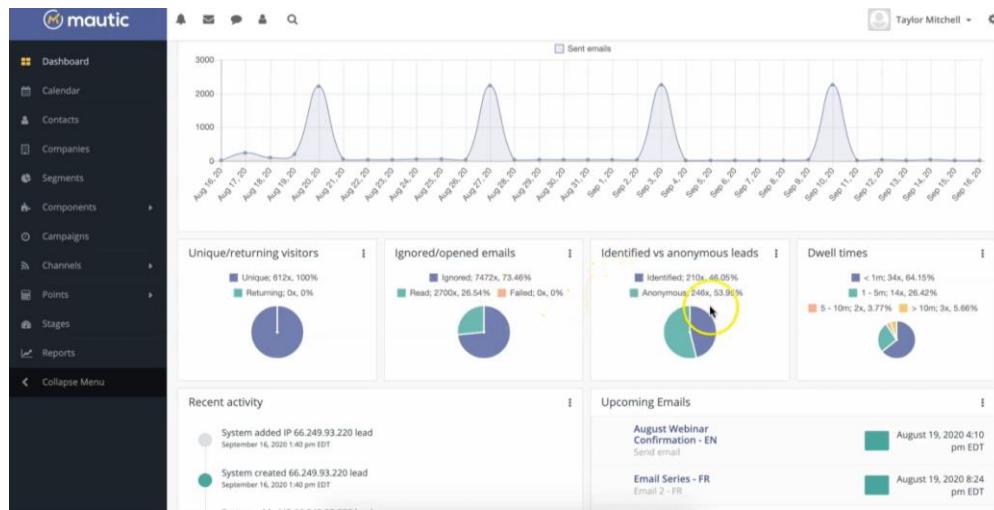


Figure 2.19 Example of reports on dashboard of Mautic for Higher Education CRM

#### 2.2.4. Comparison between existing systems

Table 2.1 compares the existing systems along with the new system.

Table 2.1 Comparison between existing system and new system

<b>Criteria</b>	<b>Zoho CRM</b>	<b>Salesforce Education Cloud CRM</b>	<b>Mautic for Higher Education CRM</b>	<b>University Strategic Partnership CRM</b>
<b>Operating platform</b>	Web-based and mobile-based	Web-based and mobile-based	Web-based	Web-based
<b>Type</b>	Business	Higher education	Higher education	Higher education
<b>Industry involved</b>	Yes	No	No	Yes
<b>Recommendation feature</b>	Available for Enterprise and Ultimate users only; Not available for Free, Standard and Professional users	Not available	Not available	Available
<b>Live chat feature</b>	Needs to be integrated with other Zoho plugin	Available	Not Available	Available

### 2.3. Existing algorithms/theories/models

Two types of existing algorithm will be discussed below, which are *Cosine similarity* and *Euclidean distance*.

a) Cosine similarity

Cosine similarity algorithm represents items as vectors, then calculates and returns the cosine value of the items [10]. The formula of the algorithm can be illustrated in Equation 2.1 below:

Equation 2.1 Cosine similarity formula

$$\text{similarity } (A, B) = \cos \theta = \frac{A \cdot B}{\|A\| \times \|B\|} = \frac{\sum_{i=1}^n A_i \times B_i}{\sqrt{\sum_{i=1}^n A_i^2 \sum_{i=1}^n B_i^2}}$$

A and B represent the vectors containing bag of words to be compared. The algorithm measures the cosine of the angle between vectors A and B. The higher the cosine value is to 1, the more similar the two vectors are.

b) Euclidean distance

Euclidean distance computes the distance of any two given points in a vector space and is represented by Equation 2.2 below:

Equation 2.2 Euclidean distance formula

$$\text{distance } (x, y) = \sqrt{\sum_{i=1}^n ((x_i - y_i)^2)} = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2 + \dots + (x_n - y_n)^2}$$

It has been known as the most common distance measure. It can also be used to measure similarities between objects. The lower the value of the distance, the more similar the objects are to each other.

For the recommendation part of the system, Cosine similarity is preferred over Euclidean distance because Euclidean distance will classify the compared vectors as

not similar, or dissimilar if there is an outlier among the two, disregarding the correlation between the two vectors [11].

## 2.4. Strengths and weaknesses of existing system

Table 2.2 shows the strengths and weaknesses of the existing systems discussed in Section 2.2 before, in comparison with the new proposed system.

Table 2.2 Strengths and weaknesses of existing system

Application	Strengths	Weaknesses
Zoho CRM	Integration with other apps such as Gmail and other Zoho apps make it easy to use Zoho without having to navigate through several apps at one moment	Limited modules available for free users lessen the experience of using the system. For example, only 1 GigaByte (GB) storage is provided for free user for storing.
Salesforce Education Cloud CRM	Easy to track student's admission progress	Not beginner friendly as the massive number of components can be daunting and takes time to learn
Mautic for Higher Education CRM	Easy account management and rich in features such as contacts, emails, and campaigns	No live chat feature provided; Communication such as sending messages requires integration with message application of user
University Strategic Partnership CRM	Recommendation system based on preferences can help users get started with their projects	Integration with other apps is not allowed yet

## 2.5. Introduction of proposed work

University Strategic Partnership CRM System is a system proposed to help university lecturers and industry create partnerships in an easier and effective way. The web system lets users to post R&D and T&L projects for potential partners to reach out. This system can be a discussion platform to spark ideas, as well as keeping progress of the project. Users can add activities and attachments related to the project. This system also has a recommendation engine for recommending projects to users in case they need something to start with. The general steps for viewing project recommendations are explained as below:

1. User chooses their preferences by choosing any preference they are interested with. The preferences are grouped according to their field electives based on the new curriculum of School of Computer Sciences, Universiti Sains Malaysia based on Table 2.3 below:

Table 2.3 Field electives

Field Electives	Topics
Intelligent Systems & Data Analytics	Artificial Intelligence, Machine Learning, Natural Language Processing
Media & Visual Computing	Multimedia System, Computer Graphics, Visual Processing
Embedded Systems	Networking, Cloud Computing, Internet of Things
Information Security & Assurance	Cybersecurity, Forensics, Cryptography
Information Systems Development	Database, Enterprise Architecture, Information Systems
Specialized Systems Development	Software Development, Web Development, Mobile and Game Development

2. Based on user preferences, match the user preferences with the projects based on the keywords, Topics as shown in Table 2.3 above.

The scenario assumed for matching the topics with the field electives would be as followed:

1. User (Lecturer/Industry Representative) edits profile.
2. Under the ‘Preferences’ option, user chooses to tick *Networking*, *Artificial Intelligence* and *Machine Learning* as their preferences and saves the information.
3. User preferences will be compared with the list of projects. Top three projects containing the keywords chosen will be recommended to user.

Before applying cosine similarity to calculate the similarities, we will first extract keywords of each project. The simplified process will be described as followed:

1. The text of each project will be parsed by splitting it into array of words.
2. The array of words is known as the keywords of each project.
3. Calculate the frequency of occurrence of each word.

After that, cosine similarity technique can be used to measure the similarities between user preference and the keywords of each project:

1. A similarity matrix is created to calculate the similarities between user preferences and the keywords of the project using cosine similarity formula:

Equation 2.3 Cosine similarity formula for the recommendation system

$$\text{similarity } (p, q) = \frac{p \cdot q}{\|p\| \times \|q\|} = \frac{\sum_{i=1}^n p_i \times q_i}{\sqrt{\sum_{i=1}^n p_i^2 \sum_{i=1}^n q_i^2}}$$

$p_i$  is the weight of  $i$  term in user preferences while  $q_i$  is the weight of the  $i$  term in the project.

2. The pseudocode of cosine similarity to identify suitable project recommendation for users is explained as below:

Table 2.4 Cosine similarity pseudocode

```

function calculateSimilarity (p, q)

1. for each term t
    calculate weight,  $w_{t,p}$  of each term t in preference p
2. for each keywords in project list, p
    calculate weight,  $w_{t,q}$  of each term t in project q
    calculate dot_PQ, the dot product of  $w_{t,p}$  and  $w_{t,q}$ 
    calculate length_PQ, the product of the two vectors' lengths
    calculate similarity, the value of dot_PQ/length_PQ
3. return three projects with the highest similarity with user preference

```

3. The three projects with the highest similarity with the user preferences is assumed to be the project user will be interested with the most. Then, the projects would be recommended to users.

### **3 SYSTEM REQUIREMENTS / ANALYSIS**

#### **3.1. Project scope, capabilities, and limitations**

##### **3.1.1. Project scope**

This project is created as an approach to connect university lecturers and industry representatives through the partnerships. At present, there has been no application, either web-based or mobile specifically developed for nurturing the partnership between university and industry. Having a web system which allows for a continuous discussion of R&D and T&L can increase the engagement rate of both parties in a long run.

The final output of the project will be a web dashboard system for three different users: admin, lecturers and industry representatives. Admin should be able to manage users, including set user access. Both lecturers and industry representatives should be able to manage their user profiles, manage projects, chat with collaborators and view project recommendation.

##### **3.1.2. System capabilities**

Table 3.1 shows some of the features/functionalities of the system:

Table 3.1 System capabilities

User	Functionalities
Admin	<ul style="list-style-type: none"> <li>• Manage user, including allow or revoke user access.</li> <li>• Add company.</li> </ul>
Lecturer	<ul style="list-style-type: none"> <li>• Add and manage R&amp;D and T&amp;L projects.</li> <li>• Display details of R&amp;D and T&amp;L projects.</li> <li>• Search R&amp;D and T&amp;L projects.</li> <li>• Discuss with collaborators.</li> <li>• Post news.</li> <li>• View recommendation of projects.</li> </ul>
Industry Representative	

### 3.1.3. System limitations

Several limitations of the system have been identified. The first limitation of the system is that the recommender system only recommends projects solely based on current user preference. It does not consider other user behaviors such as past projects or click history. This may cause user to get the same type of recommendation repeatedly.

The next limitation of the system is that the system does not have a feature to generate and show report yet. Report can help users get an insight about their performances in certain things, and not having this feature would be disadvantageous.

## 3.2. Project management

### 3.2.1. Work breakdown structure (WBS)

1. Project Bidding round
  - I. 1<sup>st</sup> round bidding. (2 days)
  - II. Project confirmation. (1 day)
2. Pre-project Activities
  - I. Determine project title. (1 day)
  - II. Study project background. (4 days)
  - III. Determine project problem. (3 days)
  - IV. Determine project scope. (2 days)
  - V. Identify proposed solutions. (3 days)
3. Plan the project.
  - I. Determine system functionalities and features. (10 days)
  - II. Define project iterations and assign tasks to each iteration. (2 days)
  - III. Identify resources needed to complete the project. (2 days)
4. Discover and understand details of all aspects of the system.
  - I. Do research to find more details. (11 days)
  - II. Identify and define use cases. (7 days)
  - III. Develop class diagram. (3 days)
5. Design the components of the solution to the system.
  - I. Identify the workflow of each use case. (8 days)

- II. Design the user interface layout for each users. (4 days)
- III. Design the database. (3 days)
- IV. Design overall details of the system. (2 days)
- 6. Build, test and integrate the components.
  - I. Code the program. (5 months)
  - II. Perform unit and integration testing. (5 months)
- 7. Perform all system-level tests and deploy the solution.
  - I. Perform system functionality tests. (15 days)
  - II. Deploy the solution. (5 days)

### 3.2.2. Gantt chart & milestone timeline

Figure 3.1 shows the Gantt chart.

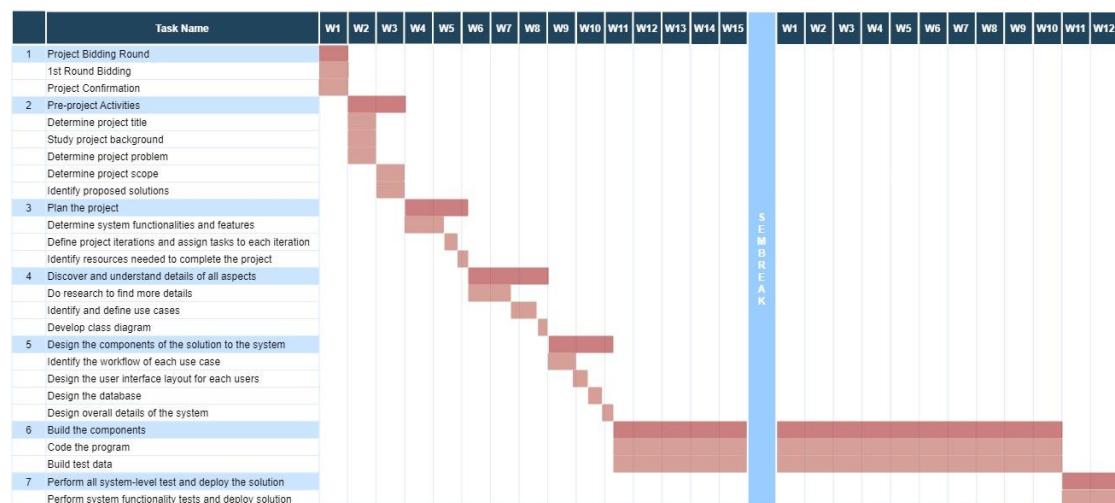


Figure 3.1 Gantt chart

The milestone timeline of the system as of this final report is depicted in Table 3.2 and Figure 3.2:

Table 3.2 Milestone timeline

Date	Milestone
01 November 2021	Project starts
13 November 2021	Pre-project Activities finished
14 November 2021	Project proposal deadline
25 November 2021	Plan the project finished
23 December 2021	Discover and understand all details of project finished
24 December 2021	Project analysis report deadline
09 January 2022	Design the components of the solution to the system finished
24 June 2022	Build the components finished
27 June 2022	Perform all system-level test finished
29 June 2022	Project final report deadline

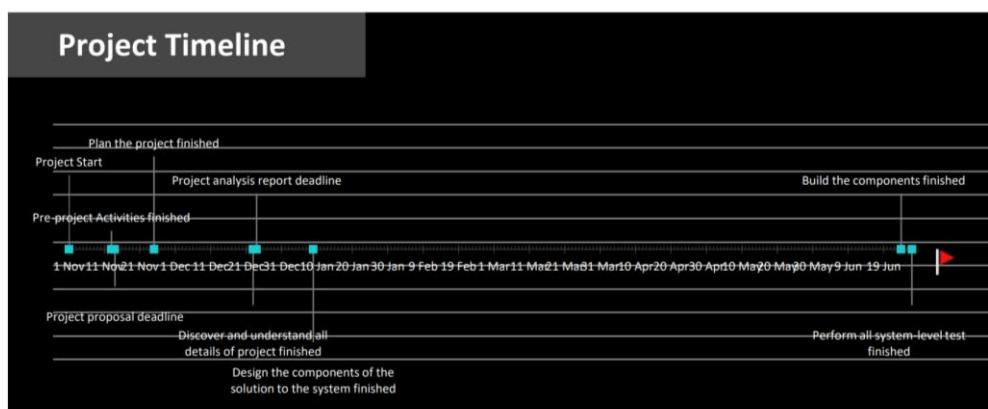


Figure 3.2 Milestone timeline

### 3.2.3. SWOT analysis

Table 3.3 shows the SWOT analysis of the system:

Table 3.3 SWOT analysis

<b><u>Strength</u></b>	<b><u>Weakness</u></b>
Project recommendation is provided based on preference which can improve user experience.	No feature to integrate with other application is allowed yet, such as Gmail compared to other CRM platforms.
<b><u>Opportunity</u></b>	<b><u>Threat</u></b>
Can reduce the workload and hassle of securing partnerships between university lecturer and industry representatives.	Recommender system developed using machine learning gives more accurate recommendation.

### 3.3. Development methodology

The development methodology that will be used to develop this project is *Agile Development Method*. Agile method is adopted as there may be unforeseen circumstances and challenges encountered during the development of the project. It involves working in iterations with constant revision for each iteration. There are several reasons for choosing agile methodology.

Firstly, agile method allows for a flexible development, in which system can always be refined during each stage. Requirement can always change over the course hence relying on predefined plans to develop the system beforehand might cause issues. Next, agile method involves breaking down the system into several iterations, where each iteration includes testing, reviews and feedbacks. Therefore, any defects and errors found earlier can also be fixed earlier. This method also encourages constant communication between developer and stakeholders. In this way, a higher-quality system can be produced as it promotes more idea exchange between the parties.

To give an example on how Agile methodology is applied for this system, we will take a module from the proposed solutions, the Relationship management module. This module main objective is to promote exchange of views between university lecturers and industry representatives to enhance their bonding. The solution proposed is to provide recommendation engine for R&D and T&L projects which help lecturer/representative identify their preferences. However, this solution might be

replaced anytime in case a better solution is found. The initial plan will undergo changes and evaluation. The rest of the proposed modules might also be changed during the development, if necessary.

### **3.4. Detailed requirement of new system**

#### **3.4.1. Functional requirements**

Table 3.4 shows the functional requirements of the system according to the stakeholders involved.

Table 3.4 Functional requirements of the system

Stakeholder	Functional Requirements
Admin	<ul style="list-style-type: none"> <li>• Allow or revoke user access.</li> <li>• Add company.</li> </ul>
University lecturer	<ul style="list-style-type: none"> <li>• Add and manage R&amp;D projects.</li> <li>• Add and manage T&amp;L projects.</li> <li>• Search R&amp;D and T&amp;L projects.</li> <li>• Add comments under industry's project discussion board.</li> <li>• Chat with collaborators.</li> <li>• Post news.</li> <li>• Display R&amp;D and T&amp;L project recommendations.</li> </ul>
Industry representative	<ul style="list-style-type: none"> <li>• Add and manage R&amp;D projects.</li> <li>• Add and manage T&amp;L projects.</li> <li>• Search R&amp;D and T&amp;L projects.</li> <li>• Add comments under lecturer's project discussion board.</li> <li>• Chat with collaborators.</li> <li>• Post news.</li> <li>• Display R&amp;D and T&amp;L project recommendations.</li> </ul>

### 3.4.2. Non-functional requirements

Table 3.5 presents the non-functional requirements of the system:

Table 3.5 Non-functional requirements of the system

Category	Non-functional requirements
Performance	<ul style="list-style-type: none"> <li>• Pages should be loaded with high speed.</li> </ul>
Reliability	<ul style="list-style-type: none"> <li>• Server must always be up to allow all processing to be done.</li> </ul>
Availability	<ul style="list-style-type: none"> <li>• The web application must be available to all users most of the time.</li> </ul>
Security	<ul style="list-style-type: none"> <li>• The system requires user to provide correct email and password before user can be logged in to their account.</li> </ul>
Usability	<ul style="list-style-type: none"> <li>• User should be able to navigate easily through the interface.</li> </ul>

### 3.4.3. Requirement gathering techniques

Several techniques have been applied to gather the requirements of the system.

#### 1. Existing systems review.

Currently, there are plenty of existing CRM systems available in the market. These CRM systems, such as Zoho CRM, Mautic for Higher Education CRM and Salesforce Education Cloud discussed in Section 2.2 will be reviewed and observed including their features and user interface designs. These criteria are then used to define and design some of the functionalities and designs of the system.

#### 2. Internet documentation and resources review.

Internet is a good source of information as it contains a huge number of topics available with only a click away. The related documentations are gathered to be assessed and evaluated. In this way, the strengths and weaknesses of the system can be identified.

### 3.5. Analysis of the new system

#### 3.5.1. Use Case Diagram

Figure 3.3 shows the overall use case diagram of the system.

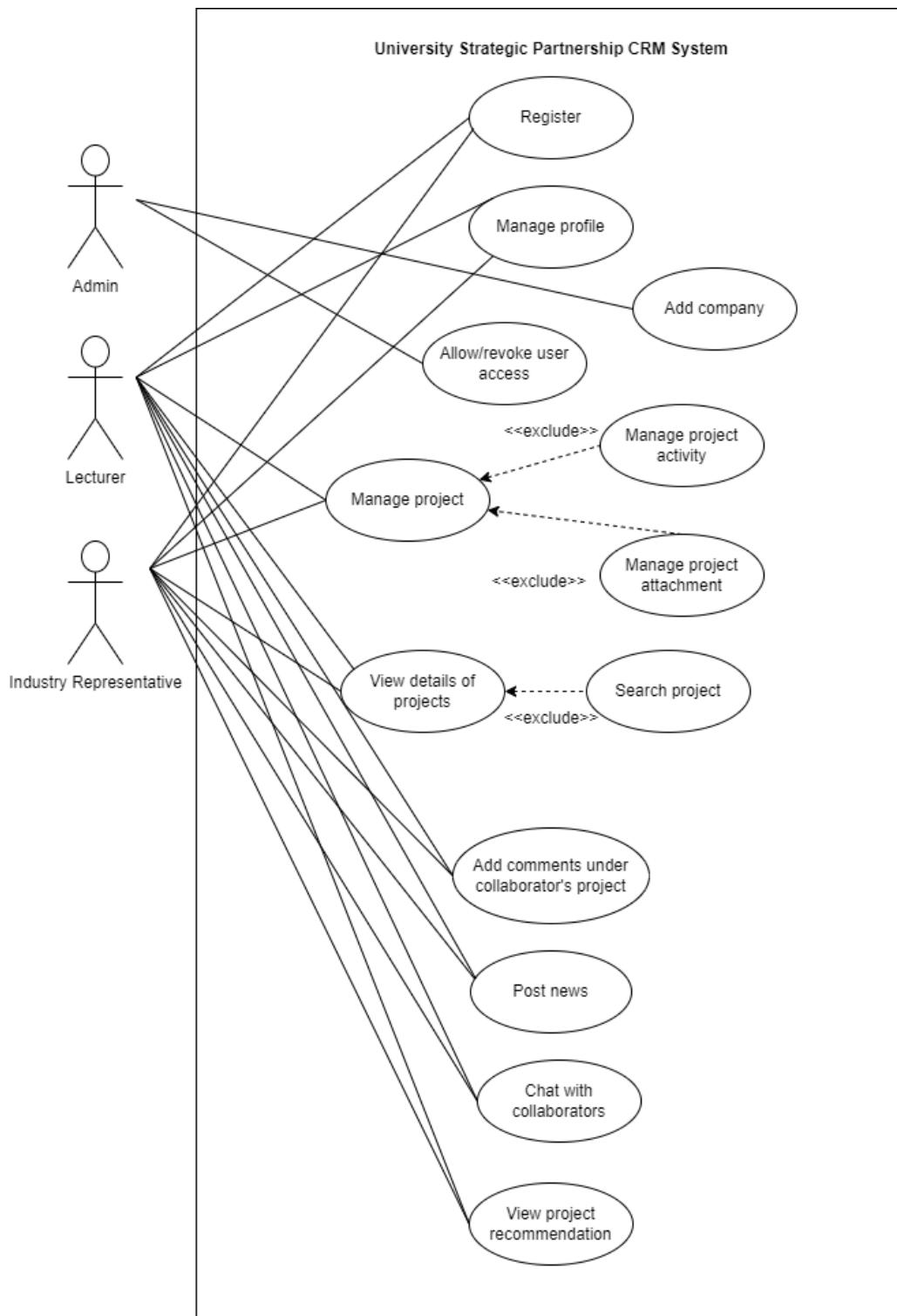


Figure 3.3 Overall use case diagram

### 3.5.2. Use Case Description

Table 3.6-3.18 show the use case descriptions for each use case.

Table 3.6 Register use case description

Use case name:	Register	
Scenario:	Lecturer/Industry Representative can register by filling out the form in the web system.	
Triggering event:	New lecturer/industry representative wants to set up an account.	
Brief description:	New lecturer/industry representative will create account by entering their basic and personal information via the web.	
Actors:	Lecturer, Industry Representative	
Related use cases:	None	
Stakeholders:	None	
Preconditions:	Lecturer/Industry Representative must not have an account.	
Postconditions:	Lecturer/Industry Representative must be created and saved. Account must be created and saved. Email and account must be associated with the user.	
Flow of activities:	Actor	System
	1. User indicates interest to create account and enters basic information.	1.1. System creates and saves the user.
Exception of conditions:	1.1. Basic user data are incomplete. 1.2. User has existed in the system.	

Table 3.7 Manage profile use case description

Use case name:	Manage profile					
Scenario:	Manage user profile of lecturer/industry representative.					
Triggering event:	User wants to view and edit their profile information.					
Brief description:	<p>User clicks on the “Profile” section from the tab, and user information will be displayed.</p> <p>User clicks on “Edit” button on their profile page and a form containing editable fields will appear. User enters relevant information and clicks “Save”.</p>					
Actors:	Lecturer, Industry Representative					
Related use cases:	None					
Stakeholders:	None					
Preconditions:	User (lecturer/industry representative) must exist.					
Postconditions:	<p>User information must be updated.</p> <p>User profile is displayed.</p>					
Flow of activities:	<table border="1"> <thead> <tr> <th>Actor</th> <th>System</th> </tr> </thead> <tbody> <tr> <td>           1. User clicks on the “Profile” tab to display profile.            2. User clicks on the “Edit” button to edit their information.            3. User clicks “Save” button.         </td> <td>           1.1. System displays profile with user information.            2.1. System displays a form with editable fields.            3.1. System updates and saves the information         </td> </tr> </tbody> </table>	Actor	System	1. User clicks on the “Profile” tab to display profile. 2. User clicks on the “Edit” button to edit their information. 3. User clicks “Save” button.	1.1. System displays profile with user information. 2.1. System displays a form with editable fields. 3.1. System updates and saves the information	
Actor	System					
1. User clicks on the “Profile” tab to display profile. 2. User clicks on the “Edit” button to edit their information. 3. User clicks “Save” button.	1.1. System displays profile with user information. 2.1. System displays a form with editable fields. 3.1. System updates and saves the information					

		and displays profile.
Exception of conditions:	1. Invalid data are entered.	

Table 3.8 Allow or revoke user access use case description

Use case name:	Allow or revoke user access							
Scenario:	Admin allows or revokes access of a specific user.							
Triggering event:	Admin wants to allow or revoke access of a specific user for the system.							
Brief description:	<p>Admin clicks on “User” tab to display list of users.</p> <p>Admin chooses either “Allow” or “Reject” user access.</p>							
Actors:	Admin							
Related use cases:	None							
Stakeholders:	None							
Preconditions:	User must exist.							
Postconditions:	User access is updated and saved.							
Flow of activities:	<table border="1"> <tr> <th>Actor</th> <th>System</th> </tr> <tr> <td>1. Admin clicks on “User” tab.</td> <td>1.1. System displays a list of users.</td> </tr> <tr> <td>2. Admin edits user access.</td> <td>2.1. System updates and saves the information.</td> </tr> </table>	Actor	System	1. Admin clicks on “User” tab.	1.1. System displays a list of users.	2. Admin edits user access.	2.1. System updates and saves the information.	
Actor	System							
1. Admin clicks on “User” tab.	1.1. System displays a list of users.							
2. Admin edits user access.	2.1. System updates and saves the information.							
Exception of conditions:	<p>1. User does not exist.</p>							

Table 3.9 Add company

Use case name:	Add company					
Scenario:	Admin adds new company.					
Triggering event:	Admin wants to add a new company.					
Brief description:	Admin clicks on “Company” tab to display list of companies. Admin adds new company.					
Actors:	Admin					
Related use cases:	None					
Stakeholders:	None					
Preconditions:	Company must not exist yet in system.					
Postconditions:	Company is updated and saved.					
Flow of activities:	<table border="1"> <tr> <th>Actor</th> <th>System</th> </tr> <tr> <td>           1. Admin clicks on “Company” tab.            2. Admin clicks on “Add Company” button.            3. Admin adds and saves company.         </td> <td>           1.1. System displays a list of companies.             2.1. System views form for adding new company.             3.1. System saves and displays list of companies.         </td> </tr> </table>	Actor	System	1. Admin clicks on “Company” tab. 2. Admin clicks on “Add Company” button. 3. Admin adds and saves company.	1.1. System displays a list of companies.  2.1. System views form for adding new company.  3.1. System saves and displays list of companies.	
Actor	System					
1. Admin clicks on “Company” tab. 2. Admin clicks on “Add Company” button. 3. Admin adds and saves company.	1.1. System displays a list of companies.  2.1. System views form for adding new company.  3.1. System saves and displays list of companies.					
Exception of conditions:	1. Company has existed.					

Table 3.10 Manage project use case description

Use case name:	Manage project	
Scenario:	Lecturer/Industry Representative manages project.	
Triggering event:	Lecturer/Industry Representative wants to manage project.	
Brief description:	<p>Lecturer/Industry Representative clicks on “Add Project” button to add new project, enters details and saves.</p> <p>Lecturer/Industry Representative clicks on a project and displays the details.</p> <p>Lecturer/Industry Representative edits a project and saves.</p>	
Actors:	Lecturer, Industry Representative	
Related use cases:	Manage project attachment, Manage project activity	
Stakeholders:	Lecturer, Industry Representative	
Preconditions:	<p>Lecturer/Industry Representative must exist.</p> <p>Project must exist. (View, Update)</p>	
Postconditions:	<p>Project must be created and saved. (Create)</p> <p>Project is displayed. (View)</p> <p>Project must be updated and saved. (Update)</p>	
Flow of activities:	Actor	System

	<p>1. Lecturer/Industry Representative enters relevant information about project and clicks “Save”.</p> <p>2. Lecturer/Industry Representative clicks on “Edit” button to update project.</p> <p>3. Lecturer/Industry Representative enters updated information about project and clicks “Save”.</p> <p>4. Lecturer/Industry Representative clicks on project to view details.</p>	<p>1.1. System creates and saves the project.</p> <p>2.1. System displays a form with editable fields.</p> <p>3.1. System updates and saves project information.</p> <p>4.1. System displays the project details.</p>
Exception of conditions:	<p>1. Invalid data are entered.</p>	

Table 3.11 Manage project activity use case description

Use case name:	Manage project activity	
Scenario:	Lecturer/Industry Representative manages project activity.	
Triggering event:	Lecturer/Industry Representative wants to manage project activity.	
Brief description:	<p>Lecturer/Industry Representative clicks on a project and navigates to “Activity”.</p> <p>Lecturer/Industry Representative clicks on “Add Activity” button, enters activity information and saves.</p> <p>Lecturer/Industry Representative clicks on “Update Activity”, enters updated information and saves.</p> <p>Lecturer/Industry Representative deletes activity.</p>	
Actors:	Lecturer, Industry Representative	
Related use cases:	Manage project	
Stakeholders:	Lecturer, Industry Representative	
Preconditions:	Project must exist.	
Postconditions:	<p>Activity must be created and saved. (Create)</p> <p>Activity is displayed. (View)</p> <p>Activity must be updated and saved. (Update)</p> <p>Activity is deleted from system. (Delete)</p>	
Flow of activities:	Actor	System
	1. Lecturer/Industry Representative enters	1.1. System creates and saves the activity.

	<p>relevant information about project's activity and clicks "Save".</p> <p>2. Lecturer/Industry Representative clicks on "Edit" button to update activity.</p> <p>3. Lecturer/Industry Representative enters updated information about activity and clicks "Save".</p> <p>4. Lecturer/Industry Representative clicks on activity to view details.</p> <p>5. Lecturer/Industry Representative selects an activity and clicks "Delete".</p>	<p>2.1. System displays a form with editable fields.</p> <p>3.1. System updates and saves activity information.</p> <p>4.1. System displays the activity details.</p> <p>5.1. System deletes the activity.</p>
Exception of conditions:	<p>1. Invalid data are entered.</p>	

Table 3.12 Manage project attachment use case description

Use case name:	Manage project attachment	
Scenario:	Lecturer/Industry Representative manages project attachment.	
Triggering event:	Lecturer/Industry Representative wants to manage project attachment.	
Brief description:	<p>Lecturer/Industry Representative clicks on a project and navigates to “Attachment”.</p> <p>Lecturer/Industry Representative clicks on “Add Attachment” button, uploads attachment and saves.</p> <p>Lecturer/Industry Representative deletes attachment.</p>	
Actors:	Lecturer, Industry Representative	
Related use cases:	Manage project	
Stakeholders:	Lecturer, Industry Representative	
Preconditions:	Project must exist.	
Postconditions:	<p>Attachment must be created and saved. (Create)</p> <p>Attachment is displayed. (View)</p> <p>Attachment is deleted from system. (Delete)</p>	
Flow of activities:	Actor	System
	<ol style="list-style-type: none"> <li>1. Lecturer/Industry Representative adds new attachment and clicks “Save”.</li> <li>2. Lecturer/Industry Representative updates</li> </ol>	<p>1.1. System creates and saves the attachment.</p> <p>2.1. System updates and</p>

	<p>attachment and clicks “Save”.</p> <p>3. Lecturer/Industry Representative clicks on attachment to view it.</p> <p>4. Lecturer/Industry Representative selects an attachment and clicks “Delete”.</p>	<p>saves attachment.</p> <p>3.1. System displays the attachment.</p> <p>4.1. System deletes the attachment.</p>
Exception of conditions:	<p>1. Invalid attachment type is uploaded.</p>	

Table 3.13 View details of projects use case description

Use case name:	View details of projects	
Scenario:	User views the details of projects.	
Triggering event:	User wants to view the details of projects.	
Brief description:	User clicks on “Projects” tab and views list of projects.  User clicks on a project’s name and views the project details.	
Actors:	Lecturer, Industry Representative	
Related use cases:	Search project	
Stakeholders:	None	
Preconditions:	Project must exist.	
Postconditions:	Display project details.	
Flow of activities:	Actor	System
	1. User clicks on “Projects” tab. 2. User clicks on a project’s name.	1.1 System displays a list of projects. 2.1 System displays the project details.
Exception of conditions:	1. Project does not exist.	

Table 3.14 Search project use case description

Use case name:	Search project	
Scenario:	User searches for a project.	
Triggering event:	User wants to search a project based on the name.	
Brief description:	<p>User clicks on “Projects” tab and views list of projects.</p> <p>User enters a project’s name and views the list of projects related.</p>	
Actors:	Lecturer, Industry Representative	
Related use cases:	View details of projects	
Stakeholders:	None	
Preconditions:	Project must exist.	
Postconditions:	Display list of related projects.	
Flow of activities:	Actor	System
	1. User clicks on “Projects” tab. 2. User enters a project’s name.	1.1. System displays a list of projects. 2.1. System displays a list of related projects.
Exception of conditions:	1. System returns a message if project does not exist.	

Table 3.15 Add comments under collaborator's project use case description

Use case name:	Add comments under collaborator's project	
Scenario:	Lecturer/Industry Representative adds comments under collaborator's project.	
Triggering event:	Lecturer/Industry Representative wants to add comments under collaborator's project.	
Brief description:	<p>Lecturer/Industry Representative clicks on a project and views the project.</p> <p>Lecturer/Industry Representative leaves a comment under the project's discussion board.</p>	
Actors:	Lecturer, Industry Representative	
Related use cases:	None	
Stakeholders:	Lecturer, Industry Representative	
Preconditions:	Project must exist.	
Postconditions:	Comment is added under project and saved.	
Flow of activities:	Actor	System
	1. Lecturer/Industry Representative clicks on a project. 2. Lecturer/Industry Representative writes a comment and clicks "Comment" button.	1.1. System displays the project. 2.1. System adds, saves and displays the comment.
Exception of conditions:	1. Project does not exist.	

Table 3.16 Post news use case description

Use case name:	Post news	
Scenario:	Lecturer/Industry Representative posts news.	
Triggering event:	Lecturer/Industry Representative wants to post news to alert users.	
Brief description:	<p>Lecturer/Industry Representative clicks on “News” tab.</p> <p>Lecturer/Industry Representative enters the information they want to post and clicks “Post”.</p>	
Actors:	Lecturer, Industry Representative	
Related use cases:	None	
Stakeholders:	Lecturer, Industry Representative	
Preconditions:	None	
Postconditions:	News is added, saved, and displayed.	
Flow of activities:	Actor	System
	1. Lecturer/Industry Representative enters relevant information about news and clicks “Save”.	1.1. System creates, saves and displays the news.
Exception of conditions:	None	

Table 3.17 Chat with collaborators use case description

Use case name:	Chat with collaborators	
Scenario:	Lecturer/Industry Representative chats with collaborator	
Triggering event:	Lecturer/Industry Representative wants to chat with collaborator	
Brief description:	<p>Lecturer/Industry Representative adds new chat title, then adds a user.</p> <p>Lecturer/Industry Representative sends chat message.</p>	
Actors:	Lecturer, Industry Representative	
Related use cases:	None	
Stakeholders:	Lecturer, Industry Representative	
Preconditions:	Lecturer/Industry Representative must exist.	
Postconditions:	Chat is sent.	
Flow of activities:	Actor	System
	<ol style="list-style-type: none"> <li>1. Lecturer/Industry Representative clicks on “Chat” tab.</li> <li>2. Lecturer/Industry Representative creates new chat title.</li> <li>3. Lecturer/Industry Representative adds the person they want to chat with.</li> <li>4. Lecturer/Industry Representative sends message.</li> </ol>	<p>1.1. System displays the Chat page.</p> <p>2.1. System creates and saves chat.</p> <p>3.1. System creates and saves person.</p> <p>4.1. System saves and displays chat message.</p>

Exception of conditions:	1. Lecturer/Industry Representative does not exist.
--------------------------	---

Table 3.18 View project recommendation use case description

Use case name:	View project recommendation	
Scenario:	Lecturer/Industry Representative views project recommendation.	
Triggering event:	Lecturer/Industry Representative wants to view project recommendation.	
Brief description:	Lecturer/Industry Representative clicks on the “Dashboard” tab.  Lecturer/Industry Representative clicks on any of the projects under the “You might like these projects...” card.	
Actors:	Lecturer/Industry Representative	
Related use cases:	None	
Stakeholders:	None	
Preconditions:	Project must exist.	
Postconditions:	Display project details.	
Flow of activities:	Actor	System
	1. Lecturer/Industry Representative clicks on the “Dashboard” tab.  2. Lecturer/Industry Representative clicks on any of the projects	1.1. System displays dashboard.  2.1. System displays the recommended project details.

	under the “You might like these projects...” card.	
Exception of conditions:	1. User has not set any preferences yet. 2. System cannot find any suitable project for user.	

### 3.5.3. Class Diagram

Figure 3.4 shows the overall class diagram of the system. A total of 13 classes are available.

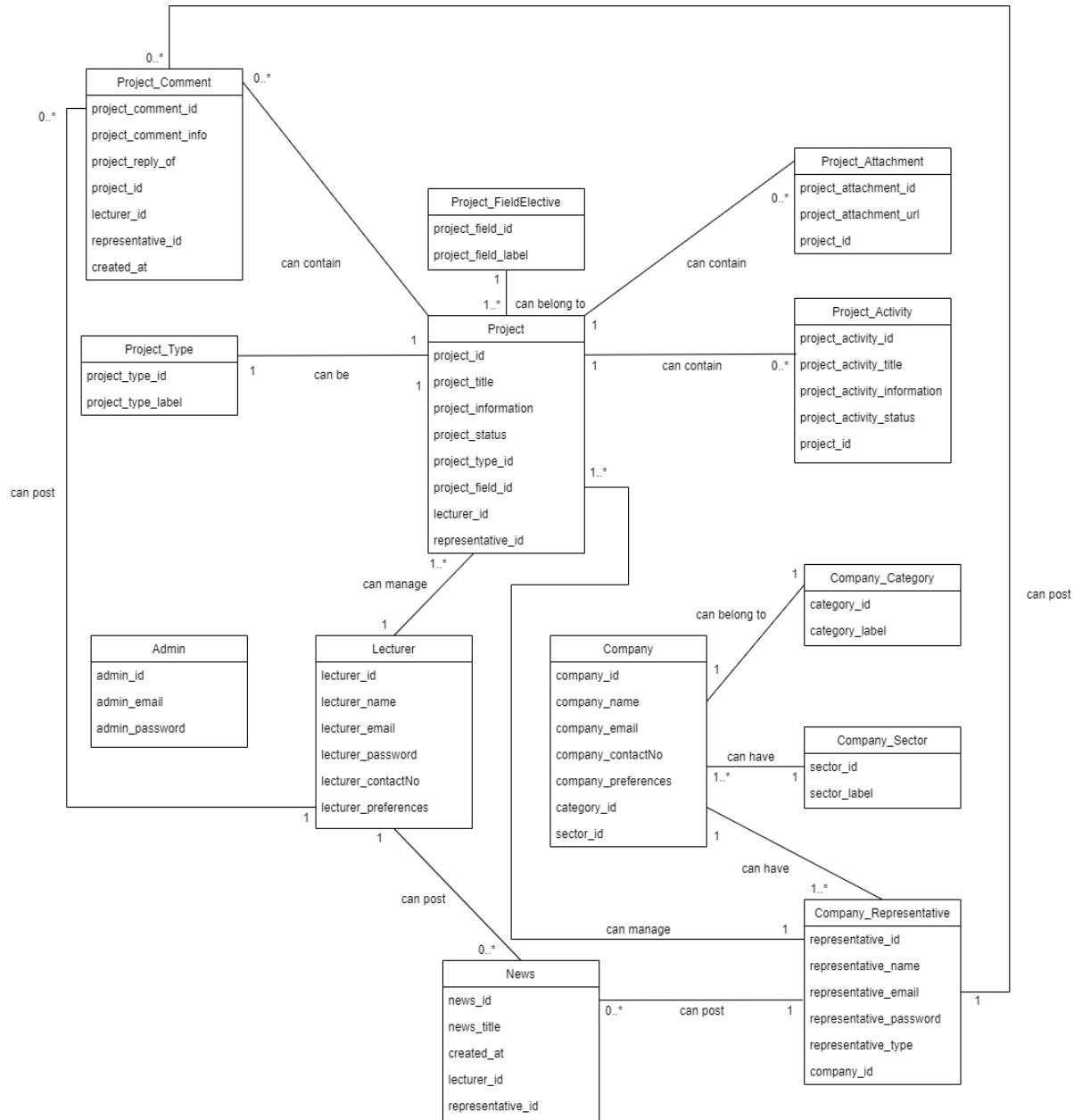


Figure 3.4 Overall class diagram

### 3.5.4. System Sequence Diagram (SSD)

Figure 3.5-3.18 illustrate the System Sequence Diagram.

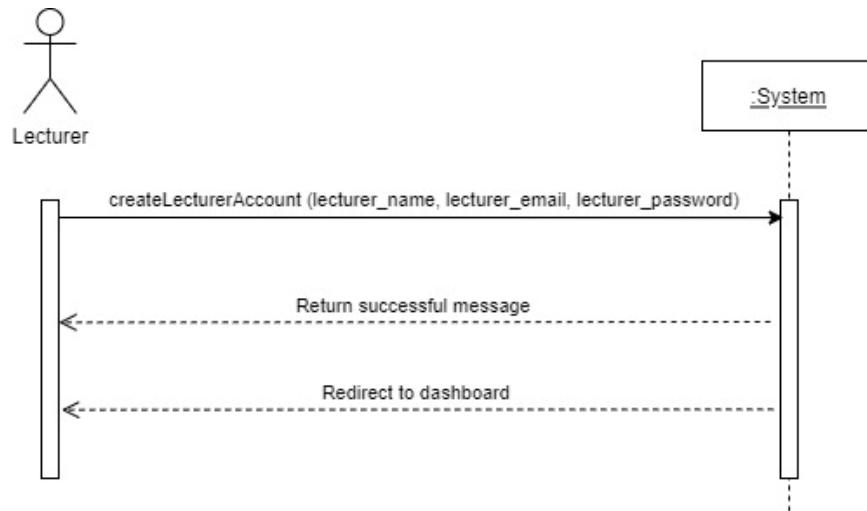


Figure 3.5 System Sequence Diagram of Register (Lecturer)

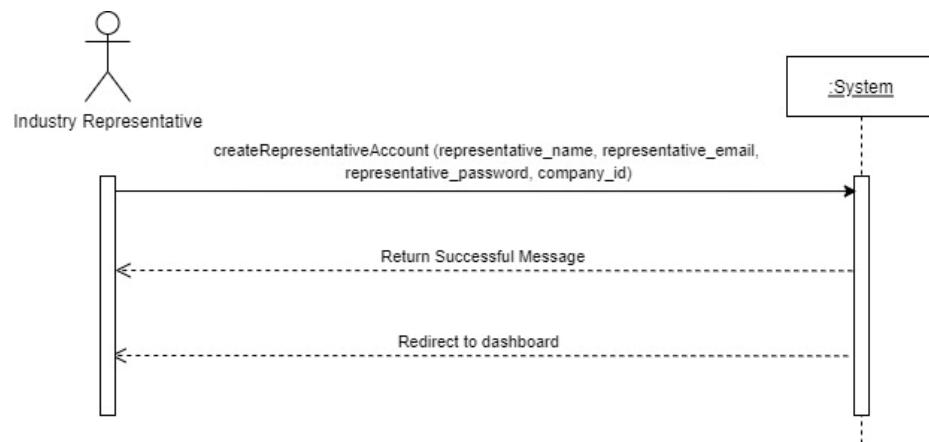


Figure 3.6 System Sequence Diagram of Register (Industry Representative)

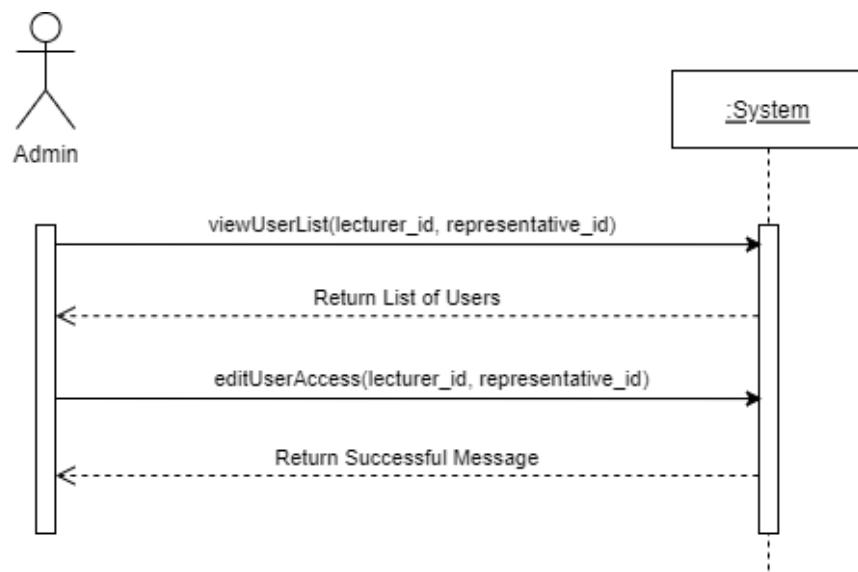


Figure 3.7 System Sequence Diagram of Set User Access (Admin)

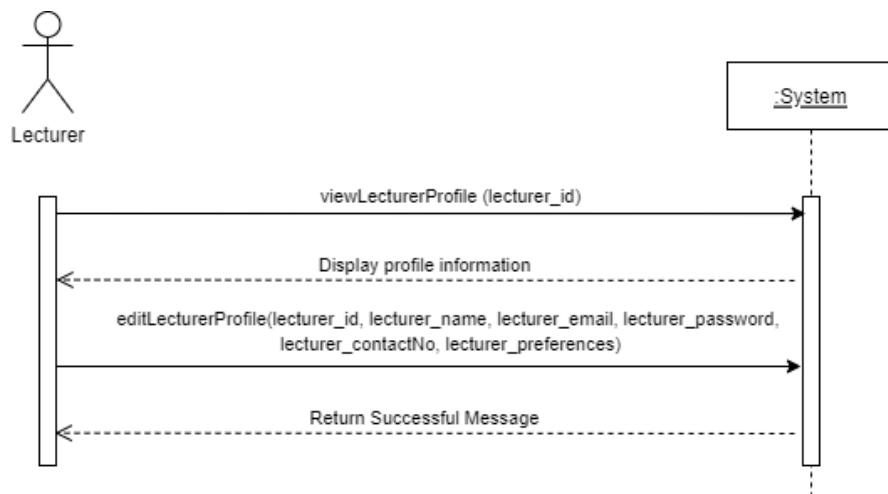


Figure 3.8 System Sequence Diagram of Manage Profile (Lecturer)

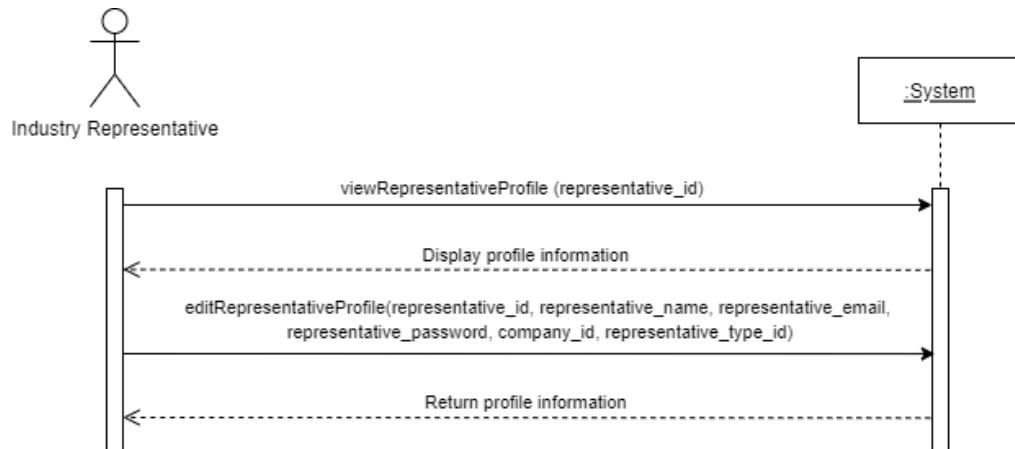


Figure 3.9 System Sequence Diagram of Manage Profile (Industry Representative)

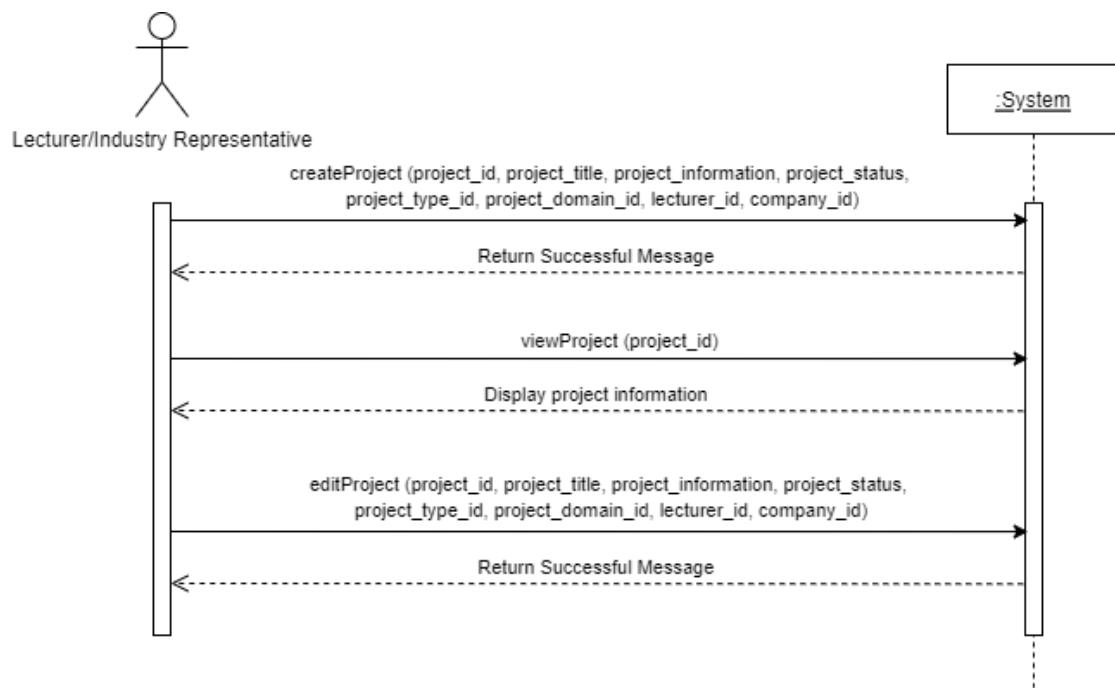


Figure 3.10 System Sequence Diagram of Manage Project

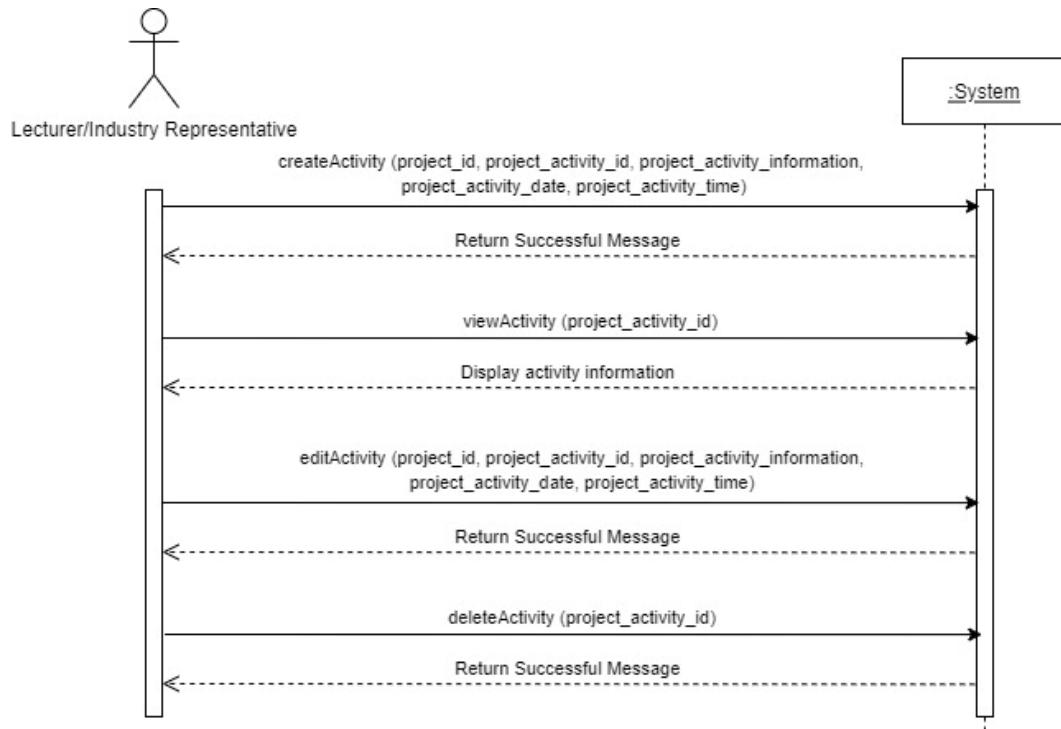


Figure 3.11 System Sequence Diagram of Manage Activity

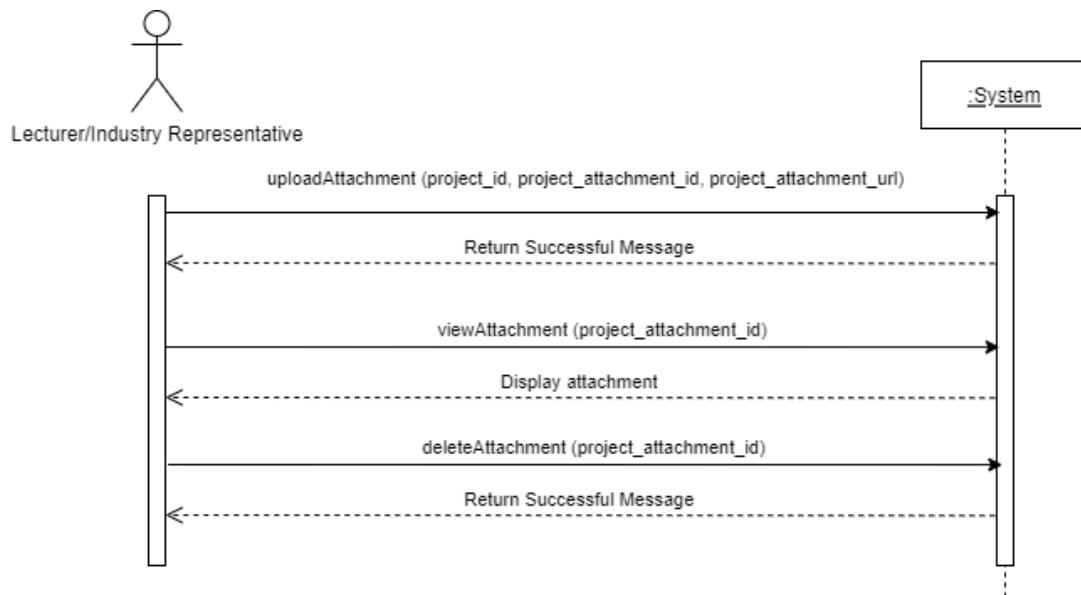


Figure 3.12 System Sequence Diagram of Manage Attachment

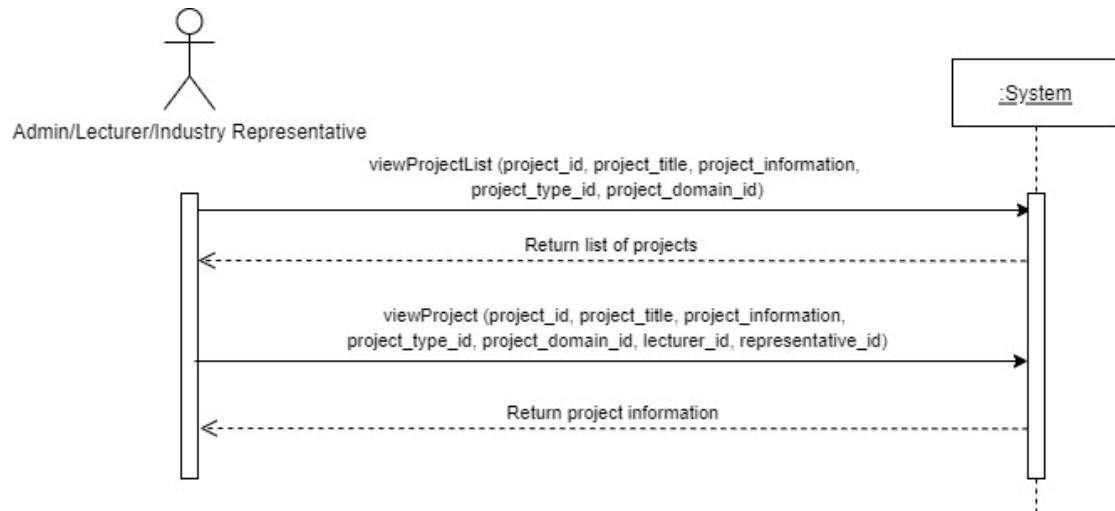


Figure 3.13 System Sequence Diagram of View details of projects

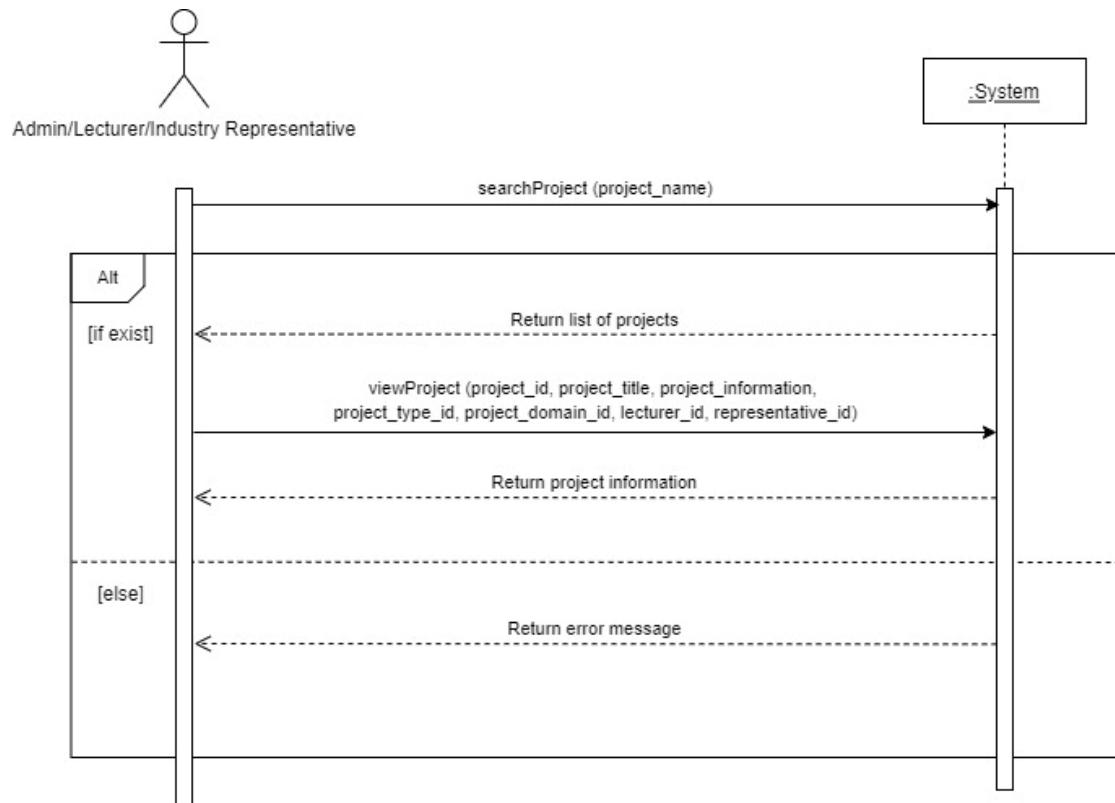


Figure 3.14 System Sequence Diagram of Search project

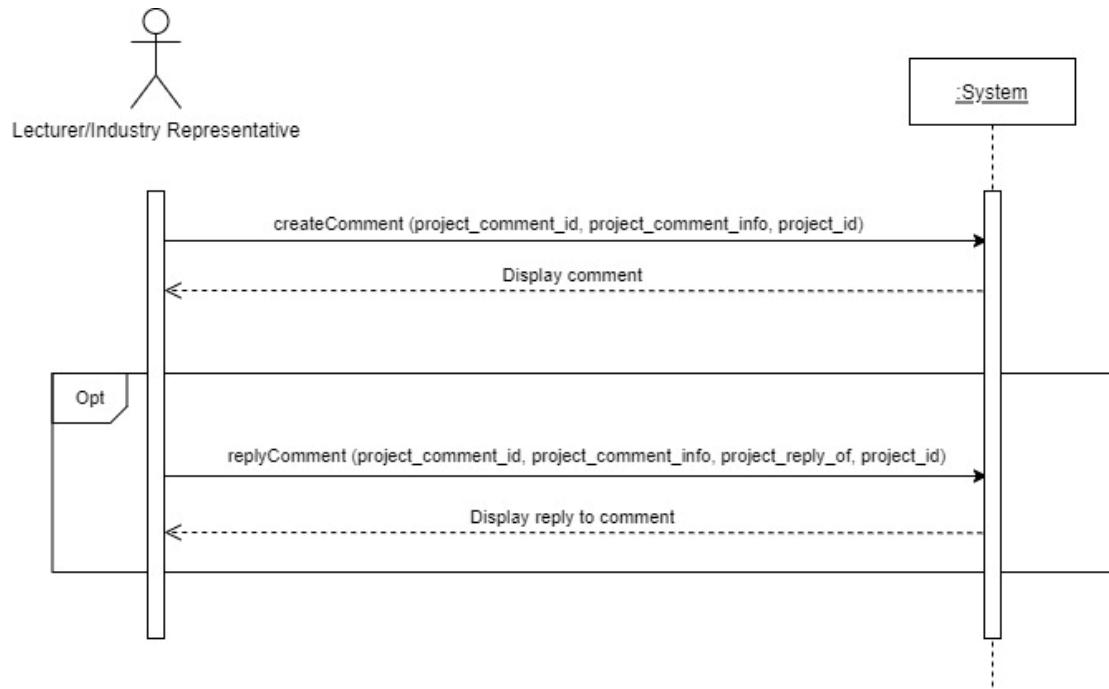


Figure 3.15 System Sequence Diagram of Add comment under project

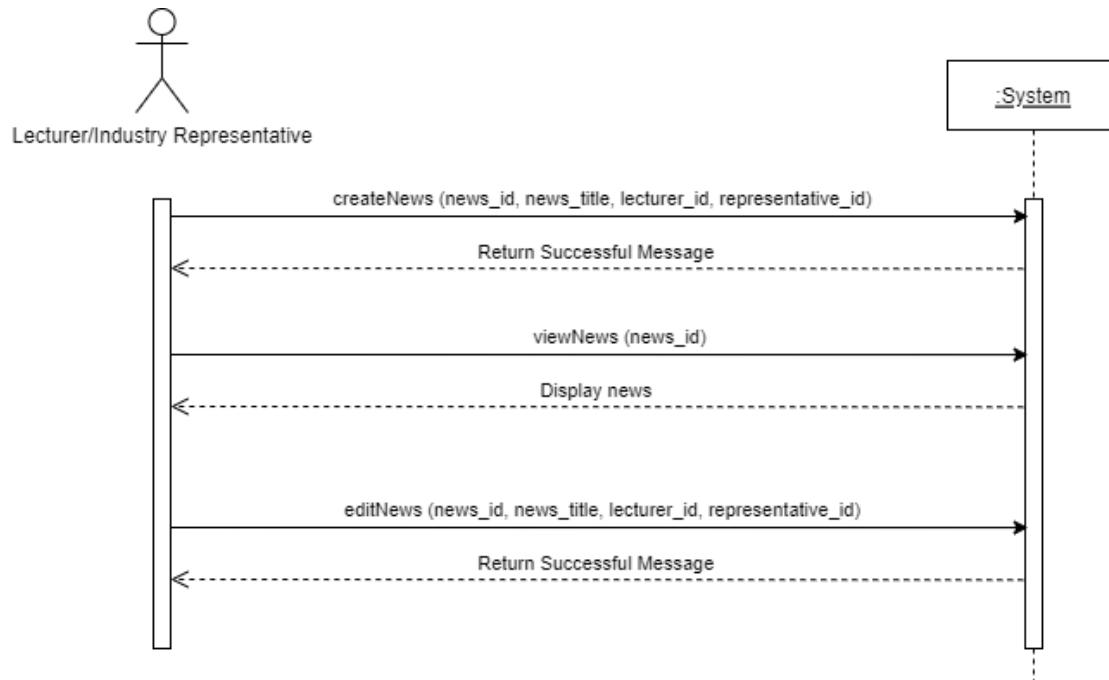


Figure 3.16 System Sequence Diagram of Post News

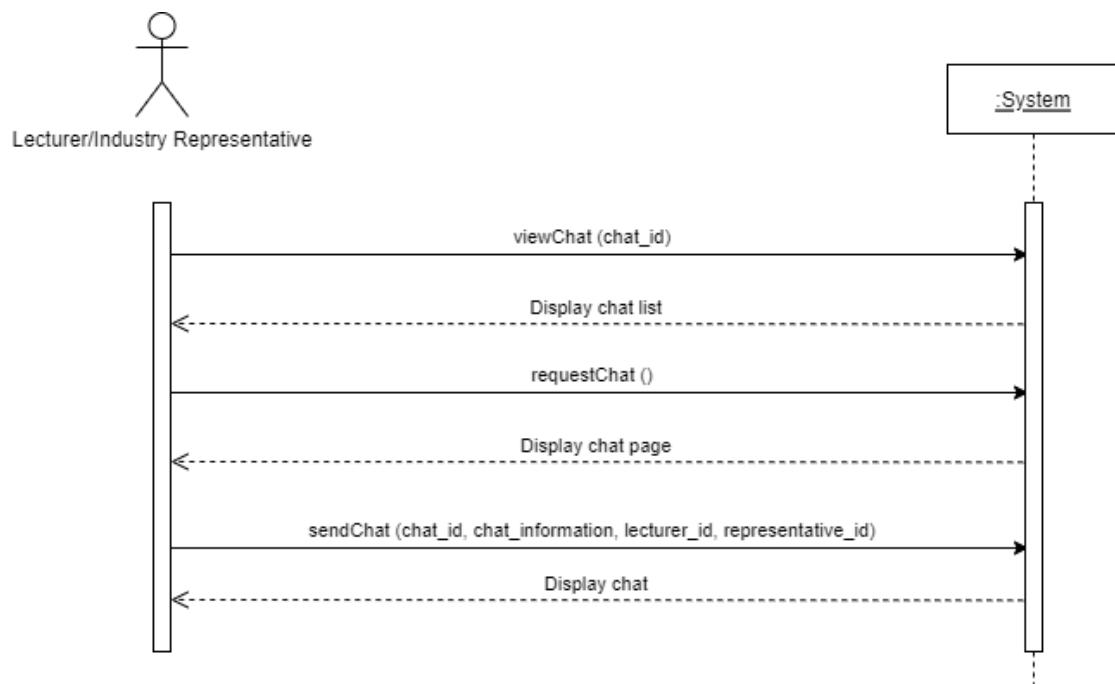


Figure 3.17 System Sequence Diagram of Chat with collaborator

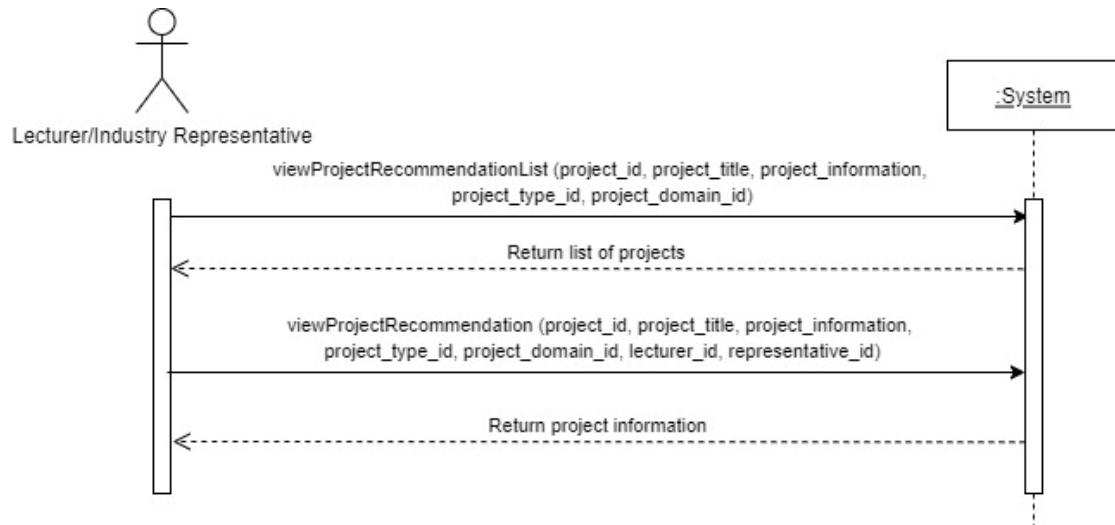


Figure 3.18 System Sequence Diagram of View project recommendation

### 3.5.5. Flowchart

Figure 3.19-3.28 show the flowchart for certain use cases.

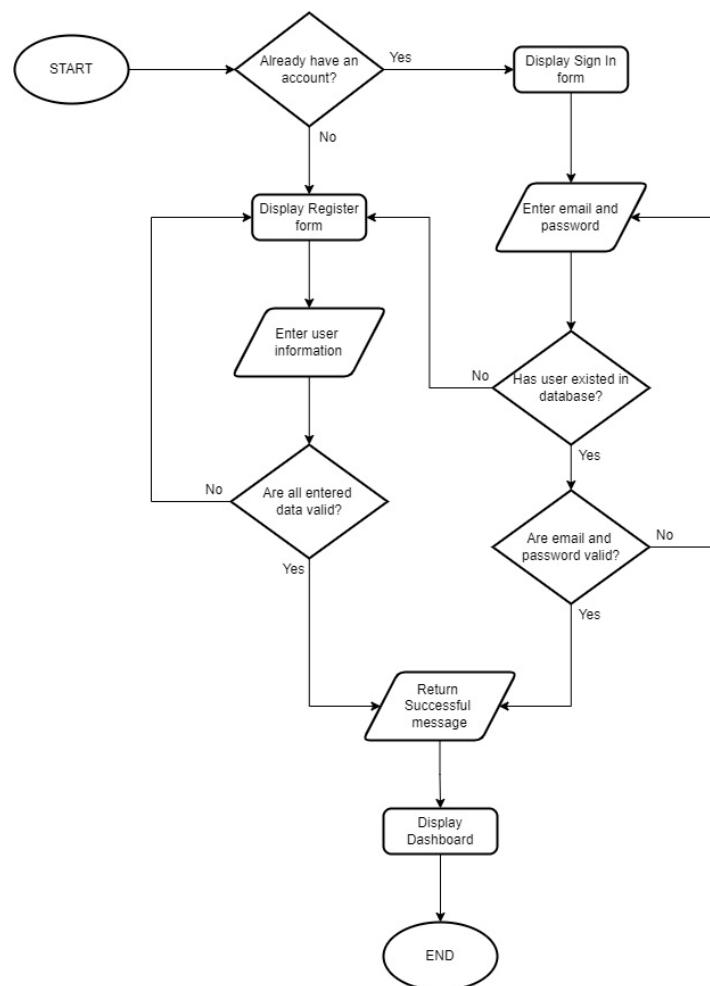


Figure 3.19 Flowchart for register

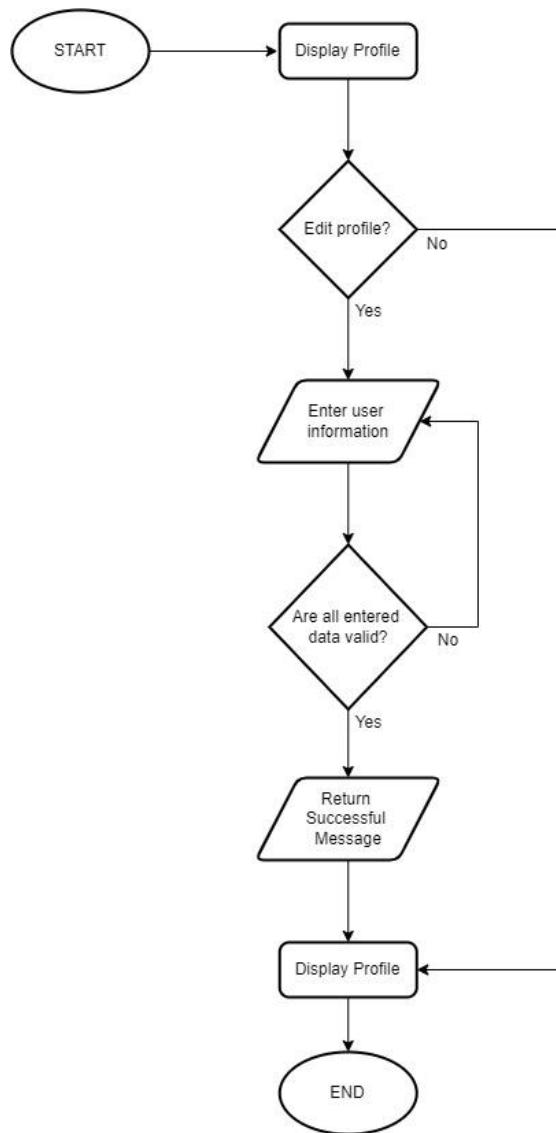


Figure 3.20 Flowchart for Manage profile

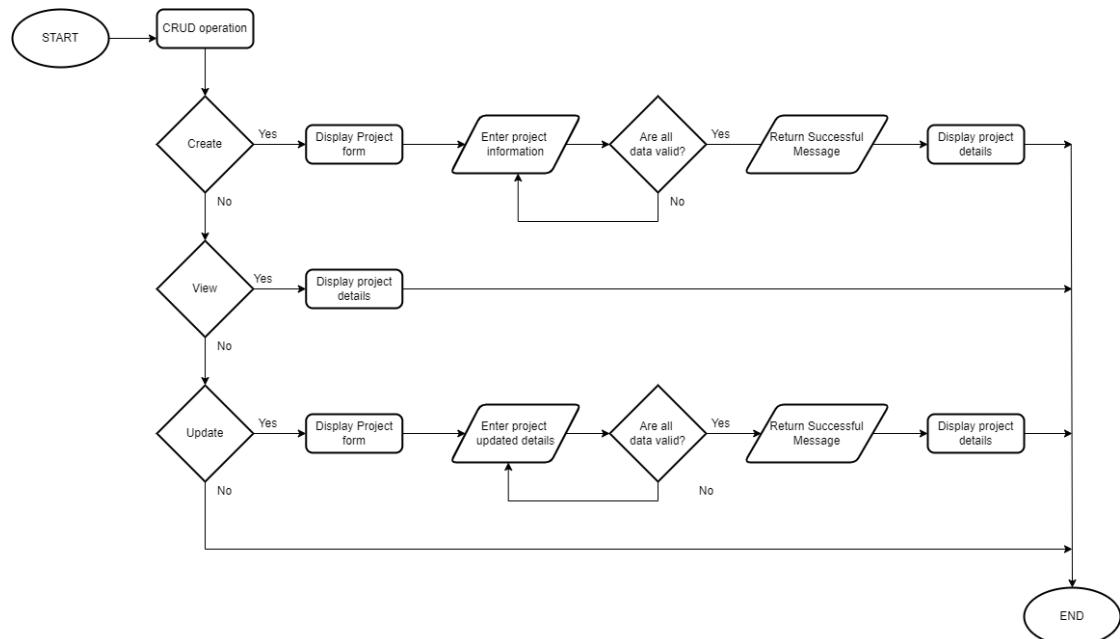


Figure 3.21 Flowchart for Manage project

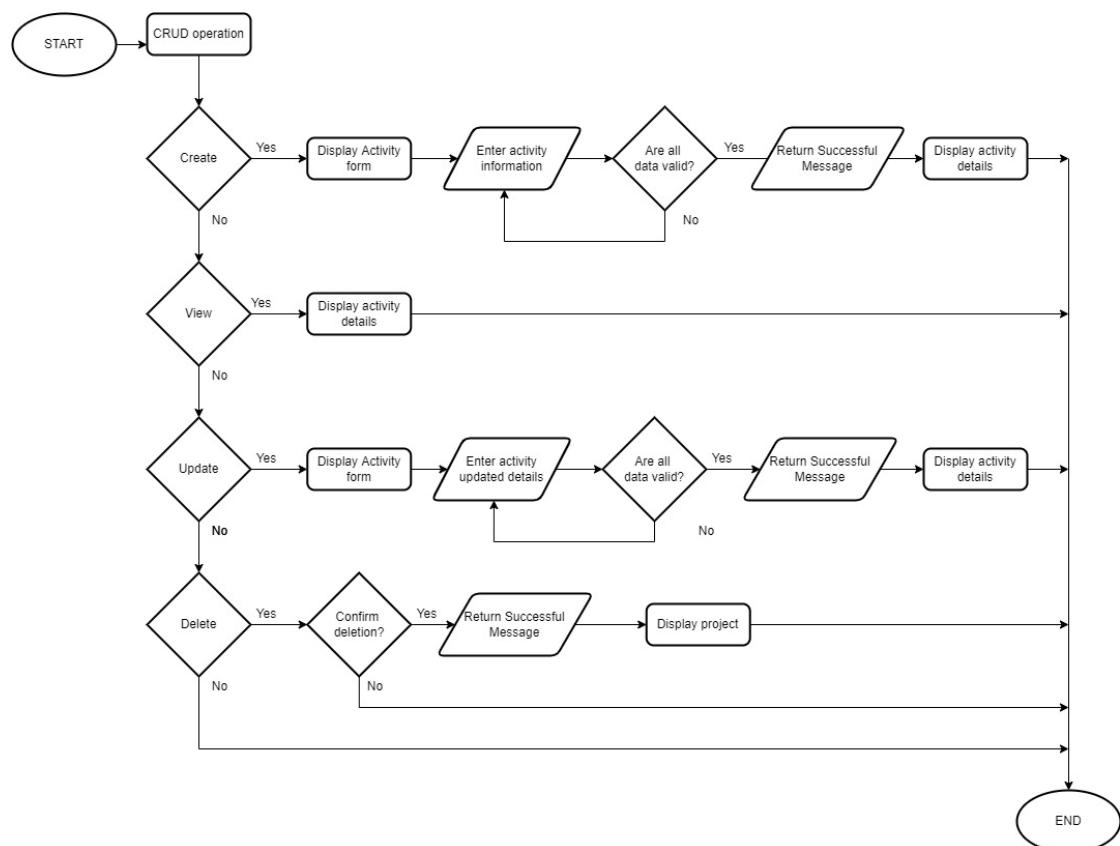


Figure 3.22 Flowchart for Manage Activity

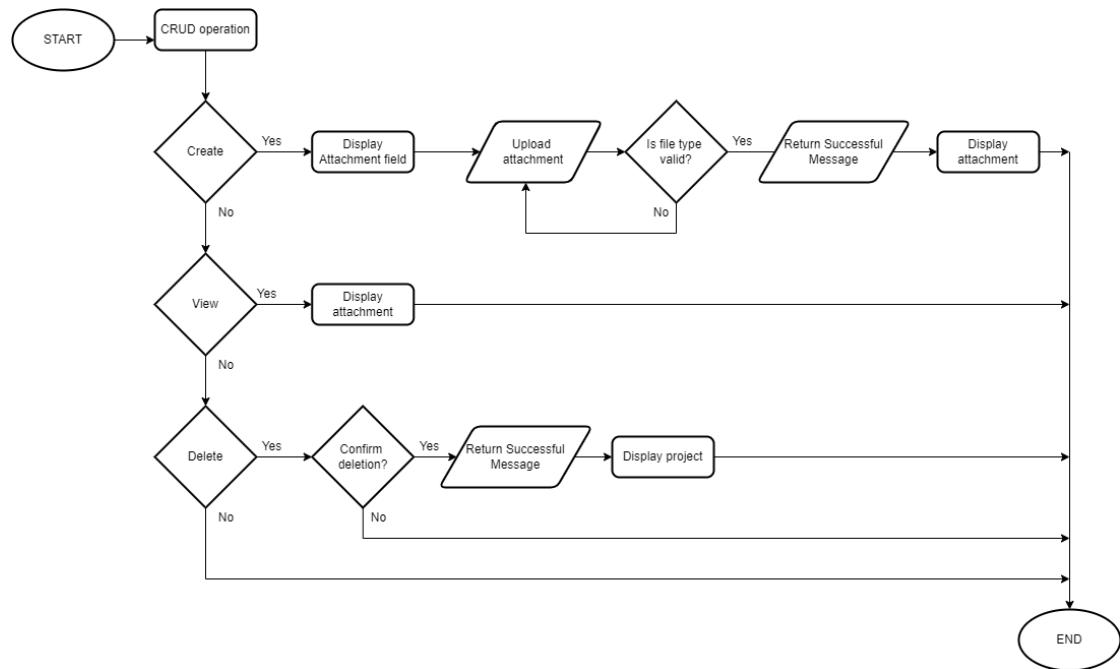


Figure 3.23 Flowchart for Manage Attachment

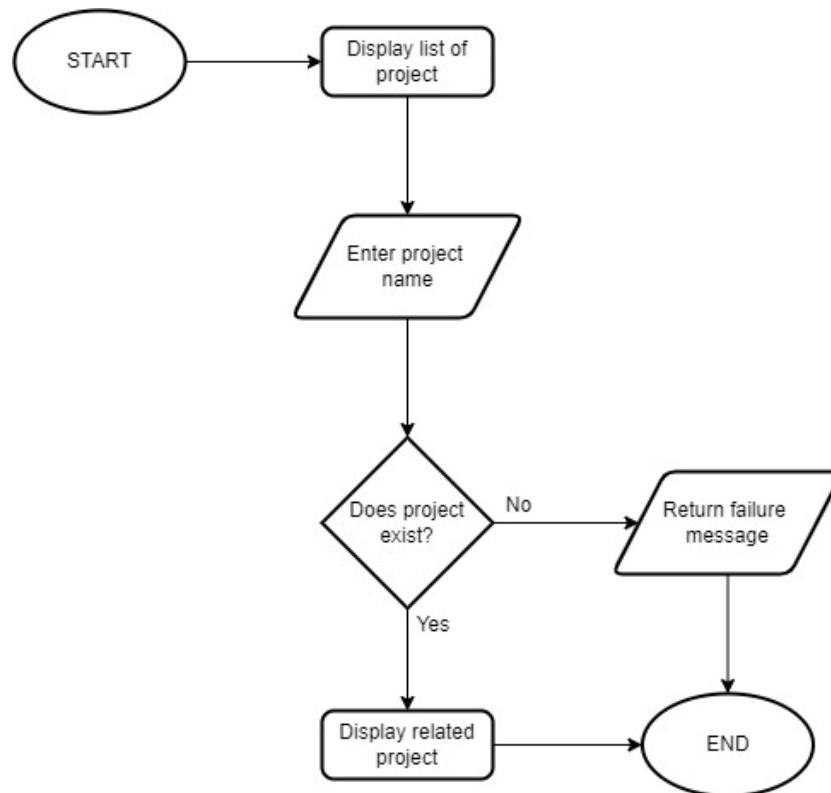


Figure 3.24 Flowchart for Search project

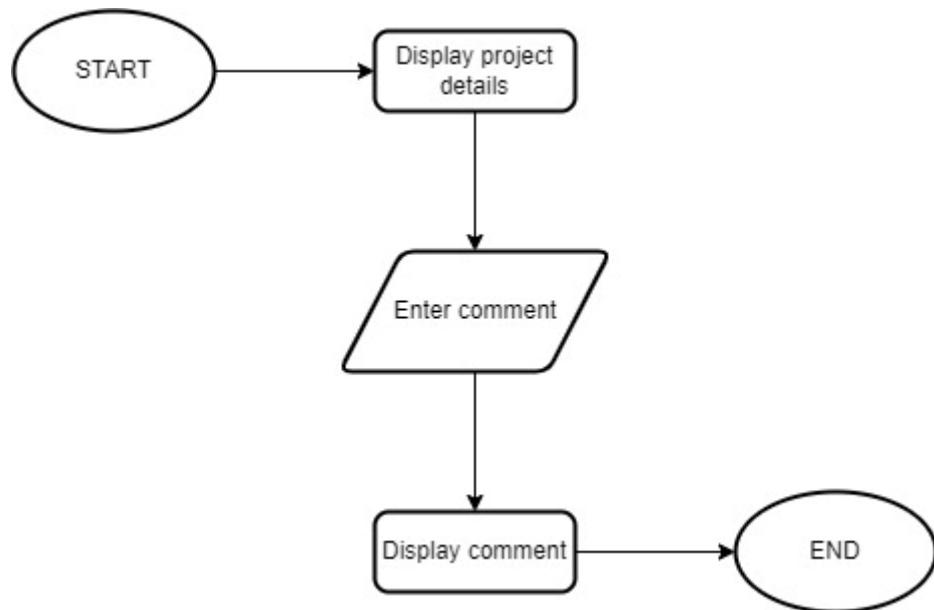


Figure 3.25 Flowchart for Add comment under project

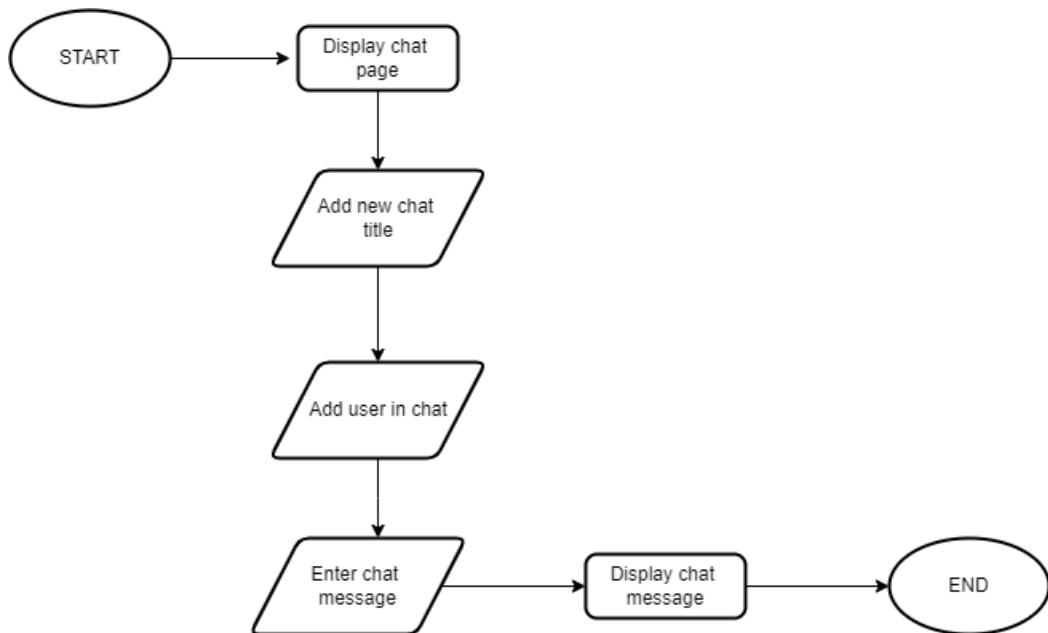


Figure 3.26 Flowchart for Chat with collaborator

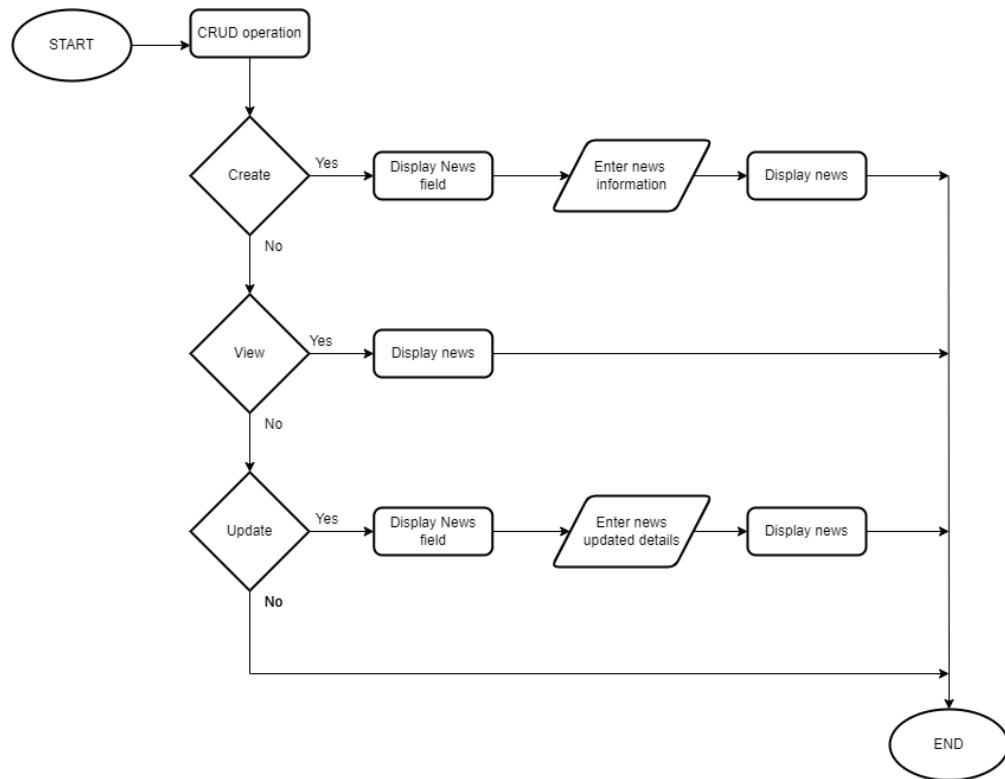


Figure 3.27 Flowchart for Post news

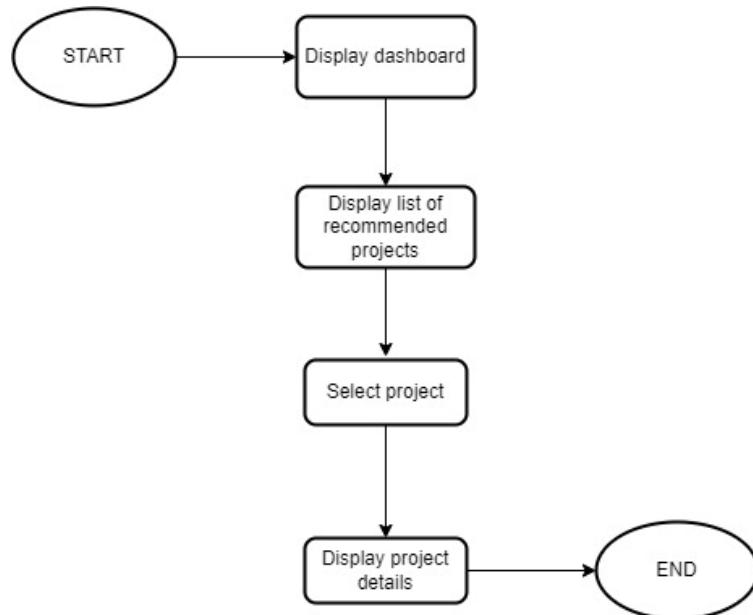


Figure 3.28 Flowchart for View project recommendation

### 3.6. Technology deployed

#### 3.6.1. Hardware

Table 3.19 shows the hardware specification for developing the system:

Table 3.19 Hardware specification

Laptop Manufacturer	HP
Model	Pavilion 15-cs0xxx
Version	64-bit
Processor	Intel Core i5 8 <sup>th</sup> gen
RAM	12 GB
Operating System	Windows 10

#### 3.6.2. Software

Table 3.20 shows the software that will be used for developing the project.

Table 3.20 Software specification

Types	Description	
Tools	Interface Design	Adobe XD
	Web Application	<ul style="list-style-type: none"> <li>• React.js as front-end framework</li> <li>• Node.js as back-end JRE</li> <li>• MySQL as database</li> <li>• Visual Studio Code by Microsoft as IDE</li> </ul>
Programming Languages	Web Application	<ul style="list-style-type: none"> <li>• Front-end: HTML, CSS, JavaScript</li> <li>• Back-end: JavaScript</li> </ul>

## 4 SYSTEM DESIGN & IMPLEMENTATION

### 4.1. System design architecture

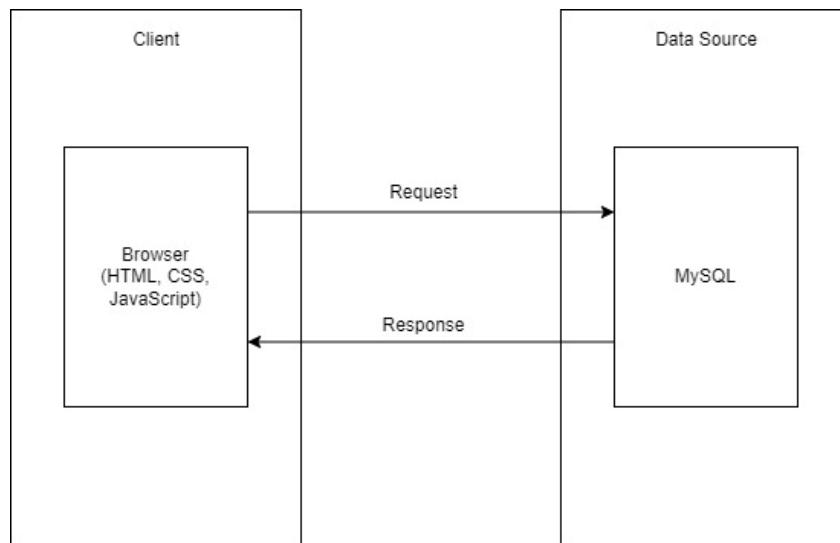


Figure 4.1 System architecture

Figure 4.1 shows the system architecture of the University Strategic Partnership CRM System. The system uses two-layer web architecture where only client and server side are involved. Client layer contains a browser which will display webpage to the user. Server layer contains MySQL database, the data source. All backend will be processed in this layer. The languages used to develop the system are HTML, CSS, and JavaScript. The database used is MySQL.

The overview of the architecture is as explained next. The client will send a request to the server. The request will then be processed, and response will be sent back to client from server.

There are two reasons for choosing two-tier layer architecture. First, it is easier to manage and maintain. Other than that, two layer is also sufficient for the website to operate smoothly without any complexity needed.

### 4.2. Design modeling

#### 4.2.1. Detailed system sequence diagram

Diagram 4.2 and 4.3 show the detailed system sequence diagram for certain use cases.

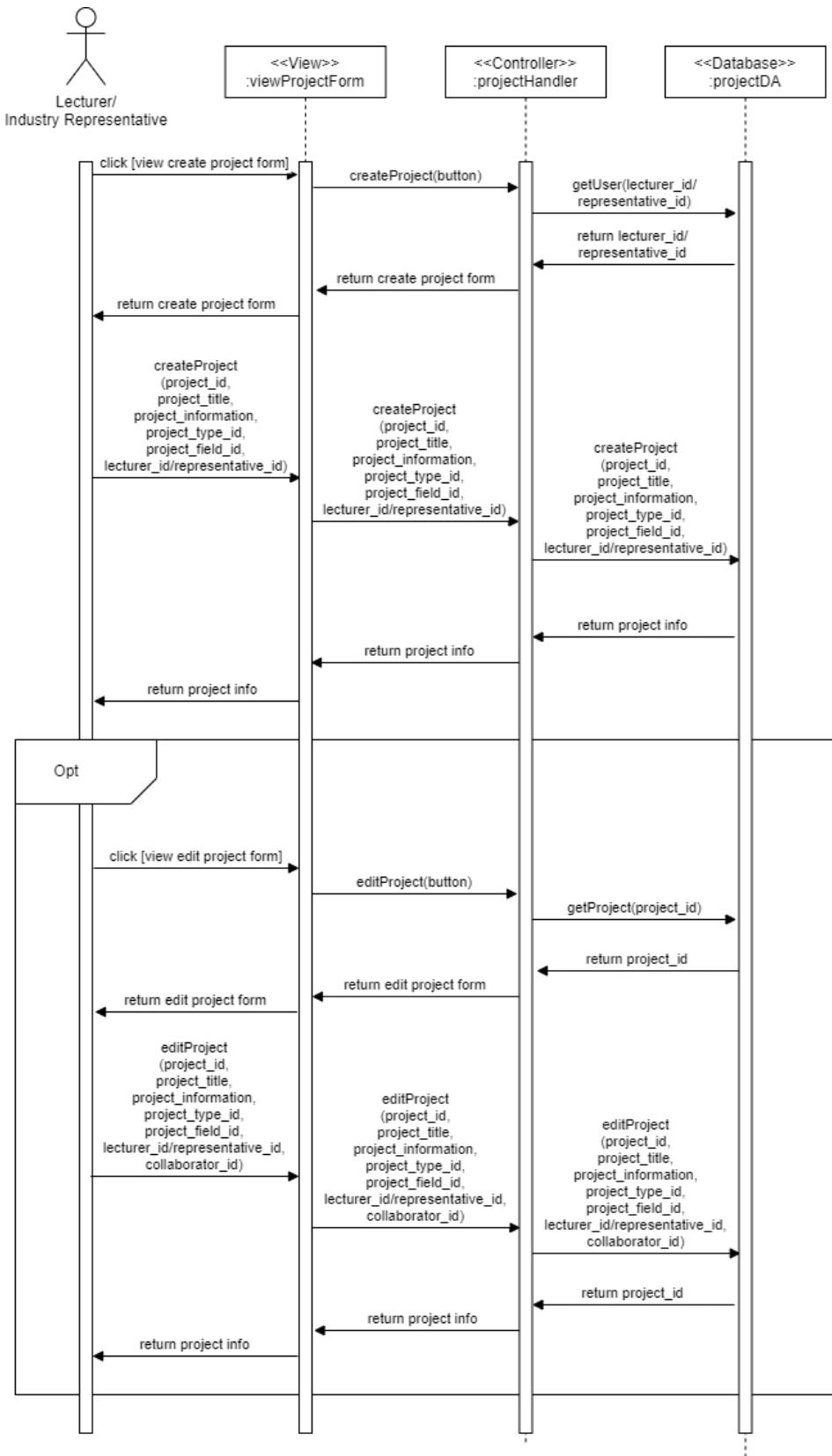


Figure 4.2 Detailed SSD for manage project use case (Create, Update)

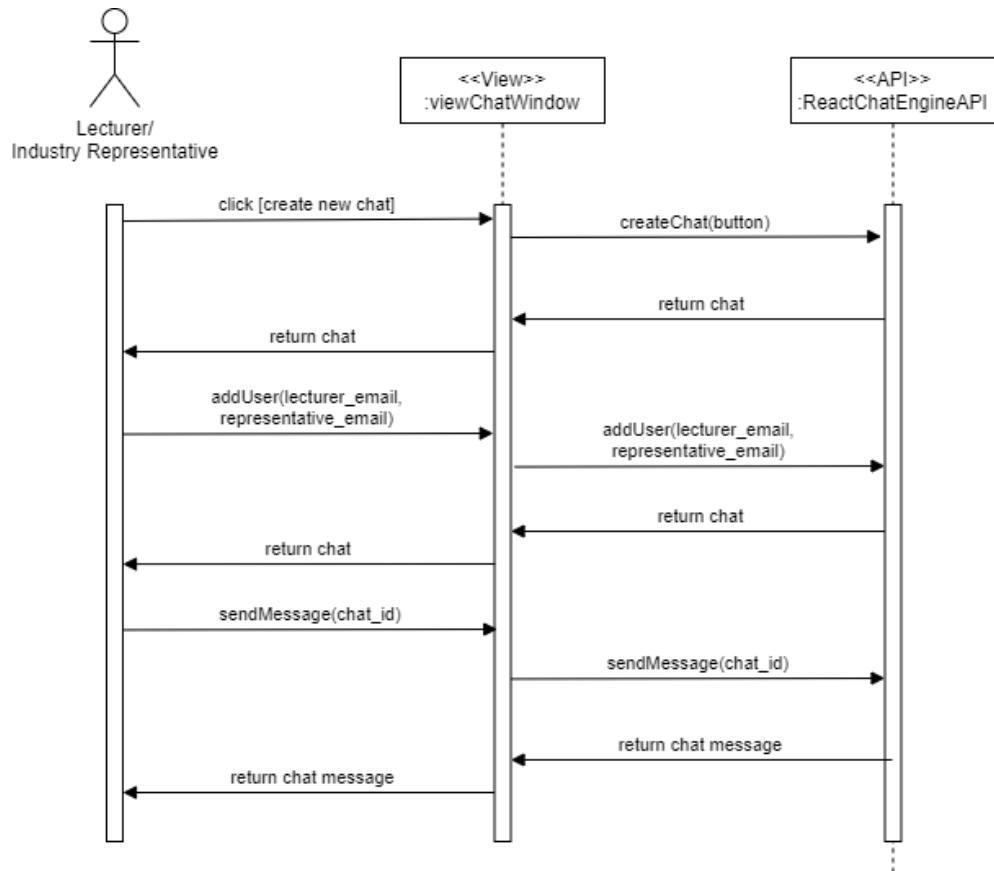


Figure 4.3 Detailed SSD for Chat use case

Note: The detailed SSDs for other important use cases can be found in *Appendices*.

#### 4.2.2. Algorithm implementation

The cosine similarity algorithm is performed to find match between user preference and project. There are several other steps that must be executed before finding a match. User preference and project list are fetched from backend. The methods explained will be executed on both user preference and project list texts. For project list, the methods will be performed on the project information attribute only.

- Map the words to their frequency count.

Table 4.1 Algorithm implementation step 1

Word Count
<ol style="list-style-type: none"> <li>Split the string into words.</li> <li>For each of the word:             <ol style="list-style-type: none"> <li>Count the frequency of occurrence of the word.</li> <li>Map the word and frequency.</li> </ol> </li> </ol>

- Make dictionary of all words present in both user preference and project list.

Table 4.2 Algorithm implementation step 2

Add Words to Dictionary
<ol style="list-style-type: none"> <li>For each of the word:             <ol style="list-style-type: none"> <li>Add the word to dictionary. This will be used later to make a vector representation of the word counts.</li> </ol> </li> </ol>

- Convert the word count map to vector.

Table 4.3 Algorithm implementation step 3

Change Word to Vector
<ol style="list-style-type: none"> <li>For each of the word in dictionary:             <ol style="list-style-type: none"> <li>Change the word to vector.</li> <li>Vector A will represent user preference while Vector B will represent project information.</li> </ol> </li> </ol>

- Calculate the cosine similarity between both vectors.

Table 4.4 Algorithm implementation step 4

Calculate cosine similarity
<ol style="list-style-type: none"> <li>Compute the dot product between Vector A and Vector B using the formula:  <math display="block">\text{dot product} = \text{vector } A \times \text{vector } B</math> </li> <li>Calculate the magnitude of both vectors using the formula:</li> </ol>

$$\text{magnitude } A = \text{vector } A \times \text{vector } A$$

$$\text{magnitude } B = \text{vector } B \times \text{vector } B$$

3. Compute the product of magnitude using the formula:

$$\text{total magnitude} = \text{magnitude } A \times \text{magnitude } B$$

4. Calculate the cosine similarity. The result is between 0 to 1 only.

$$\text{Cosine similarity} = \text{dot product} \div \text{total magnitude}$$

5. Cosine similarity is then converted to percentage:

$$\text{Score} = \text{Cosine similarity} \times 100$$

5. Sort the score from highest to lowest.
6. Return a maximum of three projects matched with user preference scored above 50%.

### 4.3. User interface design

#### 4.3.1. User interface design for lecturer

Figure 4.4 shows the dashboard of a registered lecturer. The first row of the dashboard contains the total project the lecturer currently has and the number of pending activity, or in other words, the activities of any project that are currently in progress. The second row consists of user profile, a pie chart of project category and three latest lecturer project list. Lecturer can also add more project or show more project. The last row contains project recommendation that might be of interest to the lecturer.

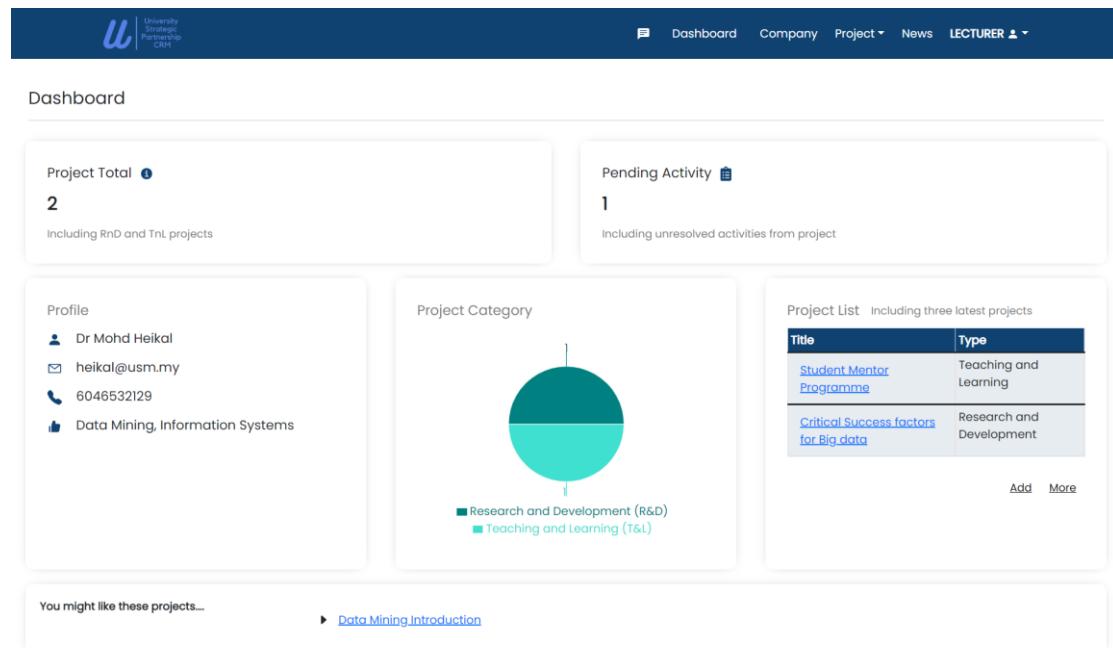


Figure 4.4 Lecturer dashboard

Figure 4.5 depicts the list of registered company that lecturer can view. Lecturer can also search for a certain company based on their name.

The figure shows the "Company List" page. At the top, there's a header with the university logo and navigation links for Dashboard, Company, Project, News, and LECTURER. Below the header, the page title is "Company List". There's a search bar with placeholder text "Enter company name here...". A table lists ten companies with columns for Name, Email, Contact, Preferences, Category, and Sector. The companies listed are Agrobank, Ammobox Studio Sdn Bhd, Arma, BASF Malaysia Sdn Bhd, BioAlpha Holdings Berhad, Brain Boost Studio, DC Logistics Sdn Bhd, Dell Global Business Center Sdn Bhd, Hidden Chest Studio, and IBM. At the bottom, there are navigation buttons for "Previous", "Next", and page numbers 1, 2, 3.

Name	Email	Contact	Preferences	Category	Sector
Agrobank	contact@agrobank.com.my	60327311600	Software Development, Web Development	Government Linked Companies (GLC)	Financial Services
Ammobox Studio Sdn Bhd	info@ammoboxstudios.com	60358860405	Mobile and Game Development	Startup	Industrial Products and Services
Arma	contact@armaworldwide.com	6038342576	Cybersecurity	Startup	Information Technology
BASF Malaysia Sdn Bhd	contact@bASF.com	60376121888	Internet of Things	Multinational Corporation (MNC)	Industrial Products and Services
BioAlpha Holdings Berhad	info@bioa.com.my	60389222286	Enterprise Architecture	Small and medium-sized enterprise (SME)	Industrial Products and Services
Brain Boost Studio	contact@isocar.my	0397790303	Mobile and Game Development	Startup	Information Technology
DC Logistics Sdn Bhd	pp@dciservices	60331790388	Database, Information Systems	Small and medium-sized enterprise (SME)	Transportation and Logistics
Dell Global Business Center Sdn Bhd	contact@dell.com	6046334888	Software Development, Internet of Things	Multinational Corporation (MNC)	Industrial Products and Services
Hidden Chest Studio	hiddencheststudio@gmail.com	0173894937	Mobile and Game Development	Startup	Information Technology
IBM	direct@my.ibm.com	60323018888	Software Development	Multinational Corporation (MNC)	Information Technology

Figure 4.5 Company list (lecturer)

Figure 4.6 shows the list of available projects by company representatives. Lecturer can also search for a certain project.

The screenshot shows a web application interface for managing projects. At the top, there is a dark blue header bar with the University of Malaya logo on the left and navigation links for Dashboard, Company, Project, News, and LECTURER on the right. Below the header is a search bar labeled "Search for project:" with the placeholder "Enter project title here...". The main content area is titled "Project List" and contains a table with five rows of project data. The columns are labeled "Title", "Information", "Type", "Field", and "Posted by". The data in the table is as follows:

Title	Information	Type	Field	Posted by
<a href="#">Contextualized Linguistic Forensics Text Analytics Combinatorial Approach for Jihadi Recruitment Detection in Online Text</a>	Artificial Intelligence	Teaching and Learning	Information Security and Assurance	Nurul Arlina
<a href="#">Code4You: A Kids' Coding Program</a>	Multimedia System	Teaching and Learning	Information Systems Development	Ali bin Abu
<a href="#">Programming Bootcamp</a>	TBA	Teaching and Learning	Specialised Systems Development	Siti Nadirah Rosli
<a href="#">Data Mining Introduction</a>	data mining intro	Teaching and Learning	Embedded Systems	Satishvaran
<a href="#">Student Mentor Programme</a>	TBA	Teaching and Learning	Embedded Systems	Nurmiza Sahbudin

At the bottom of the table, there are three navigation buttons: "Previous", a central blue square button, and "Next".

Figure 4.6 Company project list (lecturer)

Figure 4.7 shows a project page example when the lecturer is the collaborator. Project information and discussion board are public to every user. Project activity and attachment are only accessible to both project owner and collaborator.

The screenshot shows a project page for 'Student Mentor Programme'. At the top, there are navigation links: Back to Dashboard, Back to Company Project List, Back to Your Project List, Dashboard, Company, Project, News, and LECTURER. The project information includes:

- Project Information: TBA
- Project Status: Available
- Project Type: Teaching and Learning
- Project Field: Embedded Systems
- Project Collaborator: Dr Mohd Heikal

Posted by Nurmiza Sohbudin, Thursday 14-04-2022 at 12:17:37.

**Activity**

Title	Information	Status	Actions
Project flow	Webex at 9 PM	In Progress	<a href="#">Edit</a> <a href="#">Delete</a>

**Attachment**

Image	Action
<a href="http://127.0.0.1:3000/images/file-1656284763594.pdf">http://127.0.0.1:3000/images/file-1656284763594.pdf</a>	<a href="#">Delete</a>

**Discussion**

Enter your comment here

Comments (2)

**Dr Mohd Heikal** Wednesday, 22-06-2022 at 15:48:08  
This is a month project  
[Reply](#) [Edit](#)

**Nurmiza Sohbudin** Thursday, 14-04-2022 at 12:19:18  
Interesting activities coming!  
[Reply](#)

Figure 4.7 View project 1 (lecturer)

Figure 4.8 shows a project page example when lecturer is neither the owner nor collaborator. Only project information and discussion board can be viewed.

The screenshot shows a web-based project management system. At the top, there is a dark blue header bar with the university logo on the left and navigation links for Dashboard, Company, Project, News, and LECTURER on the right. Below the header, the main content area displays a project's details.

**Project Information:**

- Project Status: Available
- Project Type: Teaching and Learning
- Project Field: Information Security and Assurance
- Project Collaborator: Dr Nurul Hashimah

**Posted by:** Nurul Arlina, Monday 11-04-2022 at 15:16:27

**Discussion:**

Enter your comment here

**Comments (8):**

- Dr Mohd Heikal** Thursday, 14-04-2022 at 12:14:38  
Good project!  
[Reply](#) [Edit](#)
- Dr Nurul Hashimah** Tuesday, 21-06-2022 at 13:02:47  
Thank you Dr Heikal  
[Reply](#)
- Dr Mohd Halim Mohd Noor** Wednesday, 13-04-2022 at 23:32:33  
Great!!!  
[Reply](#)
- Dr Manmeet Kaur Singh** Wednesday, 13-04-2022 at 22:58:10  
Great  
[Reply](#)
- Dr Azizul Rahman Mohd Shariff** Wednesday, 13-04-2022 at 16:11:22  
Wow  
[Reply](#)
- Dr Gan Keng Hoon** Tuesday, 12-04-2022 at 23:40:37  
wow this is great  
[Reply](#)
- Dr Gan Keng Hoon** Tuesday, 12-04-2022 at 22:42:30  
Woww  
[Reply](#)
- Nurul Arlina** Tuesday, 13-04-2022 at 16:42:42  
Hope everyone is interested!  
[Reply](#)

Figure 4.8 View project 2 (lecturer)

Figure 4.9 depicts the chat page for lecturer. Lecturer can add new chat title, add user to chat, and send message to each other.

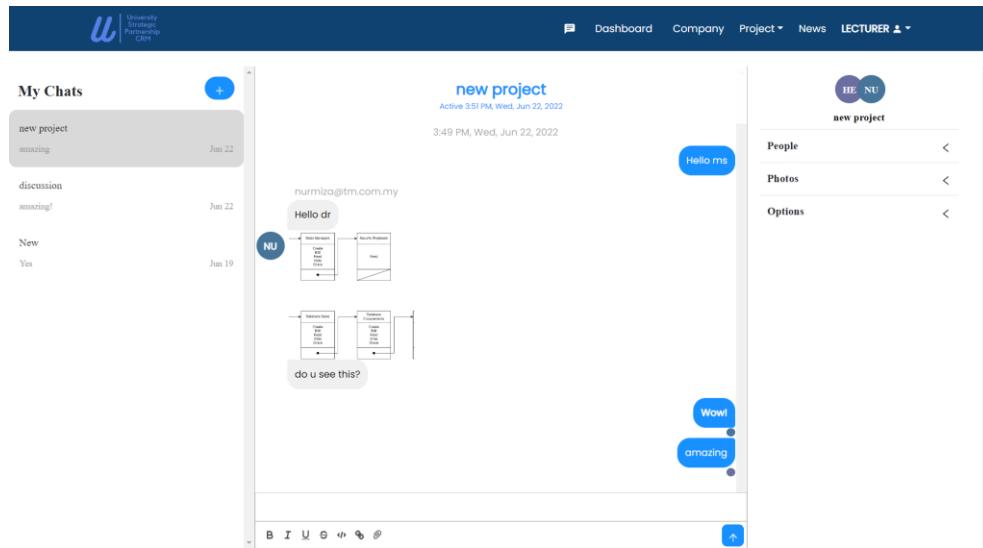


Figure 4.9 Chat (lecturer)

Figure 4.10 depicts the news page. Lecturer can post any news, e.g., current status of project and everyone can view the post.

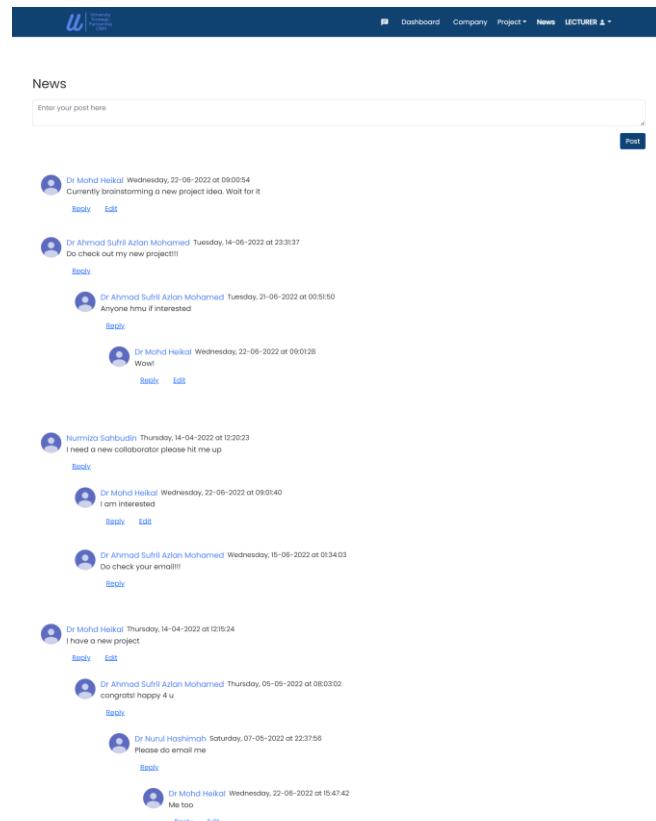


Figure 4.10 News (lecturer)

#### 4.3.2. User interface design for admin

Figure 4.11 shows the dashboard of admin. The first row consists of four parts: total of registered projects, total of registered lecturers, total of registered company representatives, and total of registered companies. The second row contains two charts; the pie chart depicts the number of registered projects according to its category (R&D or T&L) and the bar chart presents the number of registered company according to the category (MNC, SME, NGO, GLC, Startup).

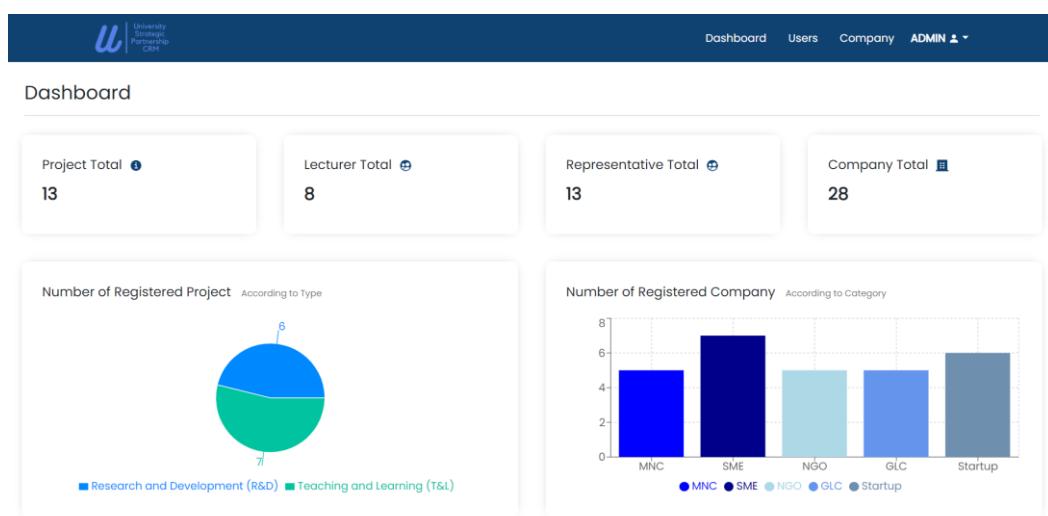


Figure 4.11 Admin dashboard

Figure 4.12 and 4.13 show the list of users according to type. Admin can either allow or reject user access.

List of Users

Name	Email	Status	Action(Allow/Reject User Access?)
Dr Mohd Helikal	helikal@usm.my	Active	None
Dr Mohd Halim Mohd Noor	halimnoor@usm.my	Active	None
Dr Manmeet Kaur Singh	manmeet@usm.my	Active	None
Dr Azizul Rahman Mohd Shariff	azizulrahman@usm.my	Active	None
Dr Ahmad Sufri Azlan Mohamed	sufril@usm.my	Active	None
Dr Gan Keng Hoon	khgan@usm.my	Active	None
Dr Jasy Liew	jasyliew@usm.my	Active	None
Dr Nurul Hashimah	nurulhashimah@usm.my	Active	None

Previous | 1 | Next

Figure 4.12 Lecturer list (admin)

List of Users

Name	Email	Status	Action(Allow/Reject User Access?)
Siti Khadijah	khadijah@oiletek.com.my	Inactive	None
Fadzli	fadzli@gmail.com	Active	None
Jalilah	jalilah@ambank.com.my	Pending	Allow   Reject
User 2	user2@gmail.com	Active	None
Muhammad	muhammad@telebort.com	Active	None
Nurul Amirah	nurul@tm.com.my	Active	None
Nurmiza Sahbudin	nurmiza@tm.com.my	Active	None
Satishvaran	satishvaran@mns.org.my	Active	None
Siti Nadirah Rosli	nadirah@siccmb.com	Active	None
Abu bin Ali	abu@telebort.com	Active	None

Previous | 1 | 2 | Next

Figure 4.13 Representative list (admin)

Note: User interface design for functionalities such as Sign In, Sign Up and industry representatives can be found in *Appendices*.

#### 4.4. Implementation strategy

The system is developed using *bottom-up* approach. The smaller chunks of the system are developed first before the bigger parts, and only then they are linked together. The JavaScript library used to develop the front-end, ReactJS consists of several functional components. Each of the component has its own use cases; and can be reused. These components when connected, form a complete working system.

There are several reasons as to why bottom-up approach is applied. First, as mentioned before, component can be reused which minimizes redundancy. Next, it is easier for testing since the system is broken down into several subsystems. After completing a small subsystem, testing can be done right away on the subsystem to test whether the component is working.

## 5 SYSTEM TESTING & EVALUATION

### 5.1. Testing strategy

#### 5.1.1. Unit testing

Unit testing is a test that involves each single part of the software to check for errors and mistakes. This test type is mainly done to discover errors within the codes. The main goal is to validate every component inside the code. For this system, each component is tested as soon as it is completed. For example, one of the very first testing done during the system development is testing whether connection to MySQL database is successful or not. This connection is important to ensure that data can be kept, stored, and fetched successfully. Another example would be components such as ‘Add project’ button and project list. Unit testing is done to ensure these components can work independently.

#### 5.1.2. Integration testing

Integration testing follows unit testing, where multiple components of the system are tested together to ensure they work together seamlessly. For example, for each project, there will be a discussion section for user to post their comments. The comment section is tested by checking whether the comments posted belonged to the project or not.

#### 5.1.3. System testing

System testing involves the entire system or independent subsystem. This type is mainly done on the whole integrated system to check whether the built project meets all the conditions or not. It involves testing the fully integrated applications and verifying the outputs through the entered inputs on the completed software before it is marketed to users. For example, the chat feature is tested whether it can send real-time chat messages or not.

## 5.2. Test Scenarios

Table 5.1 shows the test case scenarios for User Profile module while Table 5.2 contains the test case scenarios for Joint R&D pipeline and Industry in classroom modules. Table 5.3 presents the list of test case scenarios for Discussion module while Table 5.4 depicts the test case scenarios for Project Recommendation module.

Table 5.1 Test Scenario for User Profile module

<b>Test Scenario ID</b>	<b>Test Scenario</b>	<b>Prerequisites</b>
TS01	Allow user to sign up.	None.
TS02	Allow user to sign in.	Lecturer/Industry representatives must be approved by admin.
TS03	Allow/Reject user access.	User must have an account.
TS04	Allow profile management by lecturers and industry representatives.	Lecturer/Industry representatives must exist.
TS05	Display list of lecturers.	At least one lecturer must exist.
TS06	Display list of companies.	At least one company must exist.

Table 5.2 Test Scenario for Joint R&amp;D pipeline and Industry in classroom module

<b>Test Scenario ID</b>	<b>Test Scenario</b>	<b>Prerequisites</b>
TS07	Allow project management by lecturers and industry representatives.	Project must exist.
TS08	Allow project activity management by lecturers and industry representatives.	Project must exist. Activity must exist.
TS09	Allow project attachment management by lecturers and industry representatives.	Project must exist. Attachment must exist.

Table 5.3 Test Scenario for Discussion module

<b>Test Scenario ID</b>	<b>Test Scenario</b>	<b>Prerequisites</b>
TS10	Ensure lecturers and industry representatives can post comment under project's discussion board.	Project must exist.
TS11	Ensure lecturers and industry representatives can send chat message to each other.	Lecturer/Industry representative must exist. Chat must exist.
TS12	Ensure lecturers and industry representatives can post news.	Lecturer/Industry representative must exist.

Table 5.4 Test Scenario for Project Recommendation module

Test Scenario ID	Test Scenario	Prerequisites
TS13	Ensure lecturers and industry representatives can view project recommendation.	Lecturer/Industry representative has their preferences set.  Project must exist.

### 5.3. Test Report Summary

Table 5.5 shows the summary of tests performed on the system.

Table 5.5 Summary of test reports

Executed	Passed	43	
	Failed	0	
	(Total)	43	
(Total)			43

Table 5.6 below shows the test scenario reports.

Table 5.6 Test scenario reports

<b>Test Scenario ID</b>	<b>Test Case passed (%)</b>	<b>Priority</b>	<b>Related Test Cases</b>
TS01	100	High	TC01, TC02
TS02	100	High	TC03, TC04, TC05, TC06
TS03	100	High	TC07, TC08
TS04	100	High	TC09, TC10, TC11, TC12
TS05	100	High	TC13
TS06	100	High	TC14
TS07	100	High	TC15, TC16, TC17, TC18, TC19, TC20
TS08	100	High	TC21, TC22, TC23
TS09	100	High	TC24, TC25, TC26, TC27, TC28
TS10	100	High	TC29, TC30, TC31, TC32
TS11	100	High	TC33, TC34, TC35, TC36, TC37
TS12	100	High	TC38, TC39, TC40
TS13	100	High	TC41, TC42, TC43

Note: Details of test cases can be found in *Appendices*.

## 5.4. Meeting the requirements

The system developed is able to meet all of the requirements. The first objective is *to provide a dashboard system that allows academic staff and industrial representatives communicate with each other for collaboration purposes.* This objective is achieved through the discussion board, chat, and news features where users are able to post their comments enquiring about certain project, send private message to each other, and post their latest news.

The second objective is *to develop a suitable recommendation system based on similarities and differences of the industrial representative and academic staff.* This objective is achieved through the project recommendation system based on user preferences.

The final objective, *to serve as a centralized repository to keep documents related to discussed projects* is achieved through the attachment upload feature. Each project has a repository for owner and collaborator to upload attachments related to the project.

## 5.5. System evaluation

The system is evaluated in terms of strengths and weaknesses after the system has been completely built and tested.

The strengths of the system include:

- i. The current CRM system discussed, such as Mautic for Education CRM lacks chat system. University Strategic Partnership CRM system however, provides communication platform for users, which include the discussion, chat, and news system for users to keep in touch with each other. When these features are utilized, users can have fruitful and productive discussions.
- ii. The project recommendation feature is unique to this system. This feature allows user to discover new projects that might be of interest to them.

The weaknesses of the system include:

- i. The cosine similarity algorithm used is not 100% accurate to calculate similarities between user preference and project list due to the way the algorithm is implemented. The more preferences chosen by user, the less accurate the calculation would be, leading to low similarity between preference and projects. Thus, no project can be recommended to users at the time.
- ii. The similarities between user and project also solely depend on the preferences that user has set. It does not consider other behaviors such as user's project history. This may limit the type of project being recommended to user.
- iii. There is currently no feature to alert users of the activities happening in the system. For example, user may not know if someone has commented on their project due to no notification being sent.

## 6 CONCLUSION & FUTURE WORK

In conclusion, this system is a web-based solution to effectively connect the lecturers and industry representatives through the various collaboration projects proposed. To recap, lecturers and industry representatives can post their T&L and R&D projects, and collaborators can leave a comment under the project's discussion board if they are interested. Next, project owners can record the progress by adding activities or attachments for the project. Furthermore, there is a chat feature for both parties to discuss things in private. Lecturers and industry representatives can also post news to alert users of the system of the latest update of their projects. Other than that, they can get project recommendation based on their interest.

The system can be said to meet all minimum requirements. The system is developed in a proper manner using bottom-up approach to ensure proper development and testing can be done. The current solution may solve the communication issue between both lecturers and industry representatives. The system also helps with providing an archive for storing project-related documents. Other than that, lecturer and representative can get a kickstart in project through the project recommendation feature. However, the downsides of this system can also be found. The final system may have provided a dashboard with some information and charts; however, it lacks real analytical purposes that can be meaningful to the user. Next, the recommendation system can be improved by using a more accurate and powerful machine learning algorithm, rather than the cosine similarity algorithm used.

Overall, there is a lot of improvement to be done in the future. The system however can act as a good starter for CRM-based system involving industry partners and university academic staffs. The system can hopefully be refined more in the future for the ease of partnership between the two parties.

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# APPENDICES

## DETAILED SSD

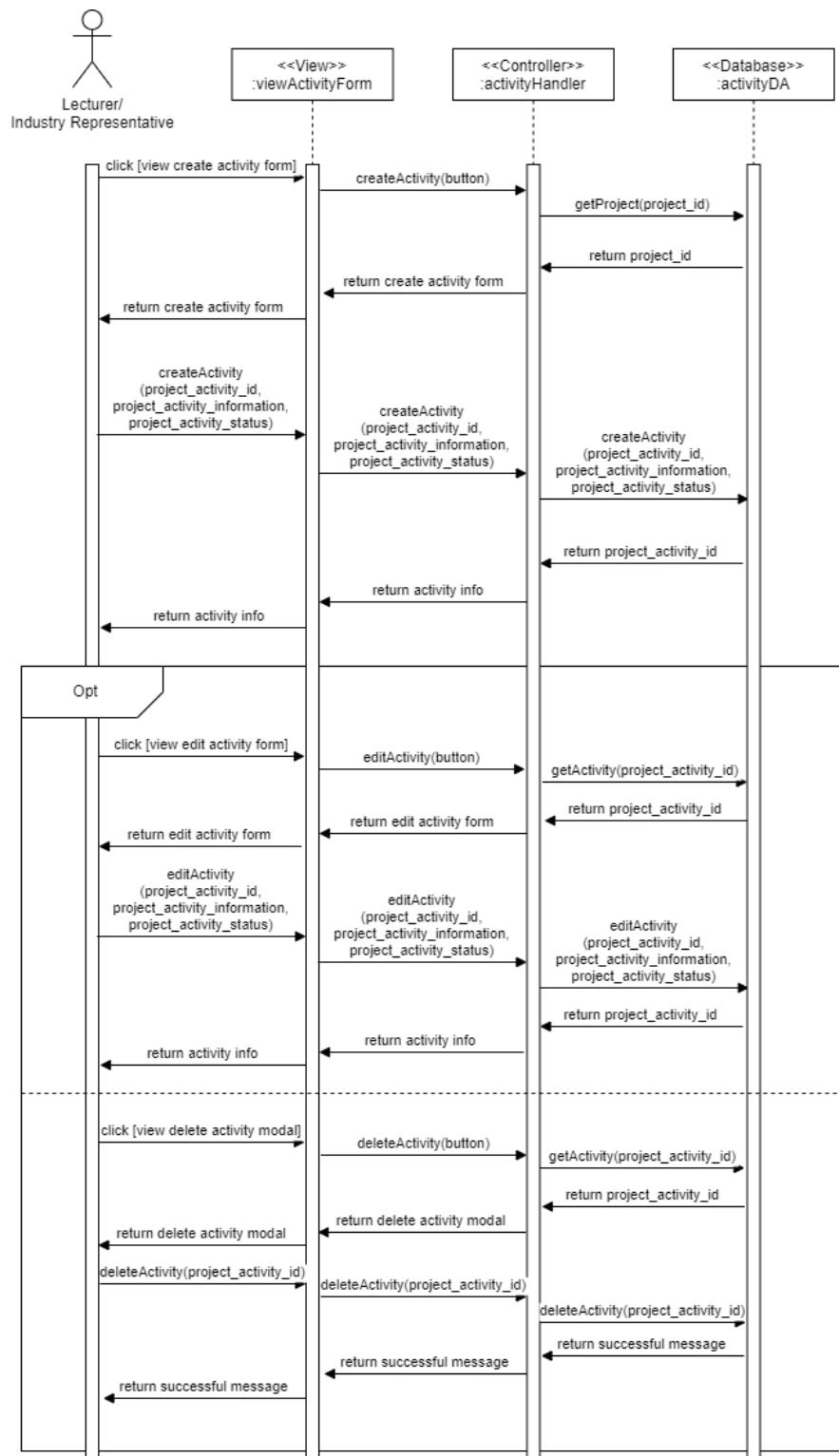


Figure A.1 Detailed SSD for Manage activity use case

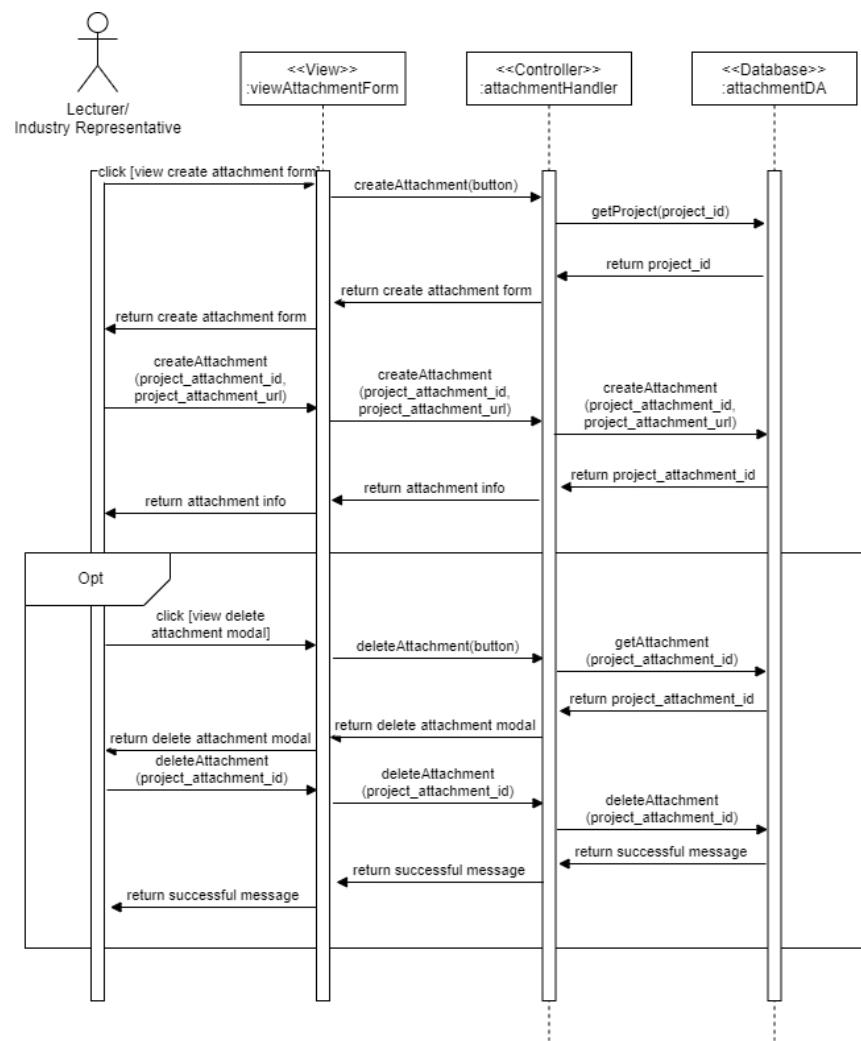


Figure A.2 Detailed SSD for Manage attachment use case

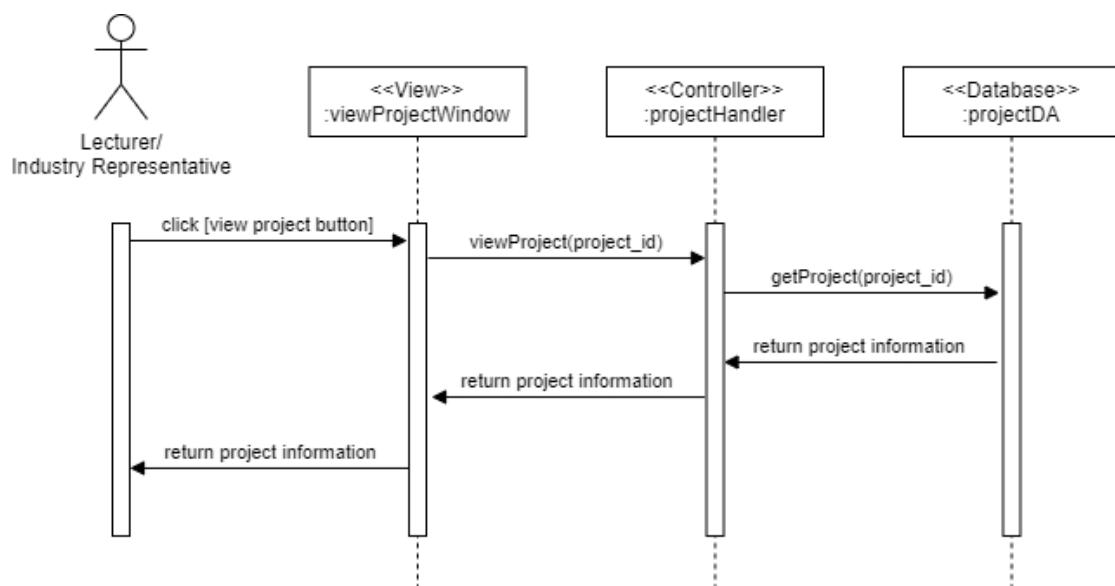
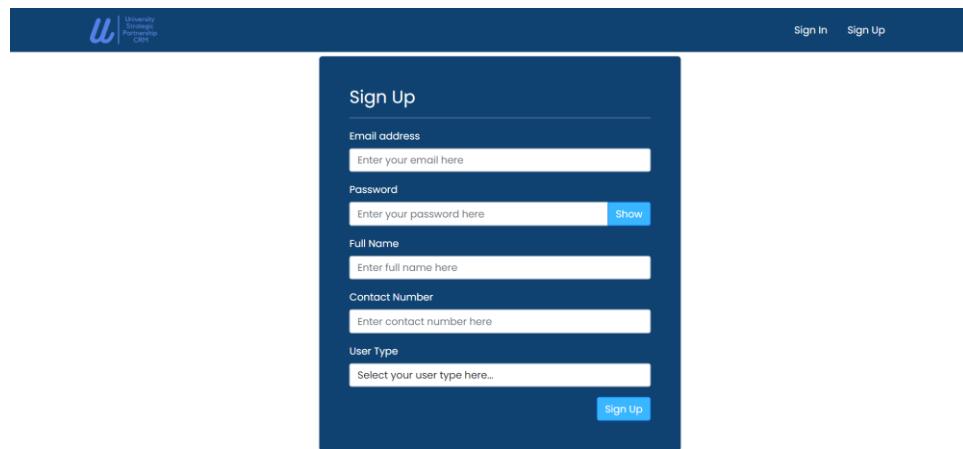


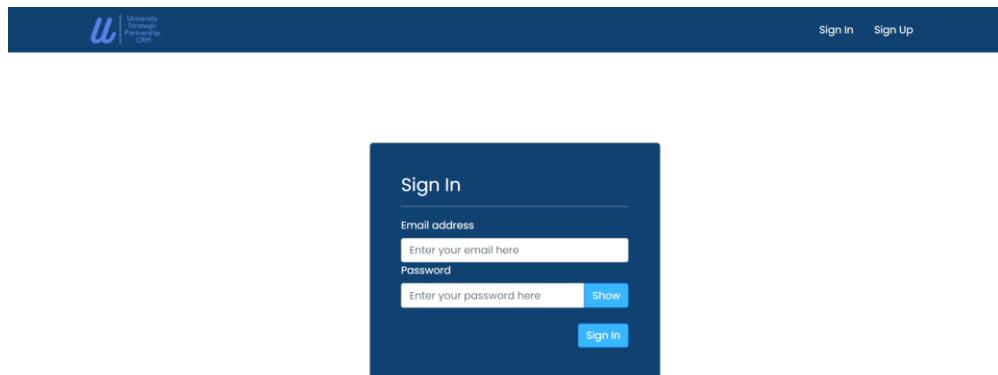
Figure A.3 Detailed SSD for View project

## USER INTERFACE DESIGN



The screenshot shows the 'Sign Up' user interface. At the top right are 'Sign In' and 'Sign Up' links. The main form has a dark blue header with the text 'Sign Up'. It contains five input fields: 'Email address' (placeholder 'Enter your email here'), 'Password' (placeholder 'Enter your password here' with a 'Show' link), 'Full Name' (placeholder 'Enter full name here'), 'Contact Number' (placeholder 'Enter contact number here'), and 'User Type' (placeholder 'Select your user type here...'). A blue 'Sign Up' button is at the bottom right.

Figure A.4 Sign Up user interface



The screenshot shows the 'Sign In' user interface. At the top right are 'Sign In' and 'Sign Up' links. The main form has a dark blue header with the text 'Sign In'. It contains two input fields: 'Email address' (placeholder 'Enter your email here') and 'Password' (placeholder 'Enter your password here' with a 'Show' link). A blue 'Sign In' button is at the bottom right.

Figure A.5 Sign In user interface

**Edit Profile**

Email address  
heikal@usm.my

Full Name  
Dr Mohd Heikal

Contact Number  
6046532129

Preferences (Tick any below)

- Artificial Intelligence
- Machine Learning
- Data Mining
- Multimedia System
- Computer Graphics
- Visual Processing
- Networking
- Cloud Computing
- Internet of Things
- Cybersecurity
- Forensics
- Cryptography
- Database
- Enterprise Architecture
- Information Systems
- Software Development
- Web Development
- Mobile and Game Development

**Update**

Figure A.6 Lecturer Edit Profile user interface

**Edit Profile**

Email address  
nadirah@sicsmb.com

Full Name  
Siti Nadirah Rosli

Contact Number  
6013246877

Type  
Human Resource (HR)

Company Name  
Software International Corporation Sdn Bhd

**Update**

Figure A.7 Representative Edit Profile user interface

Add Company

Company Name  
Enter company name here

Company Email  
Enter company email here

Company Contact  
Enter company contact here

Company Category  
Select company category here...

Company Sector  
Select company sector here...

Preferences (Tick any below)

- Artificial Intelligence
- Machine Learning
- Data Mining
- Multimedia System
- Computer Graphics
- Visual Processing
- Networking
- Cloud Computing
- Internet of Things
- Cybersecurity
- Forensics
- Cryptography
- Database
- Enterprise Architecture
- Information Systems
- Software Development
- Web Development
- Mobile and Game Development

[Cancel](#) [Add](#)

Figure A.8 Admin Add Company user interface

Add Project

(Note: Only projects related to Research and Development (RnD) and Teaching and Learning (TnL) can be added)

Project Title  
Enter your project title here

Project Information  
Enter your project information here

Project Status  
Select your project status here...

Project Type  
Select your project type here...

Project Field  
Select your project field here...

[Cancel](#) [Add](#)

Figure A.9 Add Project user interface

Edit Project

Project Title  
PROJECT 1

Project Information  
TBA

Project Status  
Available

Project Type  
Research and Development

Project Field  
Specialised Systems Development

Collaborator  
Malaysian Nature Society (MNS) - Satishvaran

Cancel Update

Figure A.10 Edit Project user interface

Add new activity

Title  
Enter activity title here

Information  
Enter activity information here

Status  
Select your activity status here...

Cancel Save

Figure A.11 Add activity user interface

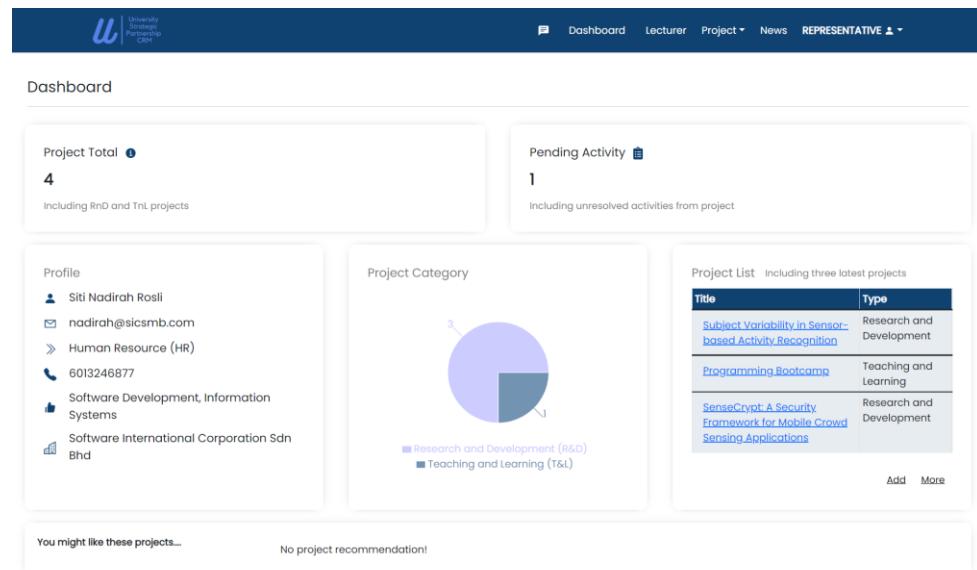


Figure A.12 Representative dashboard user interface

**SenseCrypt: A Security Framework for Mobile Crowd Sensing Applications**

Project Information	TBA
Project Status	Taken
Project Type	Research and Development
Project Field	Information Security and Assurance
Project Collaborator	Siti Nodirah Rosli

Posted by Dr Manmeet Kaur Singh, Wednesday 13-04-2022 at 22:55:18

**Activity** [+ Add](#)

Title	Information	Status	Actions
Attend conference	To be deferred	In Progress	<a href="#">Edit</a> <a href="#">Delete</a>
More	more	Completed	<a href="#">Edit</a> <a href="#">Delete</a>

**Attachment** [+ Add](#)

Image	Action
<a href="http://127.0.0.1:3000/mongo/file-1656285505477.docx">http://127.0.0.1:3000/mongo/file-1656285505477.docx</a>	<a href="#">Delete</a>

**Discussion**

Enter your comment here [Post](#)

Comments (5)

- Siti Nodirah Rosli** Monday, 27-06-2022 at 07:18:50  
Excited to be working on the project!  
[Reply](#) [Edit](#)
- Dr Manmeet Kaur Singh** Saturday, 11-06-2022 at 16:27:45  
Can WhatsApp me  
[Reply](#)
- Dr Manmeet Kaur Singh** Saturday, 11-06-2022 at 16:37:08  
Please do  
[Reply](#)
- Dr Manmeet Kaur Singh** Monday, 20-06-2022 at 16:27:04  
That is also okay for me  
[Reply](#)
- Dr Manmeet Kaur Singh** Wednesday, 13-04-2022 at 22:57:15  
Let me know if anyone interested  
[Reply](#)

Figure A.13 Representative view own project user interface

**Lecturer List**

Search for company:  
Enter lecturer name here...

Name	Email	Contact Number	Preferences
Dr Ahmad Sufriq Azlan Mohamed	sufriq@usm.my	6046530351	Multimedia System,Computer Graphics,Artificial Intelligence
Dr Azizul Rahman Mohd Shariff	azizurrahman@usm.my	6046532486	Networking
Dr Gan Keng Hoon	kgan@usm.my	6045834352	Natural Language Processing
Dr Jasy Liew	jasyliew@usm.my	6046534645	Artificial Intelligence,Machine Learning
Dr Manmeet Kaur Singh	manmeet@usm.my	6045637289	Internet of Things,Cybersecurity
Dr Mohd Halim Mohd Noor	halimnoor@usm.my	6046534757	Machine Learning
Dr Mohd Heikal	heikal@usm.my	6046532129	Data Mining,Information Systems
Dr Nurul Hashimah	nurulhashimah@usm.my	6046534640	Machine Learning,Internet of Things

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Figure A.14 Representative View Lecturer

**Project List**

Search for project:

Enter project title here...

Title	Information	Type	Field	Posted by
<a href="#">A Framework for the Identification of the Best Crosses that Produced High-yielding and Stress Tolerant Crop using Artificial Intelligence Techniques</a>	TBA	Research and Development	Intelligent Systems and Data Analytics	Dr Nurul Hashimah
<a href="#">CST434 in class project</a>	Networking	Teaching and Learning	Embedded Systems	Dr Azizul Rahman Mohd Shariff
<a href="#">Representing annotations in XML document using string-trees model</a>	TBA	Research and Development	Specialised Systems Development	Dr Gan Keng Hoon
<a href="#">PROJECT 1</a>	TBA	Research and Development	Specialised Systems Development	Dr Ahmad Sufri Azlan Mohamed

Previous    Next

Figure A.15 Representative View Lecturer Project List

**My Chats**

**framework**

Active 7:23 AM, Mon, Jun 27, 2022

7:23 AM, Mon, Jun 27, 2022

Hello, we will discuss here

**People**

- MA maameet@usn.my
- NA nadirah@sicimb.com

meet

Photos

Options

Figure A.16 Representative chat

## **TEST CASES**

### **User profile module test cases**

Table A.1 Test Case Data

Test Scenario ID	Test Case Scenario	Test Case Description	Test Steps	Test Data	Expected Results	Actual Results	Pass/Fail
TS01	TC01	Valid sign up	1. Click Sign Up. 2. Type email, password, and other details. 3. Click Sign Up button.	Email: <a href="mailto:hychan@usm.my">hychan@usm.my</a>  Password: chan  Full Name: Assoc Prof Dr Chan Huah Yong  Contact Number: 6045633335	Successful sign up	As expected	Pass
TS01	TC02	Invalid sign up	1. Click Sign Up. 2. Type email, password, and other details. 3. Click	Email: <a href="mailto:hychan@usm.my">hychan@usm.my</a>  Password: chan  Full Name: Assoc Prof Dr Chan	Email and password have been used	As expected	Pass

			Sign Up button.	Huah Yong Contact Number: 6045633335			
TS02	TC03	Unsuccessful sign in	1. Click Sign In. 2. Type email and password. 3. Click Sign In button.	Email: <a href="mailto:hychan@usm.my">hychan@usm.my</a> Password: chan	User request is pending	As expected	Pass
TS02	TC04	Successful sign in	1. Click Sign In. 2. Type email and password. 3. Click Sign In button.	Email: <a href="mailto:hychan@usm.my">hychan@usm.my</a> Password: chan	User request is accepted and right email and password	As expected	Pass
TS02	TC05	Unsuccessful sign in	1. Click Sign In. 2. Type email and password. 3. Click Sign In	Email: <a href="mailto:hychan@usm.my">hychan@usm.my</a> Password: abc1234	Email and password combination are invalid	As expected	Pass

			button.				
TS02	TC06	Unsuccessful sign in	1. Click Sign In. 2. Type email and password. 3. Click Sign In button.	Email: farhana@gmail.com  Password: farhana	User request has been rejected	As expected	Pass
TS03	TC07	Allow user access	1. Click on 'User' tab. 2. Click 'Allow' on any user with pending status.	Email: hychan@us.m.my  Status: Accepted	User request has been accepted	As expected	Pass
TS03	TC08	Reject user access	1. Click on 'User' tab. 2. Click 'Reject' on any user with pending status.	Email: <a href="mailto:farhana@gmail.com">farhana@gmail.com</a>  Status: Rejected	User request has been rejected	As expected	Pass
TS04	TC09	Display	1. Click	-	Lecturer	As	Pass

		lecturer dashboard.	on 'Dashboard' tab.		dashboard is displayed.	expected	
TS04	TC10	Display industry representative dashboard.	1. Click on 'Dashboard' tab.	-	Representative dashboard is displayed.	As expected	Pass
TS04	TC11	Edit lecturer profile - valid	1. Click on 'Edit Profile'. 2. Enter information to be edited. 3. Click 'Update' button.	Email: hychan@us m.my  Preferences: Cloud Computing	Lecturer profile is changed.	As expected	Pass
TS04	TC12	Edit representative profile - valid	1. Click on 'Edit Profile'. 2. Enter information to be edited. 3. Click 'Update' button.	Representative type: HR  Company: Cloud Comrade	Representative profile is changed.	As expected	Pass

TS05	TC13	Display list of lecturers	1. Click on 'Lecturer' tab.	-	A list of lecturers is displayed.	As expected	Pass
TS06	TC14	Display list of companies.	1. Click on 'Company' tab.	-	A list of companies is displayed.	As expected	Pass

### **Joint R&D pipeline and Industry in classroom modules test cases**

Test Scenario ID	Test Case Scenario	Test Case Description	Test Steps	Test Data	Expected Results	Actual Results	Pass/Fail
TS07	TC15	Display list of lecturer projects.	1. Click on 'Lecturer Project' tab.	-	A list of lecturer project is displayed.	As expected	Pass
TS07	TC16	Display list of company projects.	1. Click on 'Company Project' tab.	-	A list of company project is displayed.	As expected	Pass
TS07	TC17	Add R&D project.	1. Click on 'Add Project' button. 2. Enter project	Project title: Simulation of multi agent approach in multi cloud	R&D project is added.	As expected	Pass

			information 3. Click 'Add' button.	environment using Matlab Project information: TBA Project category: Research and Development (R&D) Project field: Embedded Systems			
TS07	TC18	Edit R&D project.	1. Click on 'Edit Project' button.  2. Enter updated information.  3. Click 'Update'.	Project title: Simulation of multi agent approach in multi cloud environment using Matlab Project information: To assist in cloud computing	R&D project is updated.	As expected	Pass

TS07	TC19	Add T&L project.	1. Click on ‘Add Project’ button. 2. Enter project information. 3. Click ‘Add’ button.	Project title: Migrating to cloud workshop Project information: Cloud computing workshop Project category: Teaching and Learning (T&L) Project field: Embedded Systems	T&L project is added.	As expected	Pass
TS07	TC20	Edit R&D project.	1. Click on ‘Edit Project’ button. 2. Enter updated information. 3. Click ‘Update’.	Project title: Migrating to cloud workshop Collaborator: Assoc Prof Dr Chan Huah Yong	T&L project is updated.	As expected	Pass

TS08	TC21	Add project activity.	1. Click on 'Add Activity' button. 2. Enter activity information. 3. Click 'Add' button.	Activity title: Looking for collaborator Activity information: TBA Activity status: In progress	Project activity is added.	As expected	Pass
TS08	TC22	Edit project activity.	1. Click on 'Edit Activity' button. 2. Enter updated information. 3. Click 'Update'.	Activity title: Looking for collaborator Activity information: 2 potential collaborators	Project activity is updated.	As expected	Pass
TS08	TC23	Delete project activity.	1. Click on 'Delete Activity' button. 2. Click 'Yes, delete'	Activity title: Looking for collaborator	Project activity is deleted.	As expected	Pass

			button.				
TS09	TC24	Add project attachment – PNG.	1. Click on ‘Add Attachment’ button. 2. Upload attachment 3. Click ‘Add’ button.	Project attachment: (Choose 1 PNG type image)	PNG attachment is added.	As expected	Pass
TS09	TC25	Add project attachment – JPEG.	1. Click on ‘Add Attachment’ button. 2. Upload attachment 3. Click ‘Add’ button.	Project attachment: (Choose 1 JPEG type image)	JPEG attachment is added.	As expected	Pass
TS09	TC26	Add project attachment – DOC/DOCX.	1. Click on ‘Add Attachment’ button. 2. Upload attachment	Project attachment: (Choose 1 DOC/DOCX type file)	DOC/DOCX attachment is added.	As expected	Pass

			3. Click 'Add' button.				
TS09	TC27	Add project attachment – PDF.	1. Click on 'Add Attachment' button.  2. Upload attachment  3. Click 'Add' button.	Project attachment: (Choose 1 PDF type file)	PDF attachment is added.	As expected	Pass
TS09	TC28	Delete project attachment.	1. Click on 'Delete Attachment' button.  2. Click 'Yes, delete' button.	Project attachment: (Choose 1 attachment)	Project attachment is deleted.	As expected	Pass

**Discussion module test cases**

Test Scenario ID	Test Case Scenario	Test Case Description	Test Steps	Test Data	Expected Results	Actual Results	Pass/Fail
TS10	TC29	Add comment under project's discussion board	1. Click on any project. 2. Leave a comment.	Project comment: I am interested!	Comment is added under project's discussion board.	As expected	Pass
TS10	TC30	Edit own comment under project's discussion board	1. Click on any project. 2. Click on 'Edit' button for own comment.	Project comment: I am interested! May I know more?	Comment is edited.	As expected	Pass
TS10	TC31	Reply to comment under project's discussion board	1. Click on any project. 2. Reply to any comment.	Project comment: I am interested! May I know more?  Project reply to comment: Yes, what would you	Reply to comment is added.	As expected	Pass

				like to know?			
TS10	TC32	Edit own reply under project's discussion board	1. Click on any project. 2. Click on 'Edit' button for own reply.	Project reply to comment: Yes, what would you like to know more?	Reply to comment is updated.	As expected	Pass
TS11	TC33	Add new chat title.	1. Click on 'Chat' window.	Chat title: Matlab simulation project	New chat title is added.	As expected	Pass
TS11	TC34	Add user in chat.	1. Click on any chat. 2. Add new user to chat with.	New user: <a href="mailto:hychan@usm.my">hychan@usm.my</a> (Assoc Prof Dr Chan Huah Yong)	New user is added to chat.	As expected	Pass
TS11	TC35	Send message to other user in chat.	1. Click on any chat. 2. Send chat message to user.	Chat message 1: Hello Dr Chan	Message is sent and displayed.	As expected	Pass
TS11	TC36	Reply to message in chat.	1. Click on any chat. 2. Reply to	Chat message 2: Hello Ms	Message is sent and displayed.	As expected	Pass

			chat message.	Jia Hui			
TS11	TC37	Send attachment in chat.	1. Click on any chat. 2. Send attachment .	Chat attachment: (Choose any attachment)	Attachment is sent and displayed.	As expected	Pass
TS12	TC38	Post news.	1. Click on 'News' tab. 2. Enter any news. 3. Click 'Post' button.	News title: I have a new project up	News is added and displayed.	As expected	Pass
TS12	TC39	Edit own news.	1. Click on 'News' tab. 2. Edit own news. 3. Click 'Edit' button.	News title: I have a new project up, representatives do check it out!	News is updated and displayed.	As expected	Pass
TS12	TC40	Reply to other news.	1. Click on 'News' tab. 2. Click on	News title reply: I have left a comment under your	Reply to news is added and displayed.	As expected	Pass

			<p>'Reply' button to any news.</p> <p>3. Enter reply.</p> <p>3. Click 'Reply' button.</p>	project			
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### **Relationship management module test cases**

Test Scenario ID	Test Case Scenario	Test Case Description	Test Steps	Test Data	Expected Results	Actual Results	Pass/Fail
TS13	TC41	Display no project recommendation if no preferences have been set.	<p>1. Click on dashboard.</p> <p>2. View the 'You might like these projects...' card.</p>	-	No project recommendation is displayed.	As expected	Pass
TS13	TC42	Display project recommendation if preferences have been set	<p>1. Click on dashboard.</p> <p>2. View the 'You might like these projects...' card.</p>	-	Project recommendation is displayed.	As expected	Pass

		and there are matched projects.	' card.				
TS13	TC43	Display no project recommen dation if preferenc es have been set but there are no matched projects.	1. Click on dashboard.  2. View the 'You might like these projects... ' card.	-	No project recommendat ion is displayed.	As expecte d	Pass