School of Computer Sciences

CAT400 Undergraduate Major Project

Analysis Report

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

FARHANA ZULAIKHA BINTI FADZLI

143949

Supervisor: TS. Dr. Sharifah Mashita Syed Mohamad, Dr. Nur Hana Samsudin

Examiner 1: Assoc. Prof. Dr. Umi Kalsom Yusof

Examiner 2: TS. Dr. Mohd. Najwadi Yusoff

Academic Session

2021/2022

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 dalan 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

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND SYMBOLS

CRM	- Customer Relationship Management
CSS	- Cascading Style Sheets
FYP	- Final Year Project
GB	- GigaByte
HTML	- HyperText Markup Language
IDE	- Integrated Development Environment
JRE	- Java Runtime Environment
RAKE	- Rapid Automatic Keyword Extraction
R&D	- Research & Development
SOP	- Standard Operating Procedure
SWOT	- Strength, Weakness, Opportunity, Threat
T&L	- Teaching & Learning
WAMP	- Windows, Apache, MySQL, PHP
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:

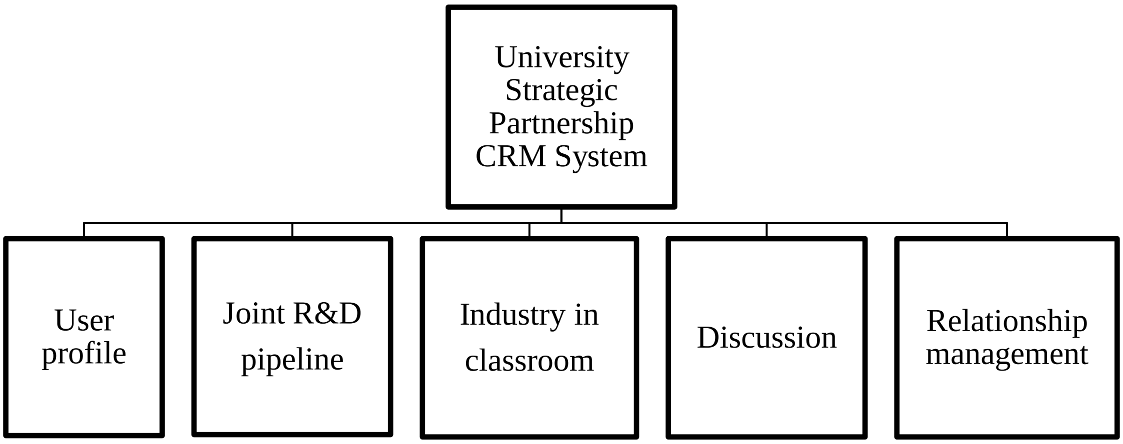

Figure 1.1. Overall module diagram of the system

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 R&D 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 admin 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.

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 analysis report starts with abstract which contains the overall description of the project. The rest of the report is divided into four main parts: Introduction, Background & Related Work, System Analysis / Requirements, 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 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.

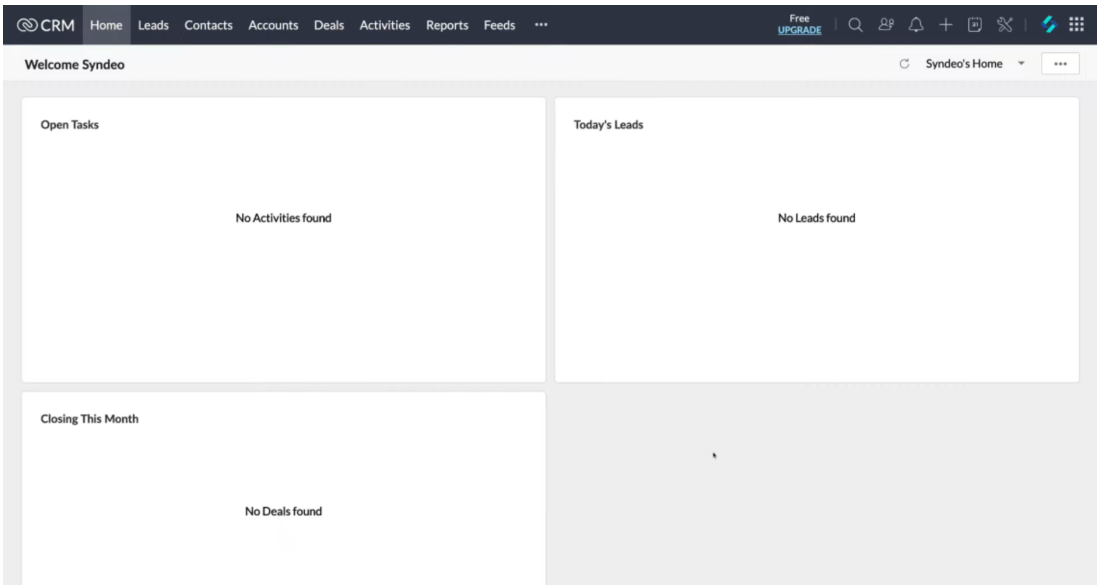

Figure 2.1 Dashboard of Zoho CRM

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.

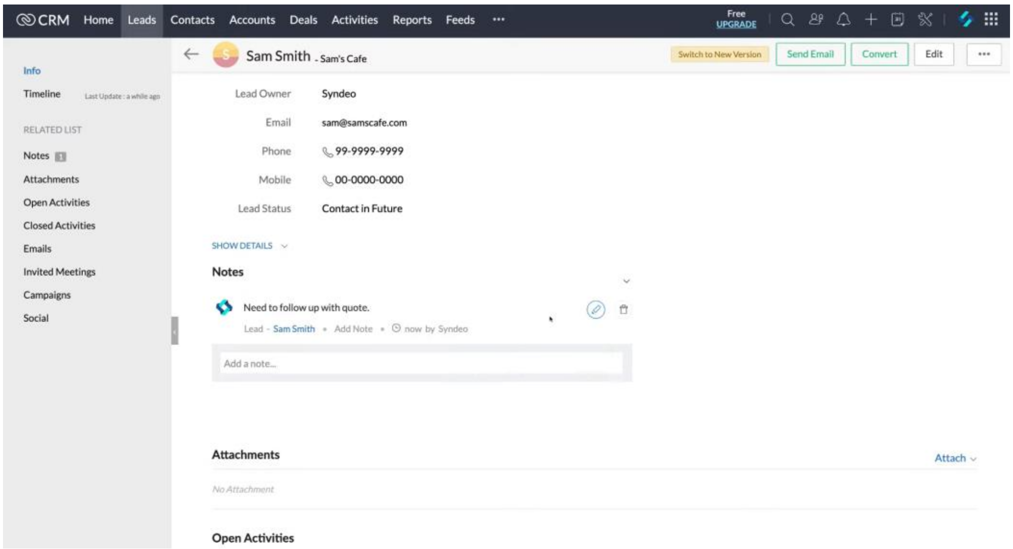

Figure 2.2 Example of Leads contact in Zoho CRM

- 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.

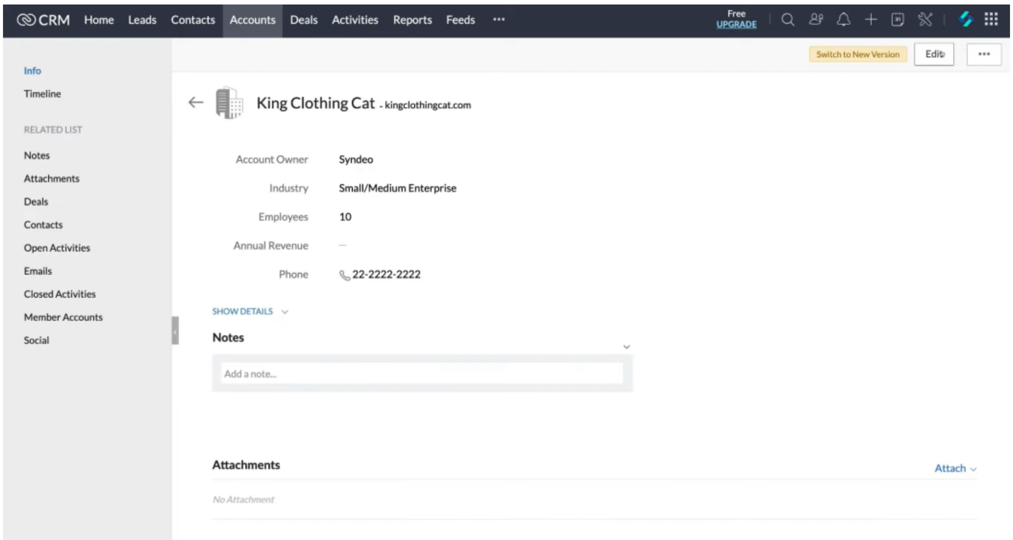

Figure 2.3 Example of organization Account in Zoho CRM

- 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.

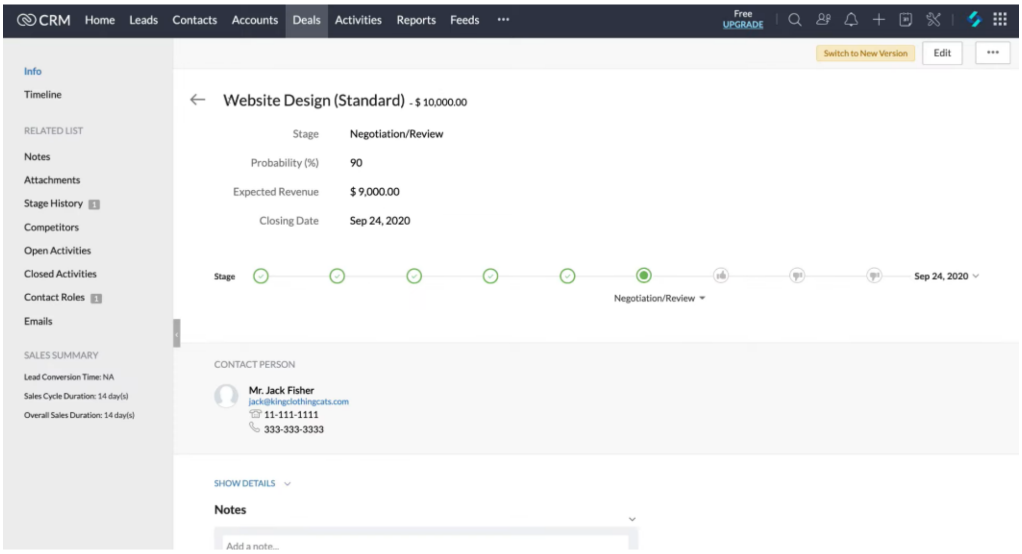

Figure 2.4 Example of deal in Zoho CRM (1)

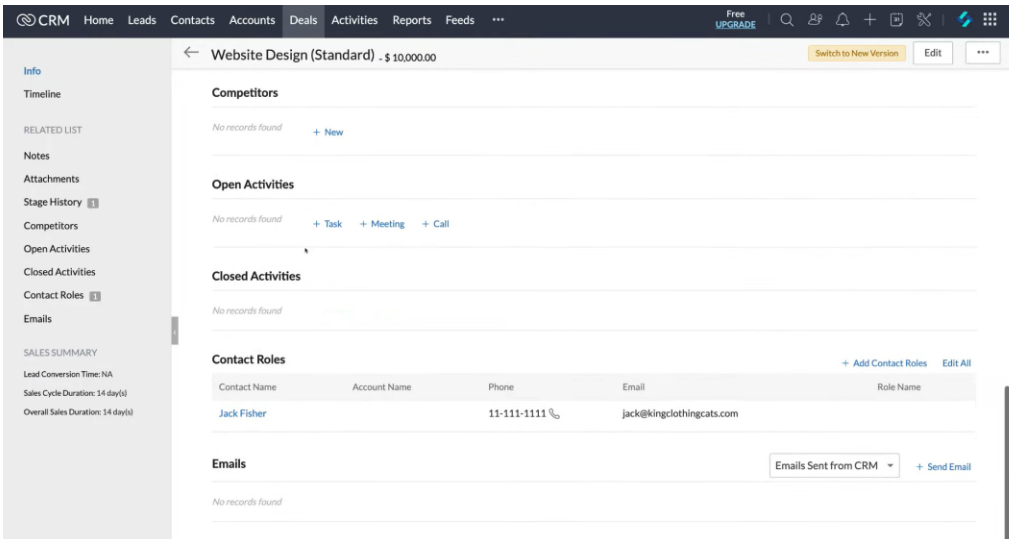

Figure 2.5 Example of deal in Zoho CRM (2)

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

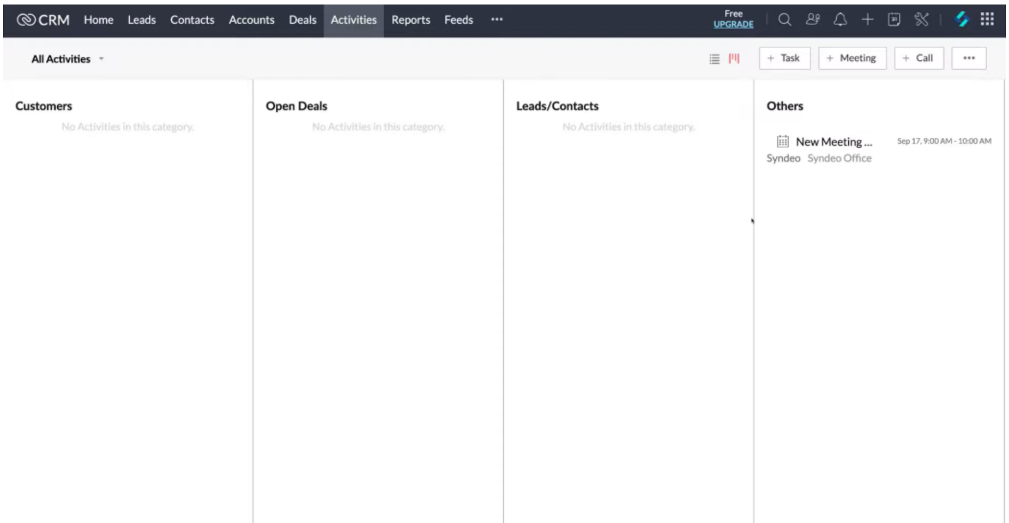

Figure 2.6 Activities feature in Zoho CRM

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

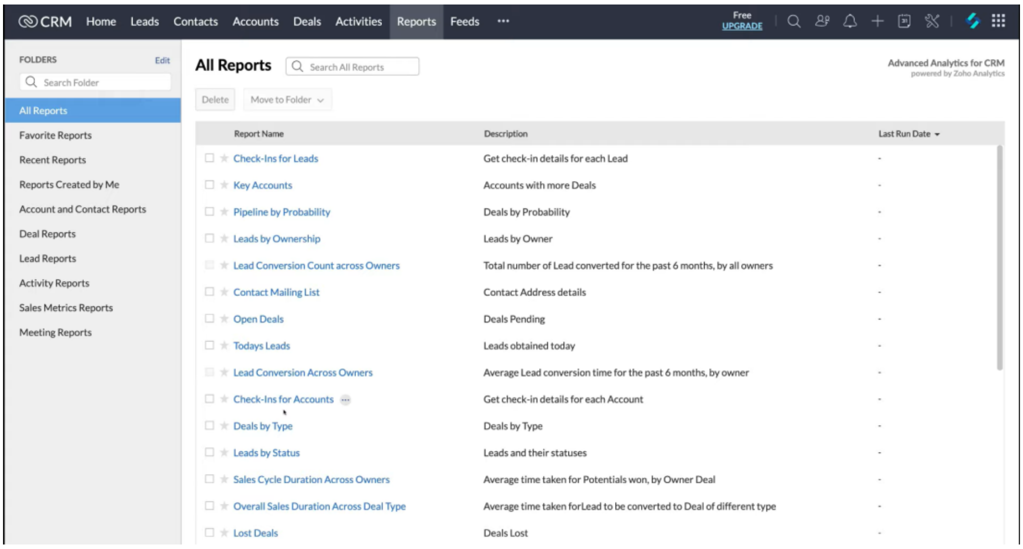

Figure 2.7 Example of reports in Zoho CRM

- 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.

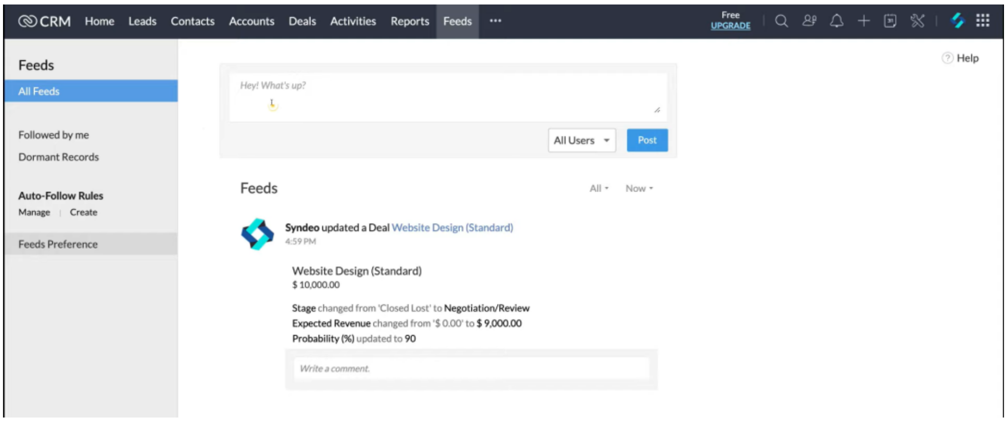

Figure 2.8 Feeds feature in Zoho CRM

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.

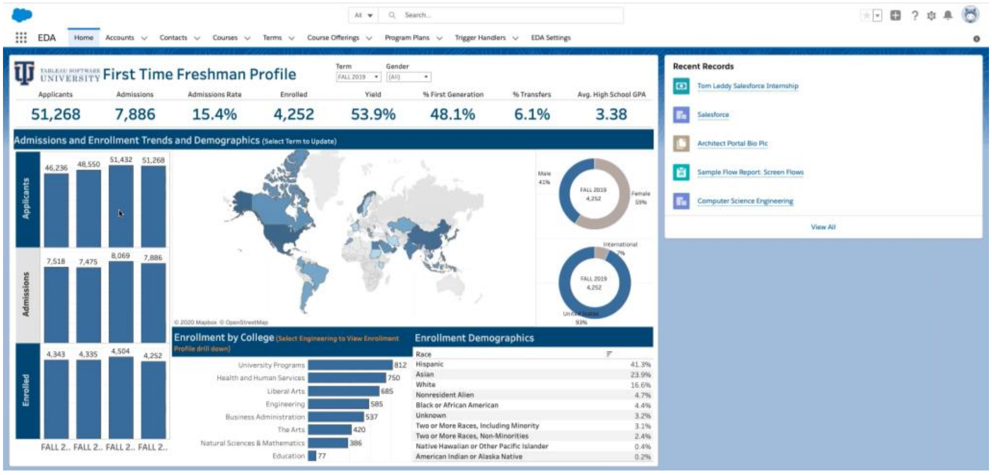

Figure 2.9 Dashboard of Salesforce Education Cloud

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.

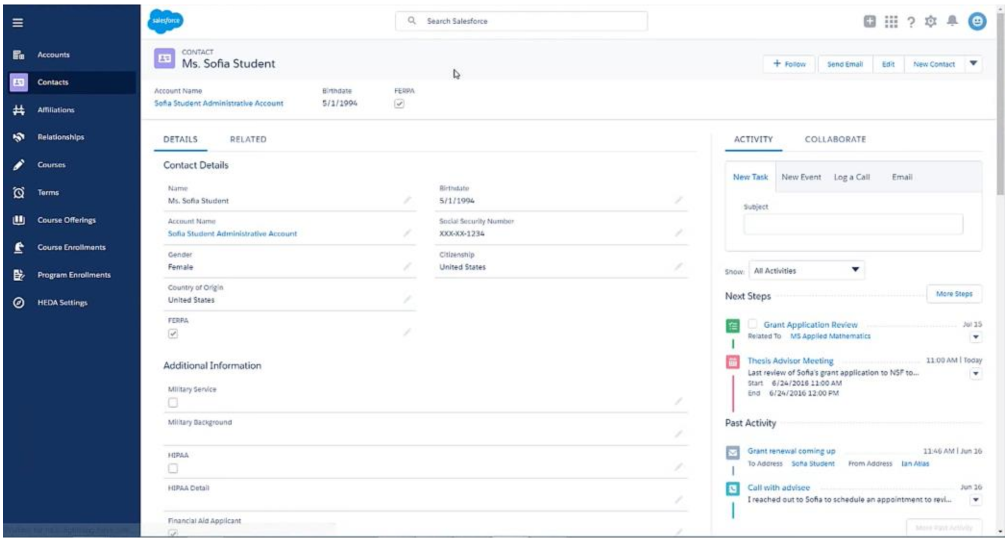

Figure 2.10 Example of Contact in Salesforce Education Cloud

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.

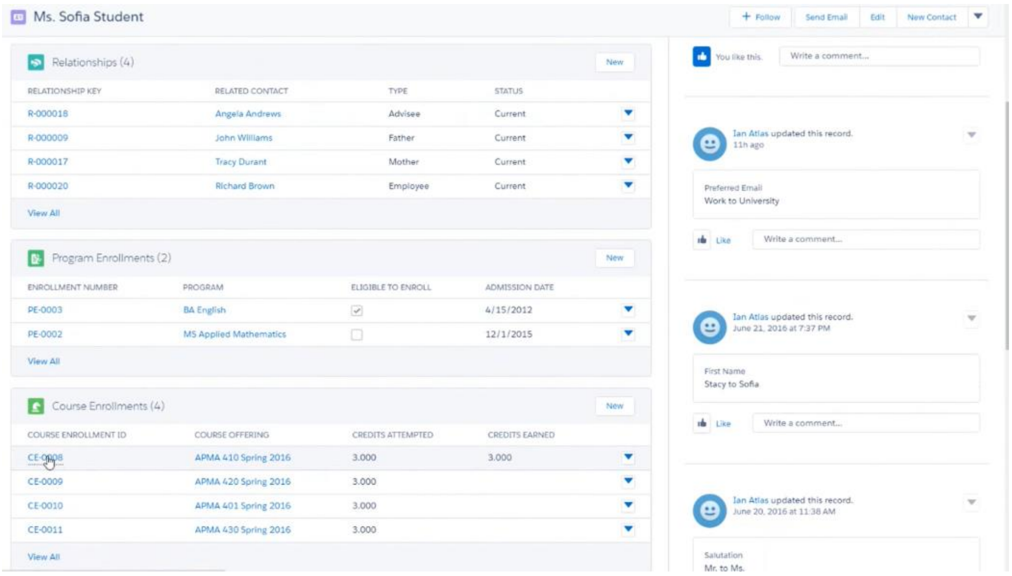

Figure 2.11 Example of Contact information in Salesforce Education Cloud

- 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.

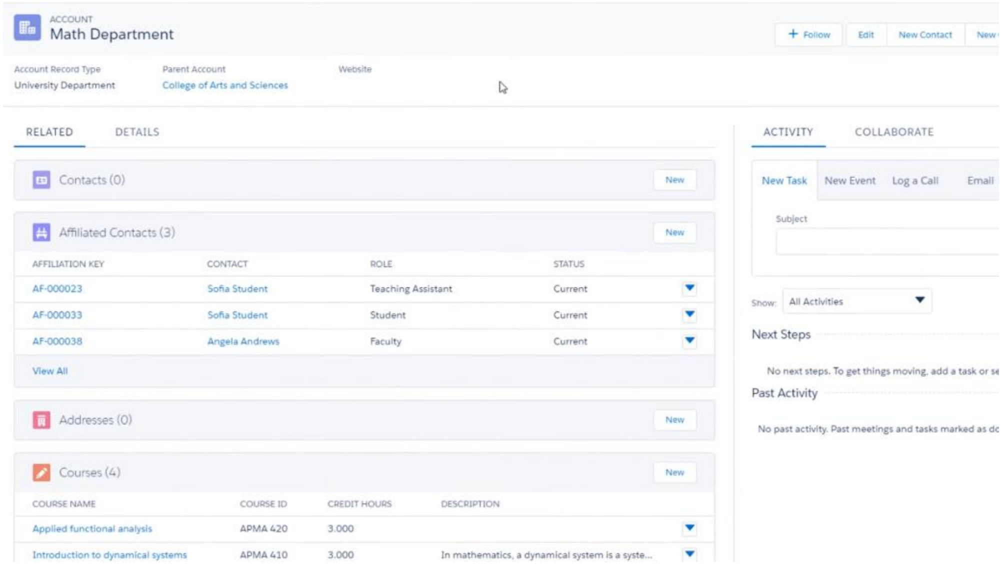

Figure 2.12 Example of Account in Salesforce Education Cloud

- 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.

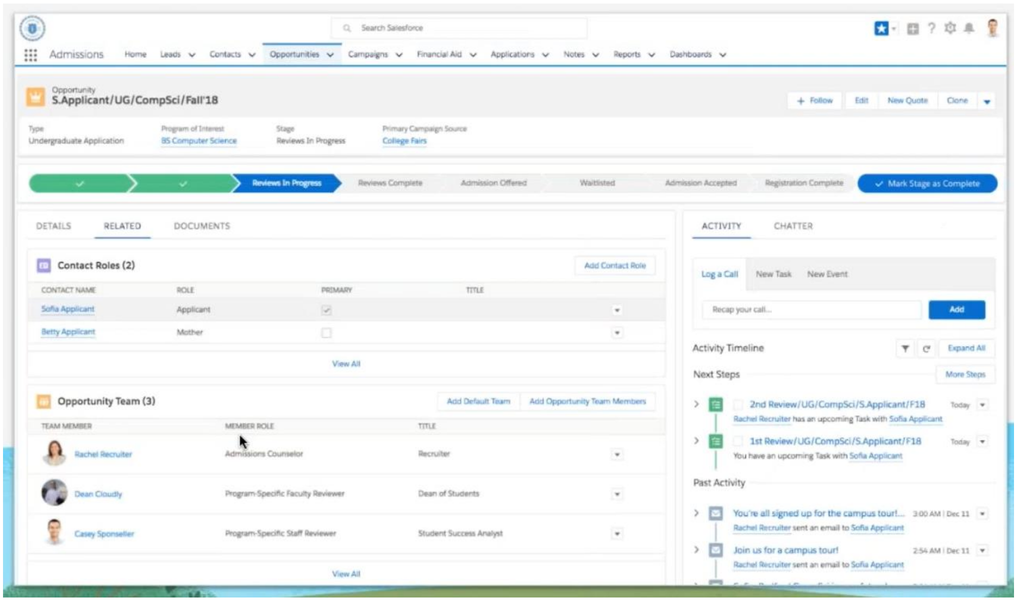

Figure 2.13 Example of Opportunity in Salesforce Education Cloud

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.

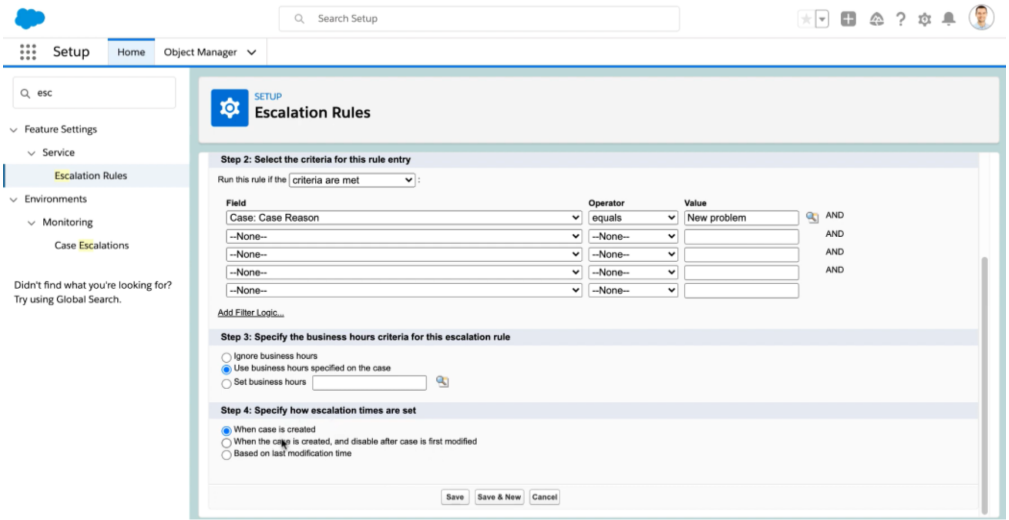

Figure 2.14 Example of adding Case rule in Salesforce Education Cloud

- 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.

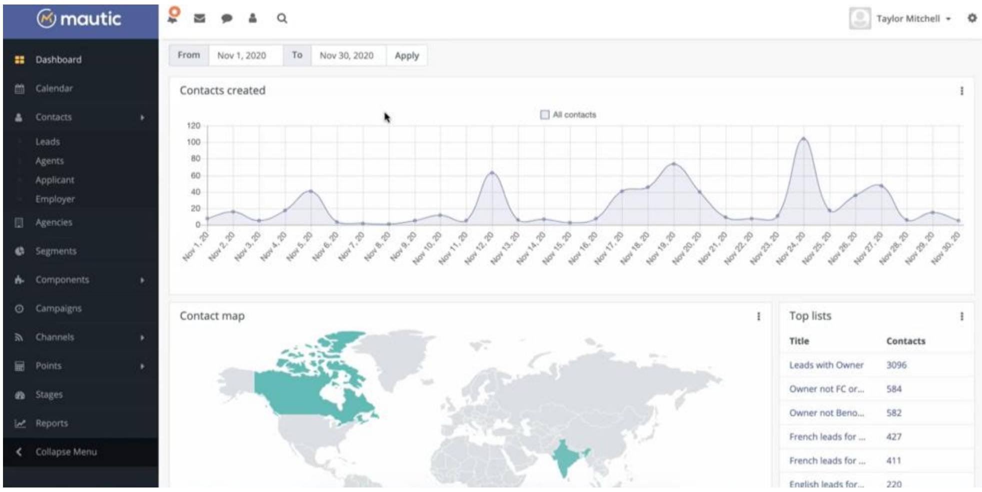

Figure 2.15 Dashboard example of Mautic for Higher Education CRM

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

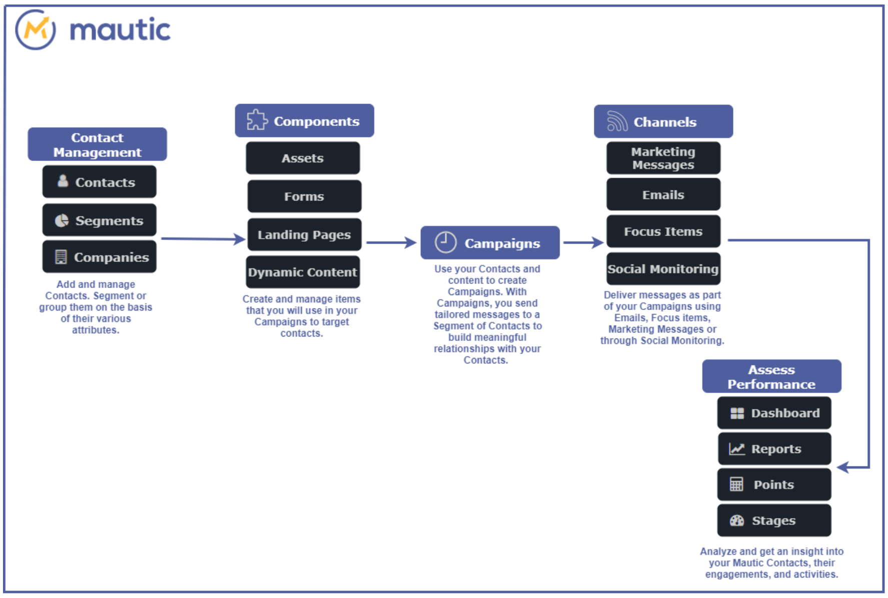

Figure 2.16 Components of Mautic for Higher Education CRM

- 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.

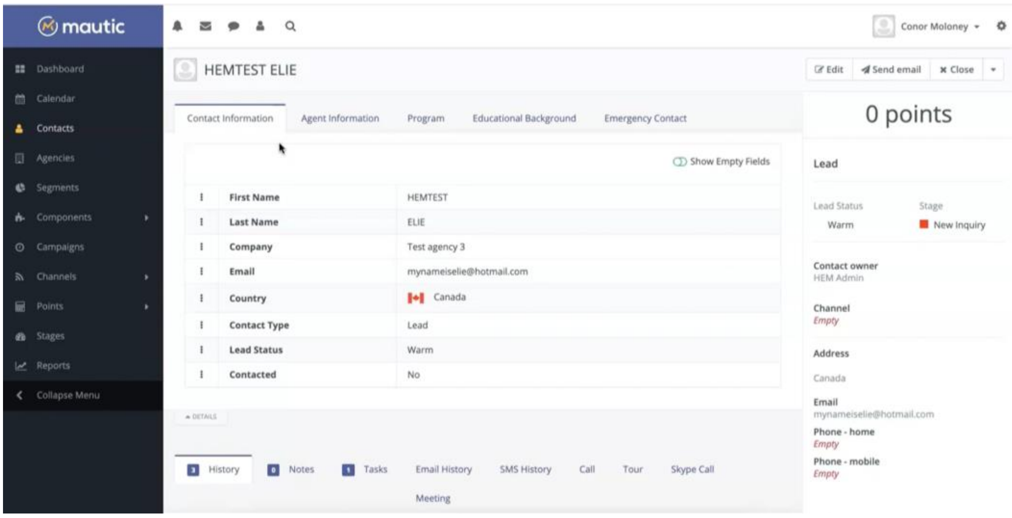

Figure 2.17 Example of Contact in Mautic for Higher Education CRM

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.

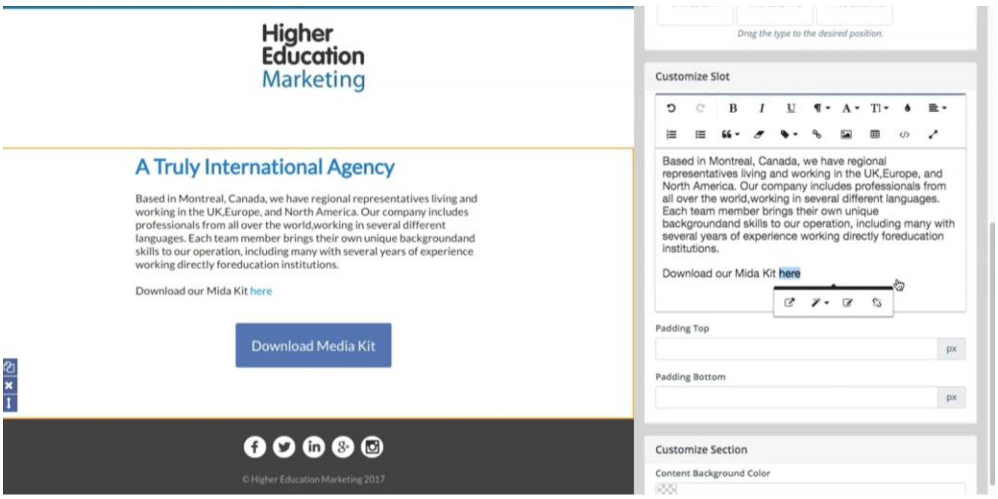

Figure 2.18 Example of brochure being sent to channel in Mautic for Higher Education CRM

- 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.

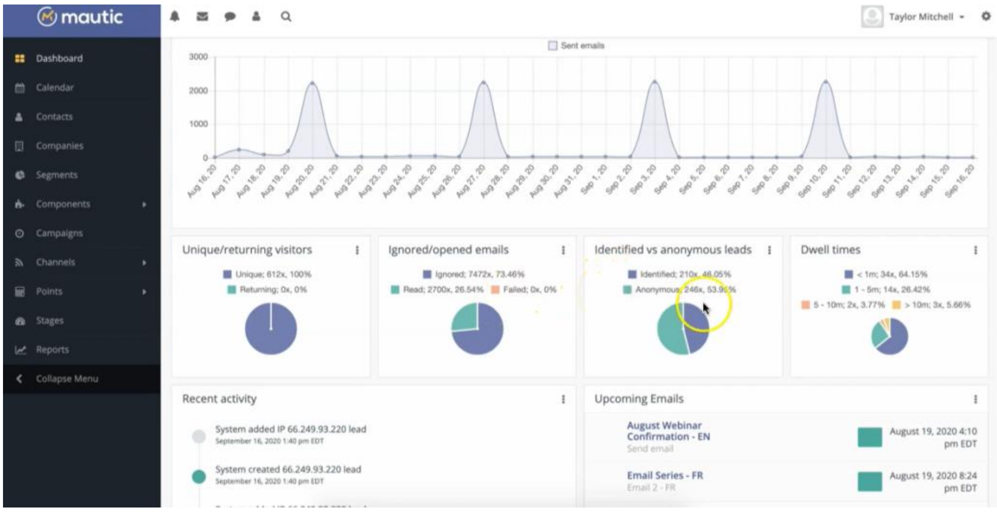

Figure 2.19 Example of reports on dashboard of Mautic for Higher Education CRM

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

Criteria	Zoho CRM	Salesforce Education Cloud CRM	Mautic for Higher Education CRM	University Strategic Partnership CRM
Operating platform	Web-based and mobile-based	Web-based and mobile-based	Web-based	Web-based
Type	Business	Higher education	Higher education	Higher education
Industry involved	Yes	No	No	Yes
Recommendation feature	Available for Enterprise and Ultimate users only; Not available for Free, Standard and Professional users	Not available	Not available	Available
Live chat feature	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

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

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

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

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 topics with the field electives 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. Since user likes two topics from the *Intelligent Systems & Data Analytics* elective which are *Artificial Intelligence* and *Machine Learning*, only one topic from *Embedded Systems* which is *Networking*, and no topic from other electives, then it is assumed the user will like projects related to *Intelligent Systems & Data Analytics*.
4. User will then be recommended projects under the Intelligent Systems & Data Analytics domain.

Before applying cosine similarity to calculate the similarities, we will first use Rapid Automatic Keyword Extraction (RAKE) algorithm [12] to extract keywords of each project to determine which field elective they belong to. 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.
4. Classify the project according to its field elective based on the keyword (topic) that appear highest. For example, if Cybersecurity and Forensics are mentioned the most, then the project is classified under Information Security & Assurance.

After using RAKE algorithm to classify the projects, cosine similarity technique can be used to measure the similarities between user preference and the topics of each field elective:

1. A similarity matrix is created to calculate the similarities between user preferences and the field elective using cosine similarity formula:

Equation 2.3 Cosine similarity formula for the recommendation system

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

p_i is the weight of *i* term in user preferences while q_i is the weight of the *i* term in the field elective.

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 elective in field elective list, p
    calculate weight, $w_{t,q}$of each term t in elective field 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 the field elective with the highest similarity with user preference

3. The elective with the highest similarity with the user preferences is assumed to be the elective user likes the most. Then, the projects under the elective 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 privileges. 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

<table>
<tr><th>User</th><th>Functionalities</th></tr>
<tr><td>Admin</td><td>Manage user, including set user privileges.
Manage R&D and T&L projects.</td></tr>
<tr><td>Lecturer</td><td rowspan="2">Add and manage R&D and T&L projects.
Display details of R&D and T&L projects.
Search R&D and T&L projects.
Discuss with collaborators.
Post news.
View recommendation of projects.</td></tr>
<tr><td>Industry Representative</td></tr>
</table>

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. 1st 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.

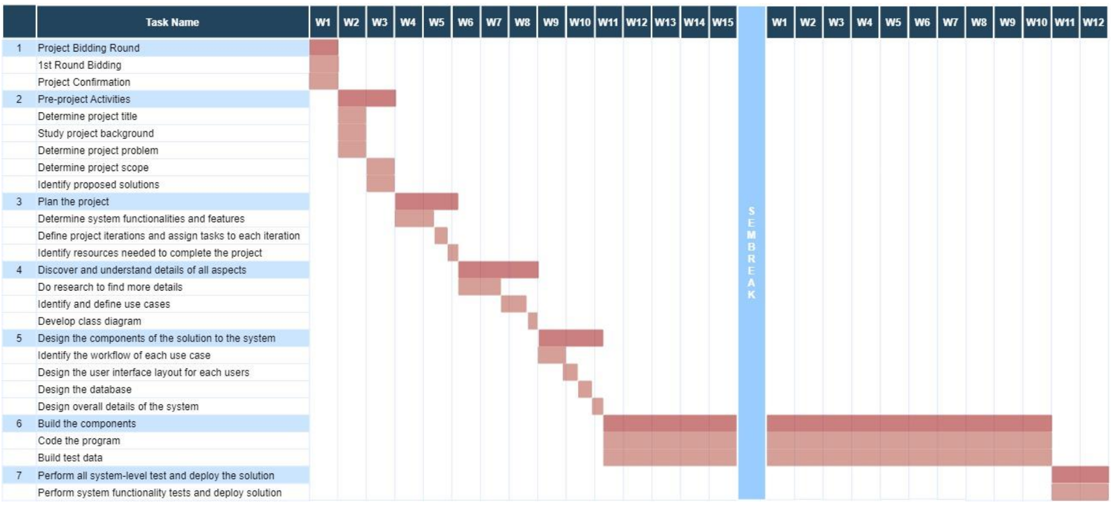

Figure 3.1 Gantt chart

The milestone timeline of the system as of this analysis 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

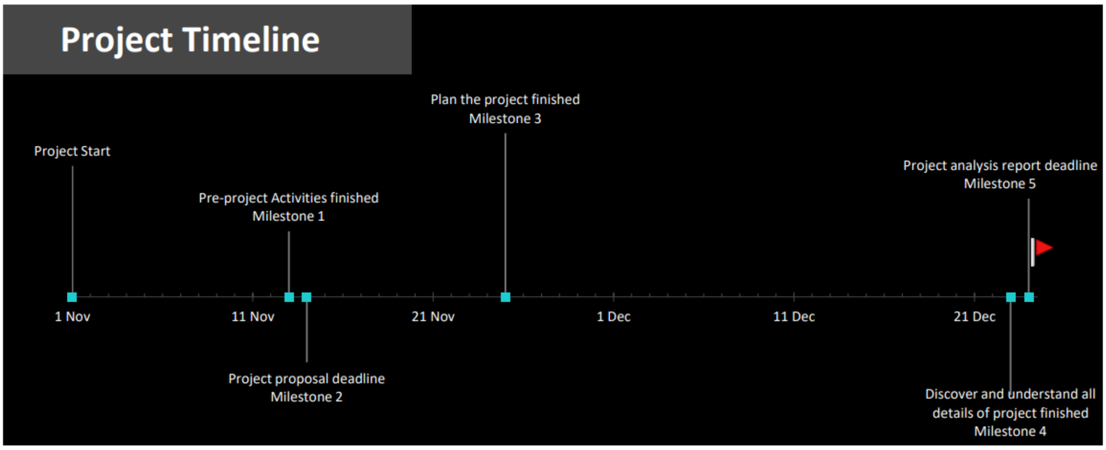

Figure 3.2 Milestone timeline

3.2.3. SWOT analysis

Table 3.3 shows the SWOT analysis of the system:

Table 3.3 SWOT analysis

Strength Project recommendation is provided based on preference which can improve user experience.	**Weakness** No feature to integrate with other application is allowed yet, such as Gmail compared to other CRM platforms.
Opportunity Can reduce the workload and hassle of securing partnerships between university lecturer and industry representatives.	**Threat** 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	• Manage user profile. • Set user privileges. (Create, Read, Update, Delete)
University lecturer	• Add and manage R&D projects. • Add and manage T&L projects. • Search R&D and T&L projects. • Add comments under industry's project discussion board. • Chat with collaborators. • Post news. • Display R&D and T&L project recommendations.
Industry representative	• Add and manage R&D projects. • Add and manage T&L projects. • Search R&D and T&L projects. • Add comments under lecturer's project discussion board. • Chat with collaborators. • Post news. • Display R&D and T&L project recommendations.

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	• Pages should be loaded with high speed.
Reliability	• Server must always be up to allow all processing to be done.
Availability	• The web application must be available to all users most of the time.
Security	• The system requires user to provide correct email and password before user can be logged in to their account.
Usability	• User should be able to navigate easily through the interface.

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.

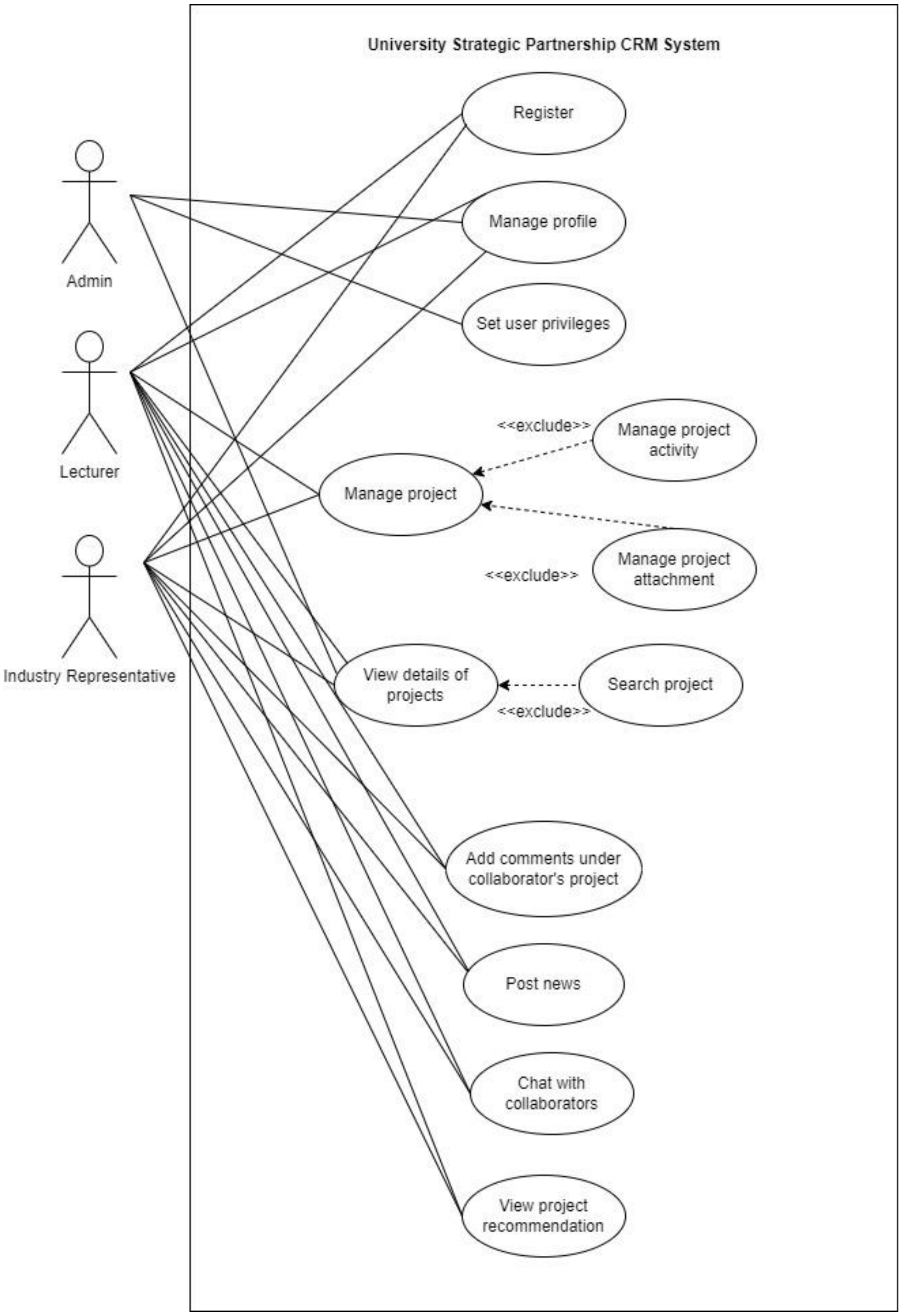

Figure 3.3 Overall use case diagram

3.5.2. Use Case Description

Table 3.6-3.17 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

<table>
<tr><td>Use case name:</td><td colspan="2">Manage profile</td></tr>
<tr><td>Scenario:</td><td colspan="2">Manage user profile of admin/lecturer/industry representative.</td></tr>
<tr><td>Triggering event:</td><td colspan="2">User wants to view and edit their profile information.</td></tr>
<tr><td>Brief description:</td><td colspan="2">User clicks on the “Profile” section from the tab, and user information will be displayed.

User clicks on “Edit” button on their profile page and a form containing editable fields will appear. User enters relevant information and clicks “Save”.</td></tr>
<tr><td>Actors:</td><td colspan="2">Admin, Lecturer, Industry Representative</td></tr>
<tr><td>Related use cases:</td><td colspan="2">None</td></tr>
<tr><td>Stakeholders:</td><td colspan="2">None</td></tr>
<tr><td>Preconditions:</td><td colspan="2">User (admin/lecturer/industry representative) must exist.</td></tr>
<tr><td>Postconditions:</td><td colspan="2">User information must be updated.

User profile is displayed.</td></tr>
<tr><td rowspan="2">Flow of activities:</td><td>Actor</td><td>System</td></tr>
<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>
</table>

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

Table 3.8 Set user privileges use case description

Use case name:	Set user privileges	
Scenario:	Admin sets user privileges of a specific user.	
Triggering event:	Admin wants to set user privileges for the system.	
Brief description:	Admin clicks on “User” tab to display list of users. Admin edits user privileges for Create, Read, Update and Delete (CRUD) and clicks “Save”.	
Actors:	Admin	
Related use cases:	None	
Stakeholders:	None	
Preconditions:	User must exist.	
Postconditions:	User privilege is updated and saved.	
Flow of activities:	Actor	System
	1. Admin clicks on “User” tab. 2. Admin edits user privileges for Create, Read, Update and Delete (CRUD) and clicks “Save”.	1.1. System displays a list of users. 2.1. System updates and saves the information.

Exception of conditions:	1. User does not exist.

Table 3.9 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:	Lecturer/Industry Representative clicks on “Add Project” button to add new project, enters details and saves. Lecturer/Industry Representative clicks on a project and displays the details. Lecturer/Industry Representative edits a project and saves. Lecturer/Industry Representative deletes a project.
Actors:	Lecturer, Industry Representative
Related use cases:	Manage project attachment, Manage project activity
Stakeholders:	Lecturer, Industry Representative
Preconditions:	Lecturer/Industry Representative must exist. Project must exist. (View, Update, Delete)
Postconditions:	Project must be created and saved. (Create) Project is displayed. (View) Project must be updated and saved. (Update) Project is deleted from system. (Delete)

Flow of activities:	Actor	System
	1. Lecturer/Industry Representative enters relevant information about project and clicks “Save”.	1.1. System creates and saves the project.
	2. Lecturer/Industry Representative clicks on “Edit” button to update project.	2.1. System displays a form with editable fields.
	3. Lecturer/Industry Representative enters updated information about project and clicks “Save”.	3.1. System updates and saves project information.
	4. Lecturer/Industry Representative clicks on project to view details.	4.1. System displays the project details.
	5. Lecturer/Industry Representative selects a project and clicks “Delete”.	5.1. System deletes the project.
Exception of conditions:	1. Invalid data are entered.	

Table 3.10 Manage project activity use case description

<table>
<tr><td>Use case name:</td><td colspan="2">Manage project activity</td></tr>
<tr><td>Scenario:</td><td colspan="2">Lecturer/Industry Representative manages project activity.</td></tr>
<tr><td>Triggering event:</td><td colspan="2">Lecturer/Industry Representative wants to manage project activity.</td></tr>
<tr><td>Brief description:</td><td colspan="2">Lecturer/Industry Representative clicks on a project and navigates to “Activity”.

Lecturer/Industry Representative clicks on “Add Activity” button, enters activity information and saves.

Lecturer/Industry Representative clicks on “Update Activity”, enters updated information and saves.

Lecturer/Industry Representative deletes activity.</td></tr>
<tr><td>Actors:</td><td colspan="2">Lecturer, Industry Representative</td></tr>
<tr><td>Related use cases:</td><td colspan="2">Manage project</td></tr>
<tr><td>Stakeholders:</td><td colspan="2">Lecturer, Industry Representative</td></tr>
<tr><td>Preconditions:</td><td colspan="2">Project must exist.</td></tr>
<tr><td>Postconditions:</td><td colspan="2">Activity must be created and saved. (Create)

Activity is displayed. (View)

Activity must be updated and saved. (Update)

Activity is deleted from system. (Delete)</td></tr>
<tr><td rowspan="2">Flow of activities:</td><td>Actor</td><td>System</td></tr>
<tr><td>1. Lecturer/Industry Representative enters</td><td>1.1. System creates and saves the activity.</td></tr>
</table>

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

Table 3.11 Manage project attachment use case description

<table>
<tr><td>Use case name:</td><td colspan="2">Manage project attachment</td></tr>
<tr><td>Scenario:</td><td colspan="2">Lecturer/Industry Representative manages project attachment.</td></tr>
<tr><td>Triggering event:</td><td colspan="2">Lecturer/Industry Representative wants to manage project attachment.</td></tr>
<tr><td>Brief description:</td><td colspan="2">Lecturer/Industry Representative clicks on a project and navigates to “Attachment”.

Lecturer/Industry Representative clicks on “Add Attachment” button, uploads attachment and saves.

Lecturer/Industry Representative clicks on “Update Attachment”, enters updated information and saves.

Lecturer/Industry Representative deletes attachment.</td></tr>
<tr><td>Actors:</td><td colspan="2">Lecturer, Industry Representative</td></tr>
<tr><td>Related use cases:</td><td colspan="2">Manage project</td></tr>
<tr><td>Stakeholders:</td><td colspan="2">Lecturer, Industry Representative</td></tr>
<tr><td>Preconditions:</td><td colspan="2">Project must exist.</td></tr>
<tr><td>Postconditions:</td><td colspan="2">Attachment must be created and saved. (Create)

Attachment is displayed. (View)

Attachment must be updated and saved. (Update)

Attachment is deleted from system. (Delete)</td></tr>
<tr><td rowspan="2">Flow of activities:</td><td>Actor</td><td>System</td></tr>
<tr><td>1. Lecturer/Industry Representative adds</td><td>1.1. System creates and saves the attachment.</td></tr>
</table>

	new attachment and clicks "Save".	
	2. Lecturer/Industry Representative clicks on "Edit" button to update attachment.	2.1. System displays editable form to update attachment.
	3. Lecturer/Industry Representative updates attachment and clicks "Save".	3.1. System updates and saves attachment.
	4. Lecturer/Industry Representative clicks on attachment to view it.	4.1. System displays the attachment.
	5. Lecturer/Industry Representative selects an attachment and clicks "Delete".	5.1. System deletes the attachment.
Exception of conditions:	1. Invalid attachment type is uploaded.	

Table 3.12 View details of projects use case description

<table>
<tr><td>Use case name:</td><td colspan="2">View details of projects</td></tr>
<tr><td>Scenario:</td><td colspan="2">User views the details of projects.</td></tr>
<tr><td>Triggering event:</td><td colspan="2">User wants to view the details of projects.</td></tr>
<tr><td>Brief description:</td><td colspan="2">User clicks on “Projects” tab and views list of projects.

User clicks on a project’s name and views the project details.</td></tr>
<tr><td>Actors:</td><td colspan="2">Admin, Lecturer, Industry Representative</td></tr>
<tr><td>Related use cases:</td><td colspan="2">Search project</td></tr>
<tr><td>Stakeholders:</td><td colspan="2">None</td></tr>
<tr><td>Preconditions:</td><td colspan="2">Project must exist.</td></tr>
<tr><td>Postconditions:</td><td colspan="2">Display project details.</td></tr>
<tr><td rowspan="2">Flow of activities:</td><td>Actor</td><td>System</td></tr>
<tr><td>1. User clicks on “Projects” tab.
2. User clicks on a project’s name.</td><td>1.1 System displays a list of projects.
2.1 System displays the project details.</td></tr>
<tr><td>Exception of conditions:</td><td colspan="2">1. Project does not exist.</td></tr>
</table>

Table 3.13 Search project use case description

<table>
<tr><td>Use case name:</td><td colspan="2">Search project</td></tr>
<tr><td>Scenario:</td><td colspan="2">User searches for a project.</td></tr>
<tr><td>Triggering event:</td><td colspan="2">User wants to search a project based on the name.</td></tr>
<tr><td>Brief description:</td><td colspan="2">User clicks on “Projects” tab and views list of projects.

User enters a project’s name and views the list of projects related.</td></tr>
<tr><td>Actors:</td><td colspan="2">Admin, Lecturer, Industry Representative</td></tr>
<tr><td>Related use cases:</td><td colspan="2">View details of projects</td></tr>
<tr><td>Stakeholders:</td><td colspan="2">None</td></tr>
<tr><td>Preconditions:</td><td colspan="2">Project must exist.</td></tr>
<tr><td>Postconditions:</td><td colspan="2">Display list of related projects.</td></tr>
<tr><td rowspan="2">Flow of activities:</td><td>Actor</td><td>System</td></tr>
<tr><td>1. User clicks on “Projects” tab.
2. User enters a project’s name.</td><td>1.1. System displays a list of projects.
2.1. System displays a list of related projects.</td></tr>
<tr><td>Exception of conditions:</td><td colspan="2">1. System returns a message if project does not exist.</td></tr>
</table>

Table 3.14 Add comments under collaborator's project use case description

<table>
<tr><td>Use case name:</td><td colspan="2">Add comments under collaborator’s project</td></tr>
<tr><td>Scenario:</td><td colspan="2">Lecturer/Industry Representative adds comments under collaborator’s project.</td></tr>
<tr><td>Triggering event:</td><td colspan="2">Lecturer/Industry Representative wants to add comments under collaborator’s project.</td></tr>
<tr><td>Brief description:</td><td colspan="2">Lecturer/Industry Representative clicks on a project and views the project.

Lecturer/Industry Representative leaves a comment under the project’s discussion board.</td></tr>
<tr><td>Actors:</td><td colspan="2">Lecturer, Industry Representative</td></tr>
<tr><td>Related use cases:</td><td colspan="2">None</td></tr>
<tr><td>Stakeholders:</td><td colspan="2">Lecturer, Industry Representative</td></tr>
<tr><td>Preconditions:</td><td colspan="2">Project must exist.</td></tr>
<tr><td>Postconditions:</td><td colspan="2">Comment is added under project and saved.</td></tr>
<tr><td rowspan="2">Flow of activities:</td><td>Actor</td><td>System</td></tr>
<tr><td>1. Lecturer/Industry Representative clicks on a project.
2. Lecturer/Industry Representative writes a comment and clicks “Comment” button.</td><td>1.1. System displays the project.

2.1. System adds, saves and displays the comment.</td></tr>
<tr><td>Exception of conditions:</td><td colspan="2">1. Project does not exist.</td></tr>
</table>

Table 3.15 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:	Lecturer/Industry Representative clicks on “News” tab. Lecturer/Industry Representative enters the information they want to post and clicks “Post”.	
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”. 2. Lecturer/Industry Representative enters updated information about news and clicks “Save”. 3. Lecturer/Industry clicks on “Delete”	1.1. System creates, saves and displays the news. 2.1. System updates, saves and displays the news. 3.1. System deletes the news.

	button for news.	
Exception of conditions:	None	

Table 3.16 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:	Lecturer/Industry Representative clicks on a project, then the name of the project owner. Lecturer/Industry Representative clicks on Chat icon beside the user's name and starts chatting.	
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
	1. Lecturer/Industry Representative clicks on a project. 2. Lecturer/Industry Representative clicks on project owner name. 3. Lecturer/Industry	1.1. System displays the project. 2.1. System displays the project owner profile.

	Representative clicks on Chat icon beside the owner's name. 4. Lecturer/Industry Representative sends message.	3.1. System displays chat page. 4.1. System saves and displays chat message.
Exception of conditions:	1. Lecturer/Industry Representative does not exist.	

Table 3.17 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 "Home" tab. Lecturer/Industry Representative clicks on any of the projects under the "Recommended Projects for You" 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	1.1. System displays dashboard.

	Representative clicks on the “Home” tab. 2. Lecturer/Industry Representative clicks on any of the projects under the “Recommended Projects for You” card.	2.1. System displays the recommended project details.
Exception of conditions:	1. User has not set any preferences yet.	

3.5.3. Class Diagram

Figure 3.4 shows the overall class diagram of the system. A total of 16 classes are available.

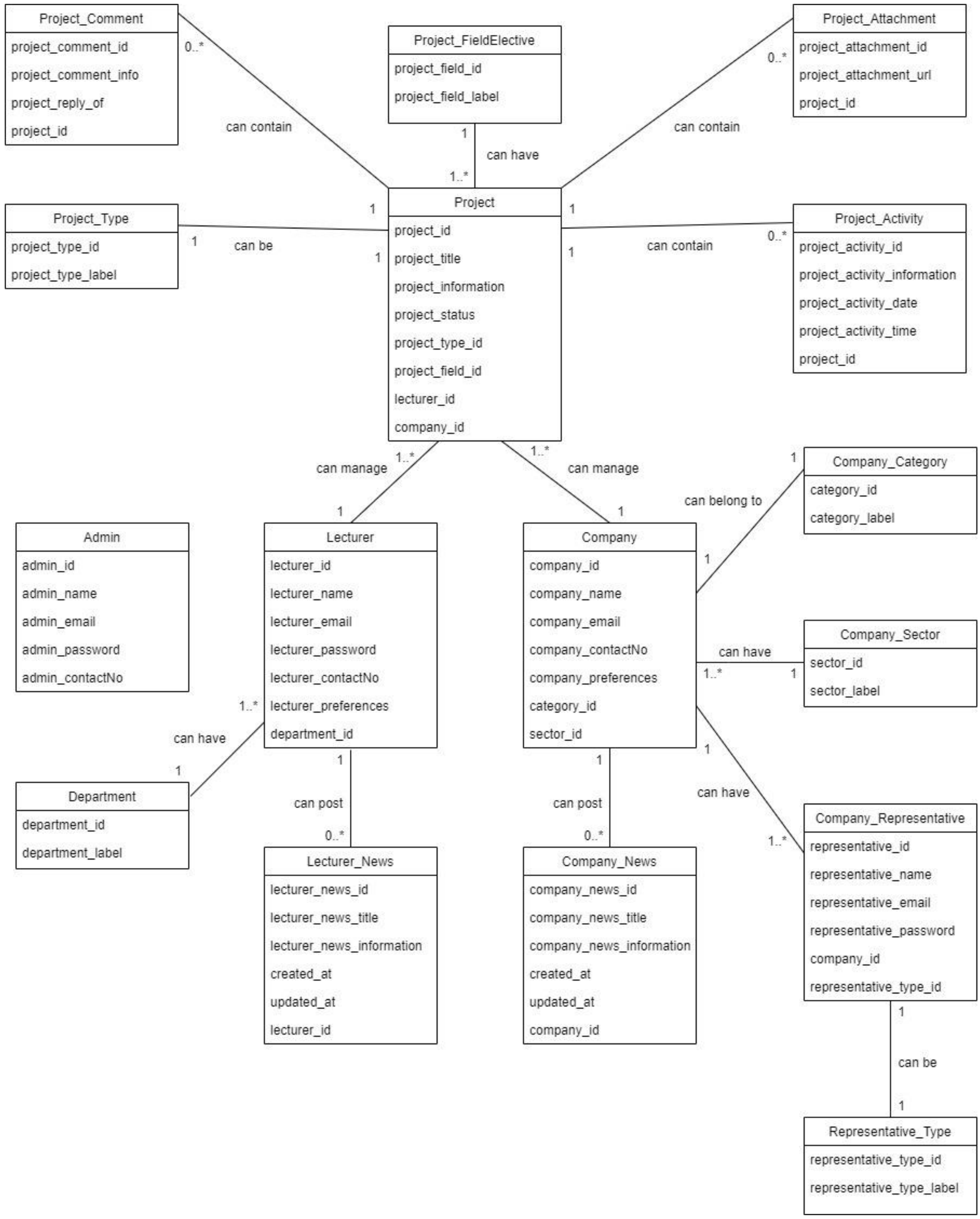

Figure 3.4 Overall class diagram

3.5.4. System Sequence Diagram (SSD)

Figure 3.5-3.20 illustrate the System Sequence Diagram.

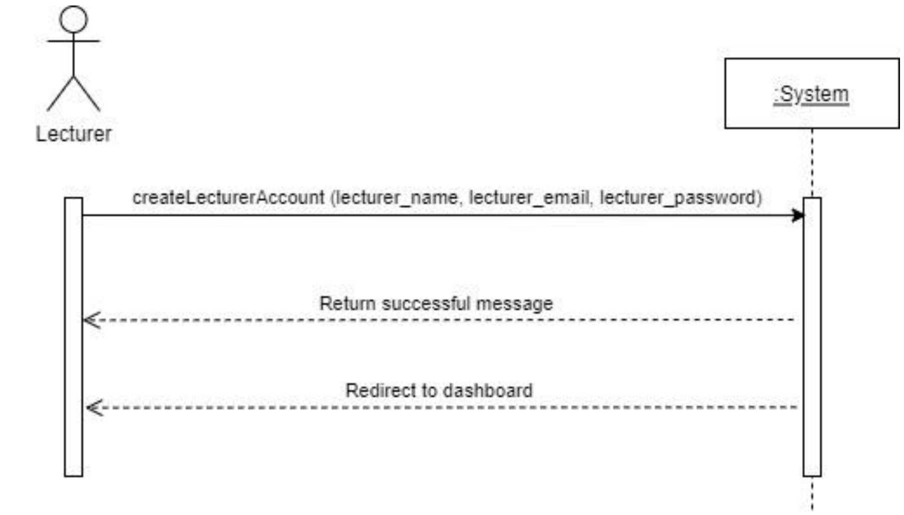

Figure 3.5 System Sequence Diagram of Register (Lecturer)

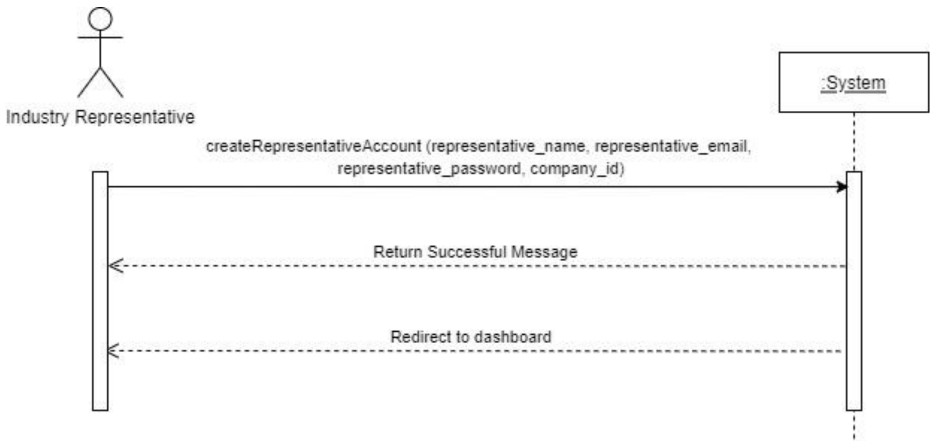

Figure 3.6 System Sequence Diagram of Register (Industry Representative)

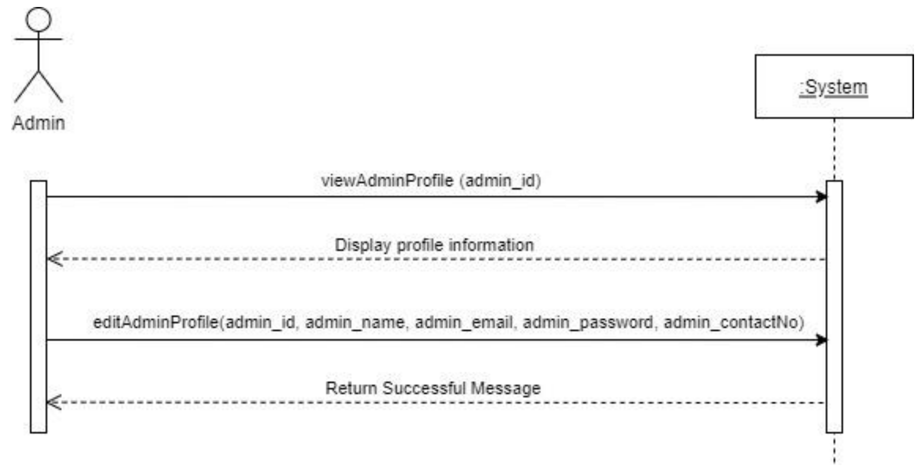

Figure 3.7 System Sequence Diagram of Manage Profile (Admin)

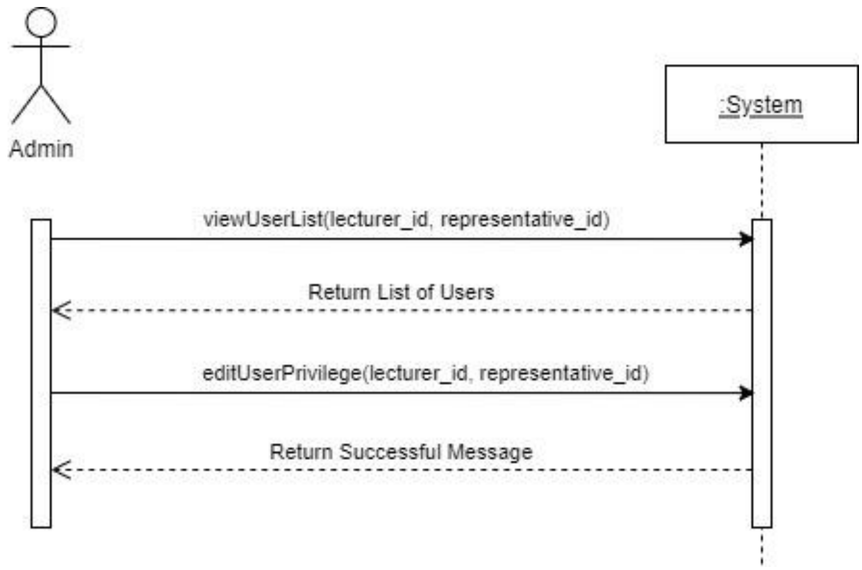

Figure 3.8 System Sequence Diagram of Set User Privileges (Admin)

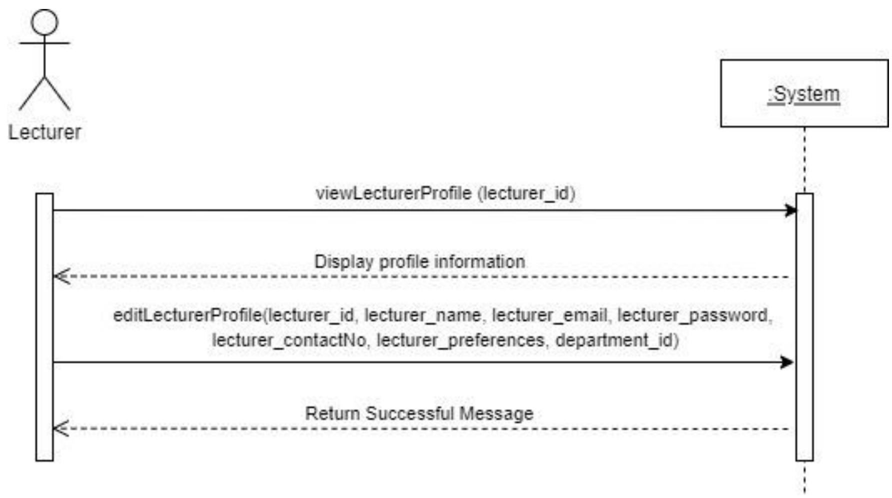

Figure 3.9 System Sequence Diagram of Manage Profile (Lecturer)

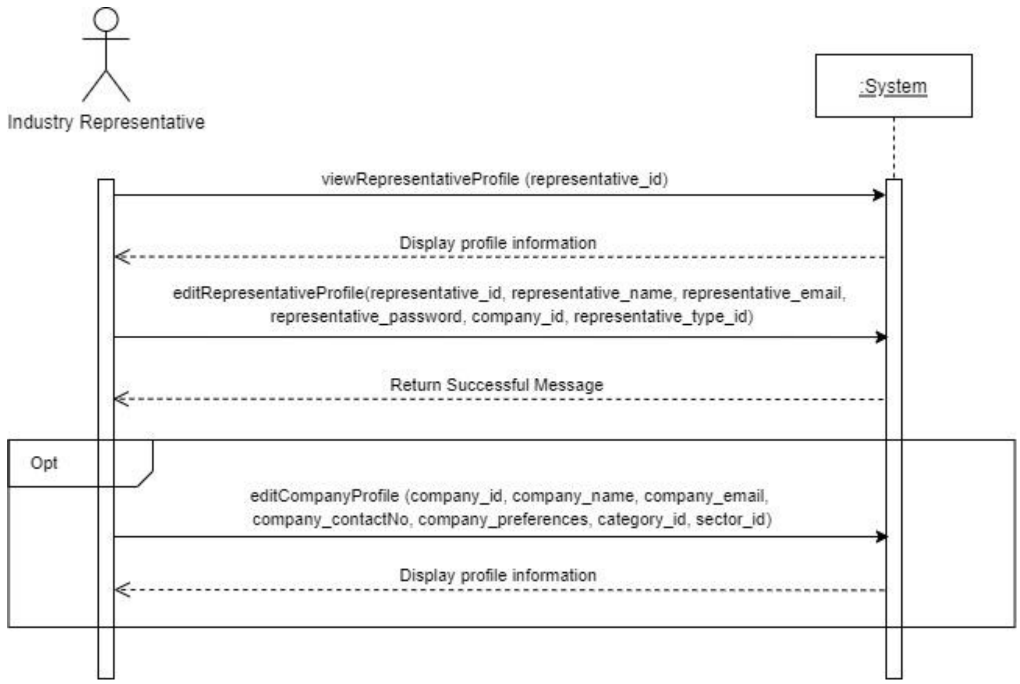

Figure 3.10 System Sequence Diagram of Manage Profile (Industry Representative)

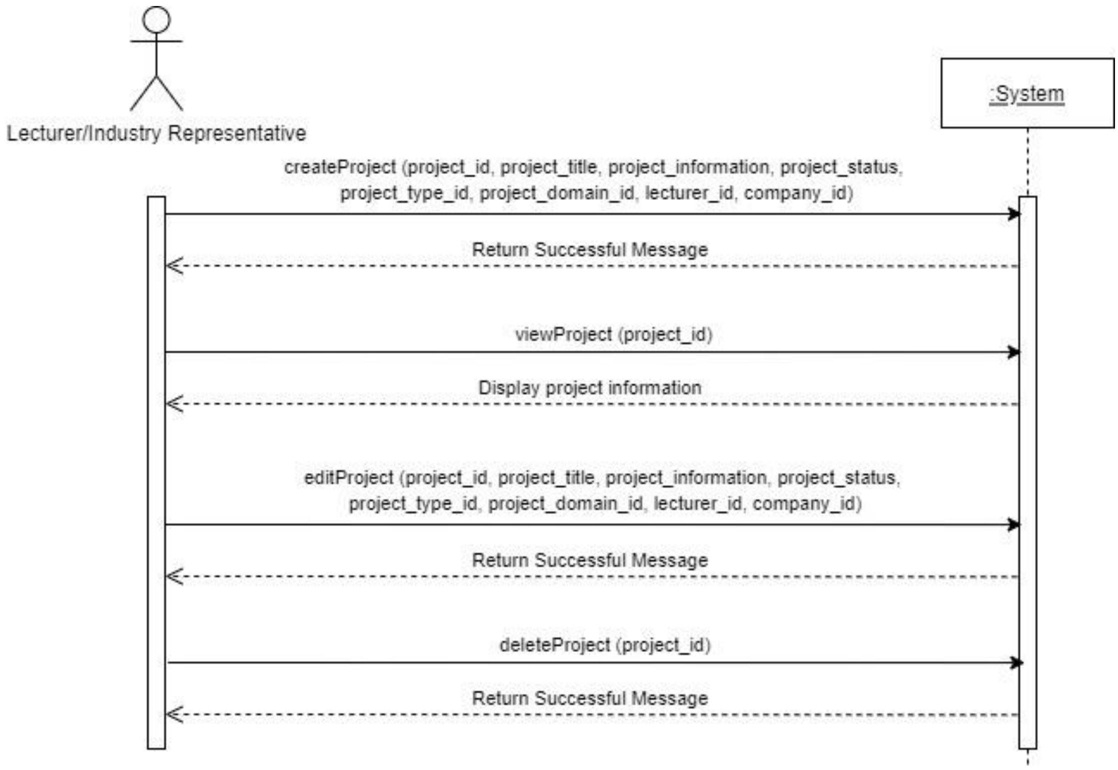

Figure 3.11 System Sequence Diagram of Manage Project

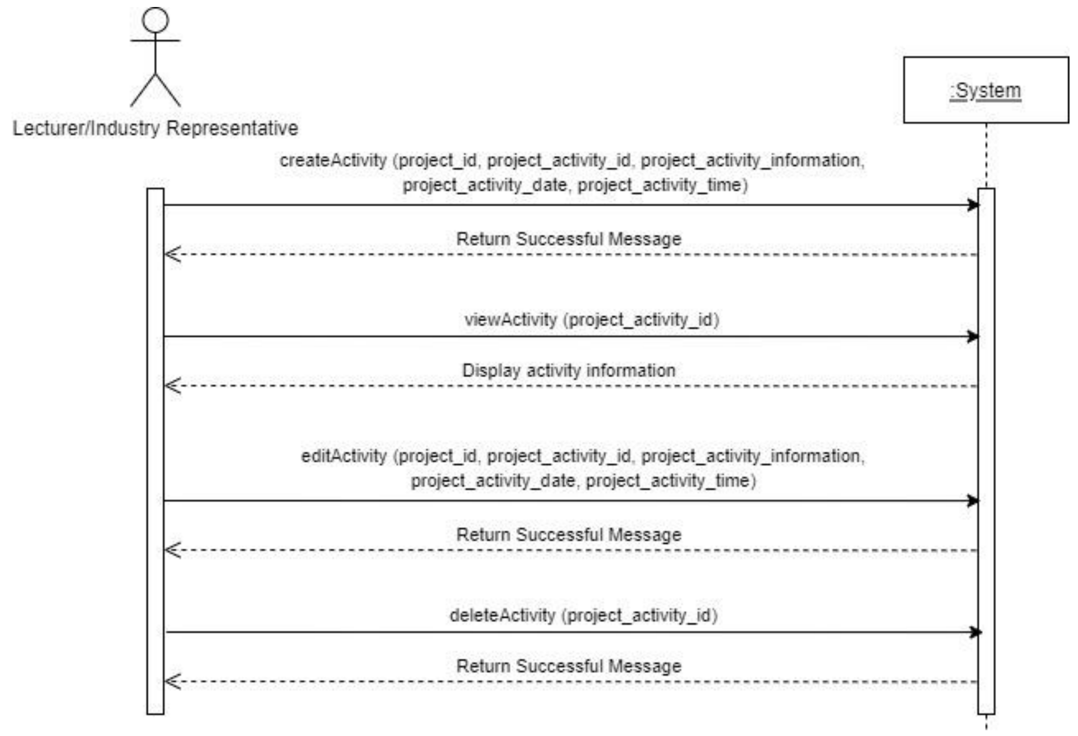

Figure 3.12 System Sequence Diagram of Manage Activity

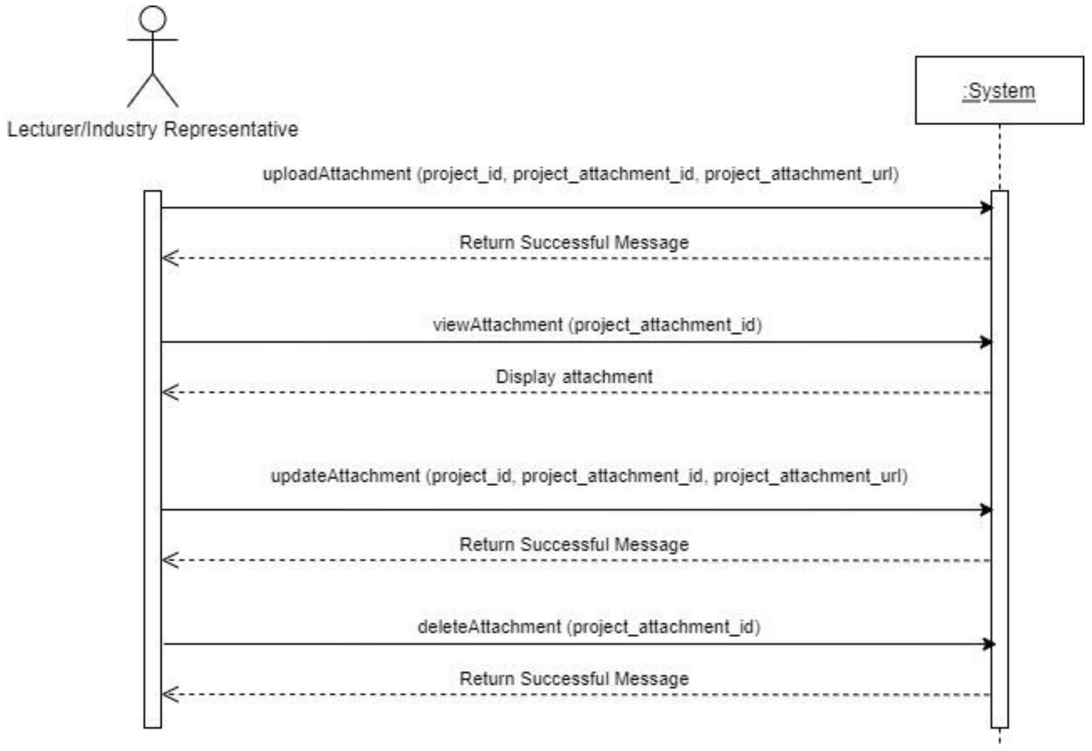

Figure 3.13 System Sequence Diagram of Manage Attachment

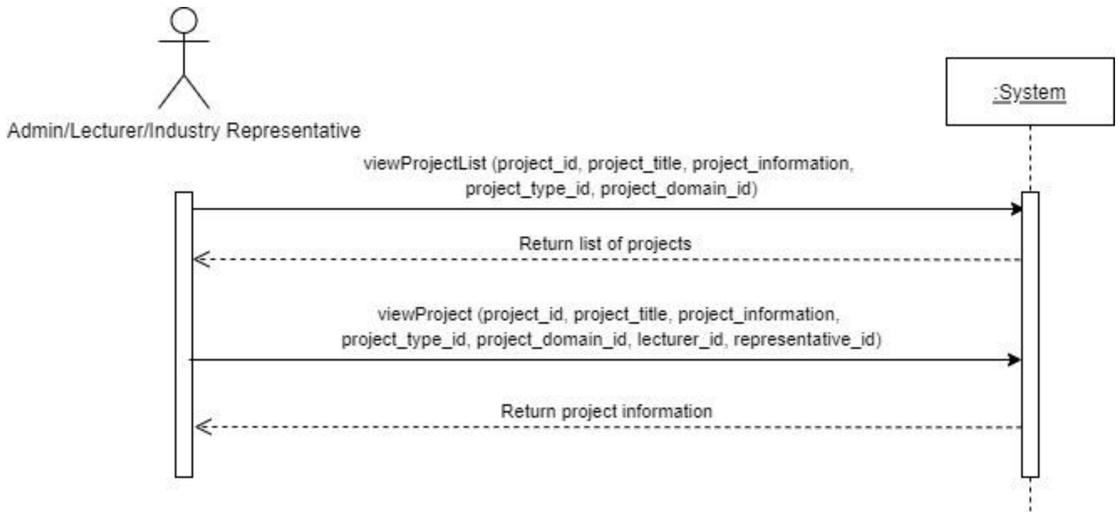

Figure 3.14 System Sequence Diagram of View details of projects

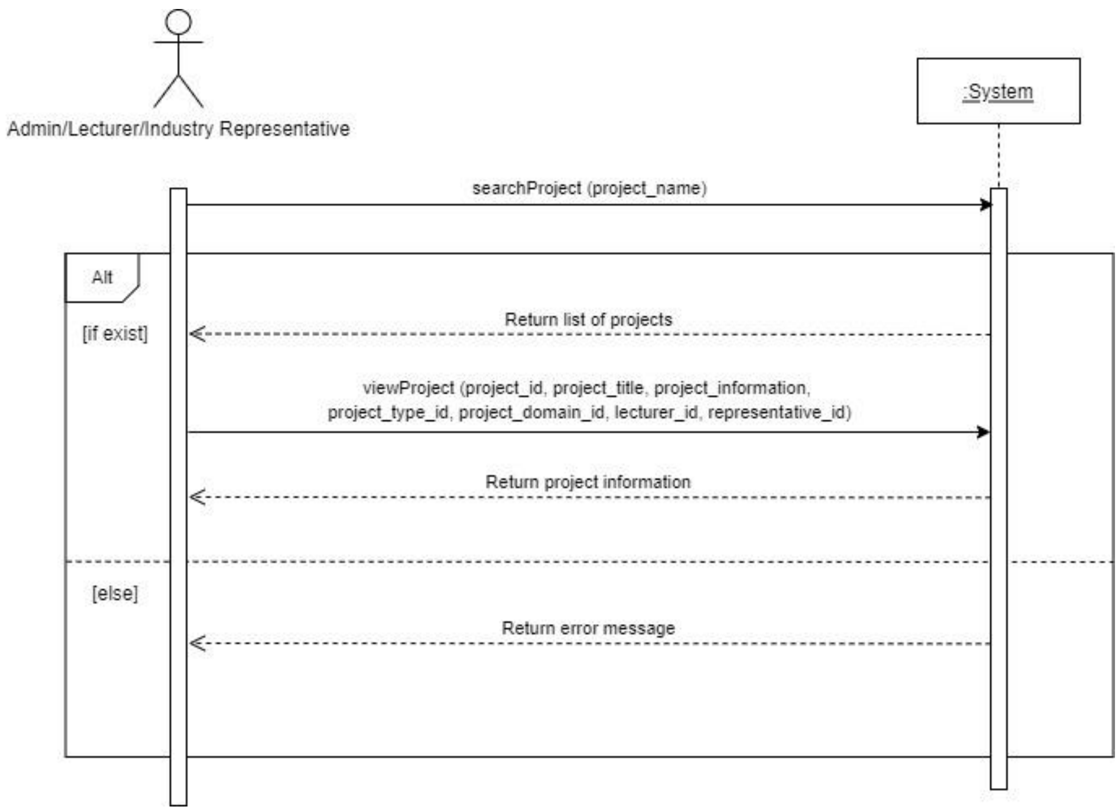

Figure 3.15 System Sequence Diagram of Search project

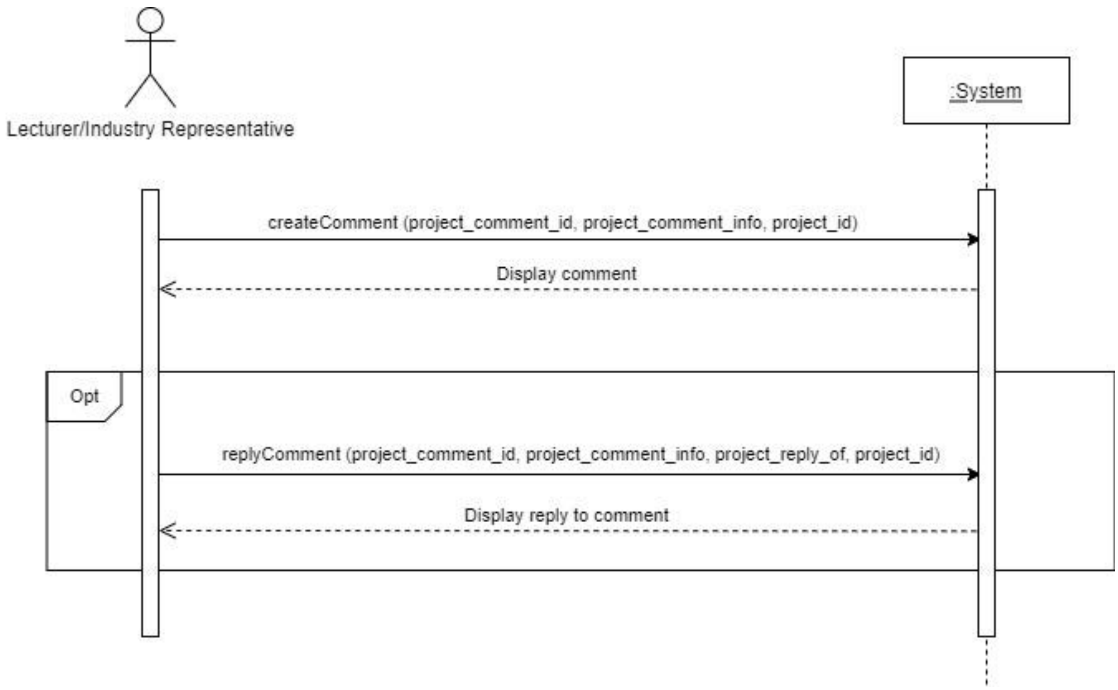

Figure 3.16 System Sequence Diagram of Add comment under project

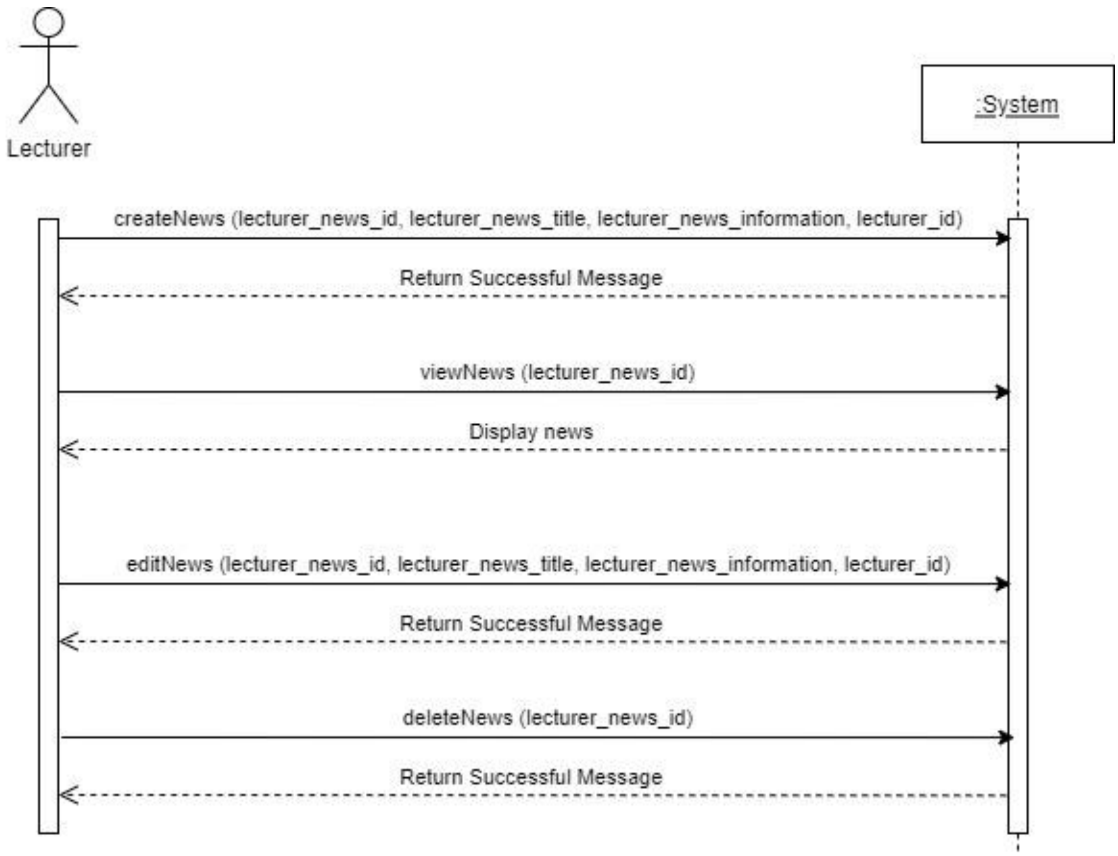

Figure 3.17 System Sequence Diagram of Post News (Lecturer)

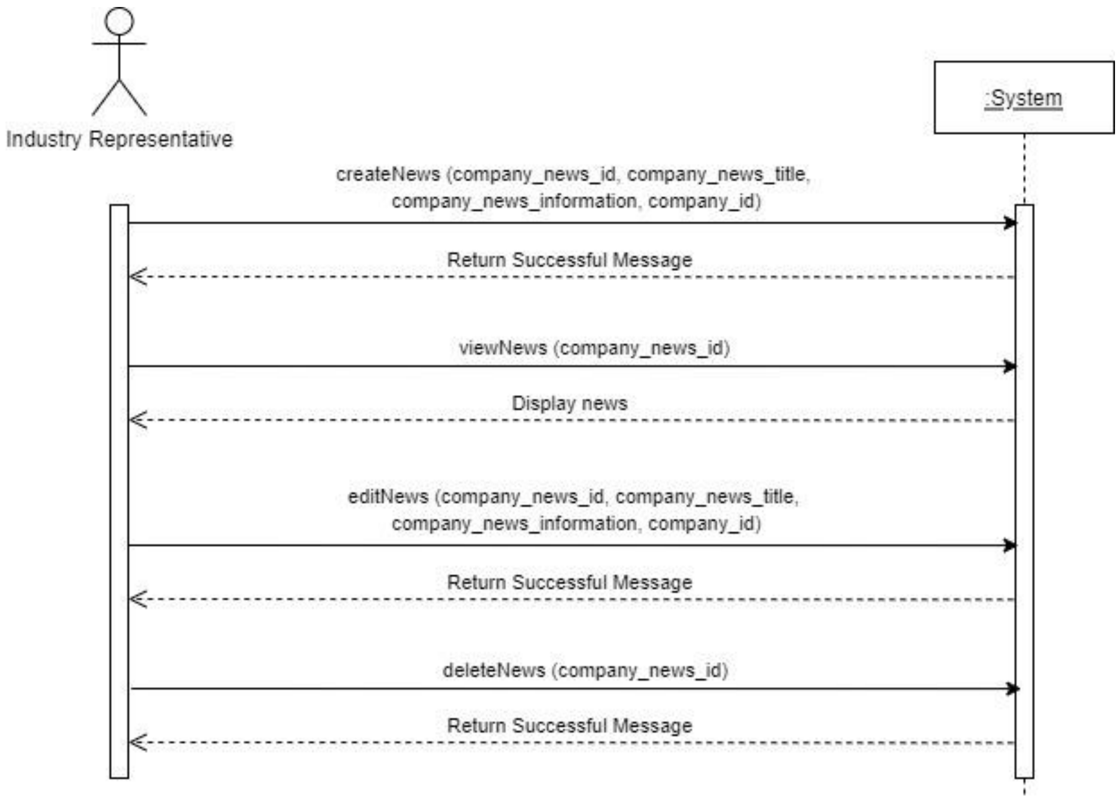

Figure 3.18 System Sequence Diagram of Post News (Industry Representative)

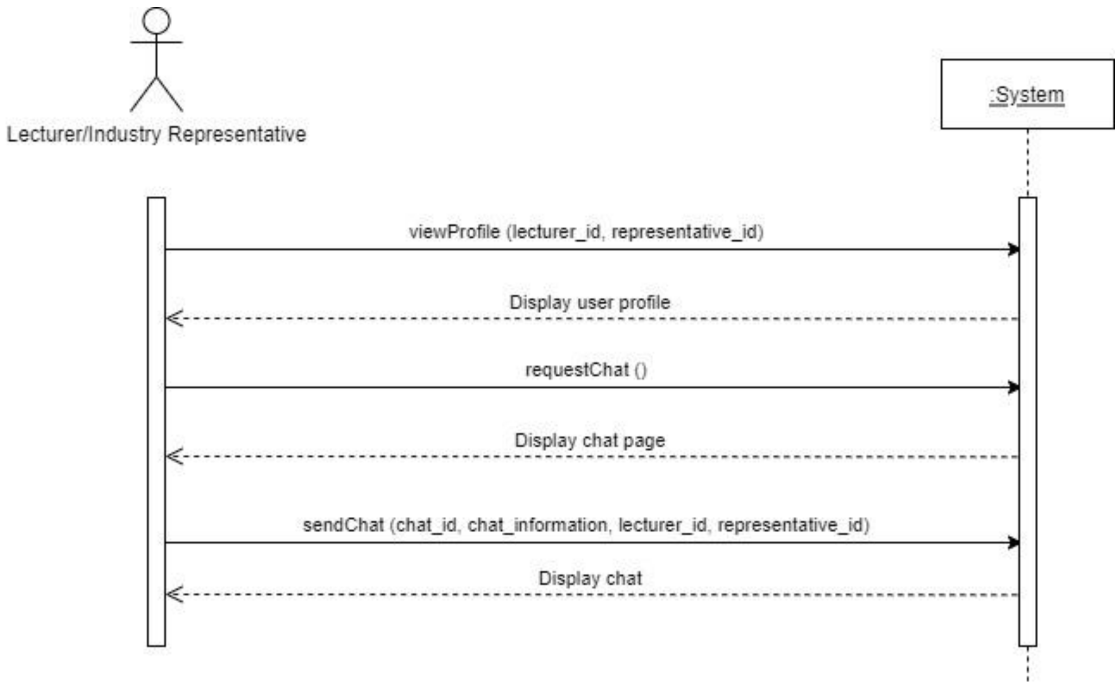

Figure 3.19 System Sequence Diagram of Chat with collaborator

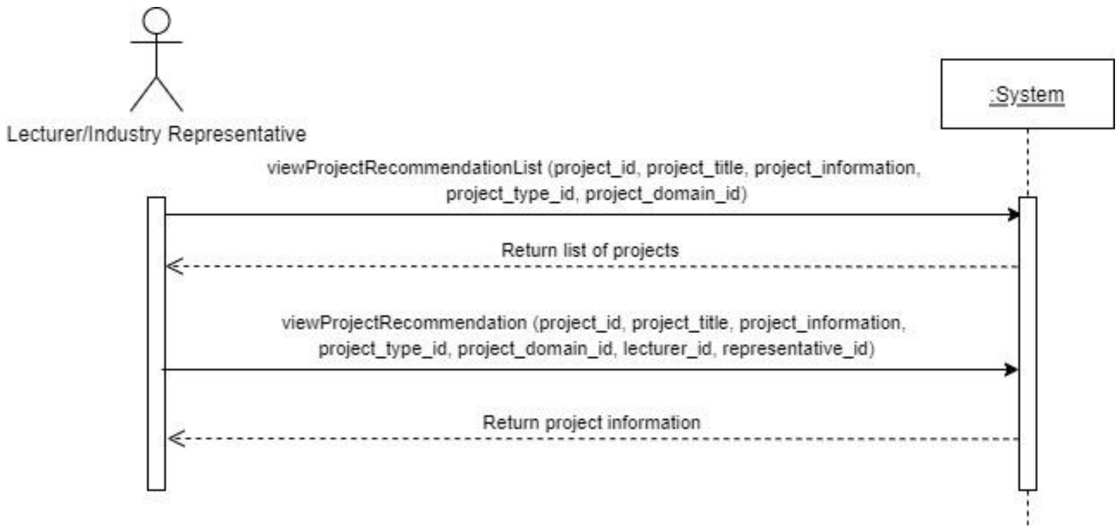

Figure 3.20 System Sequence Diagram of View project recommendation

3.5.5. Flowchart

Figure 3.21-3.30 show the flowchart for certain use cases.

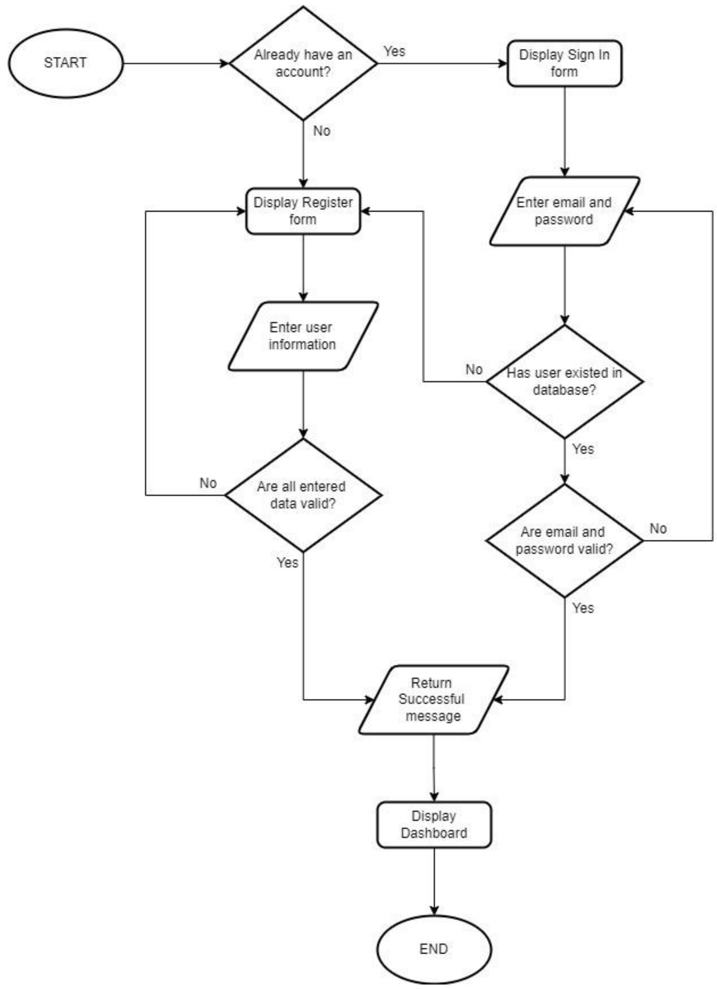

Figure 3.21 Flowchart for register

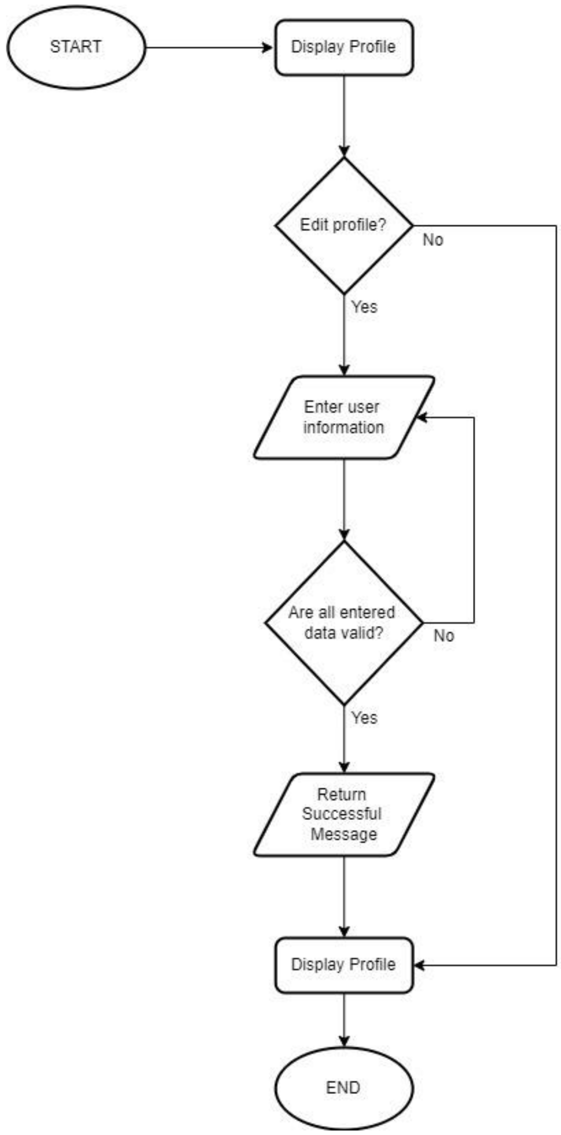

Figure 3.22 Flowchart for Manage profile

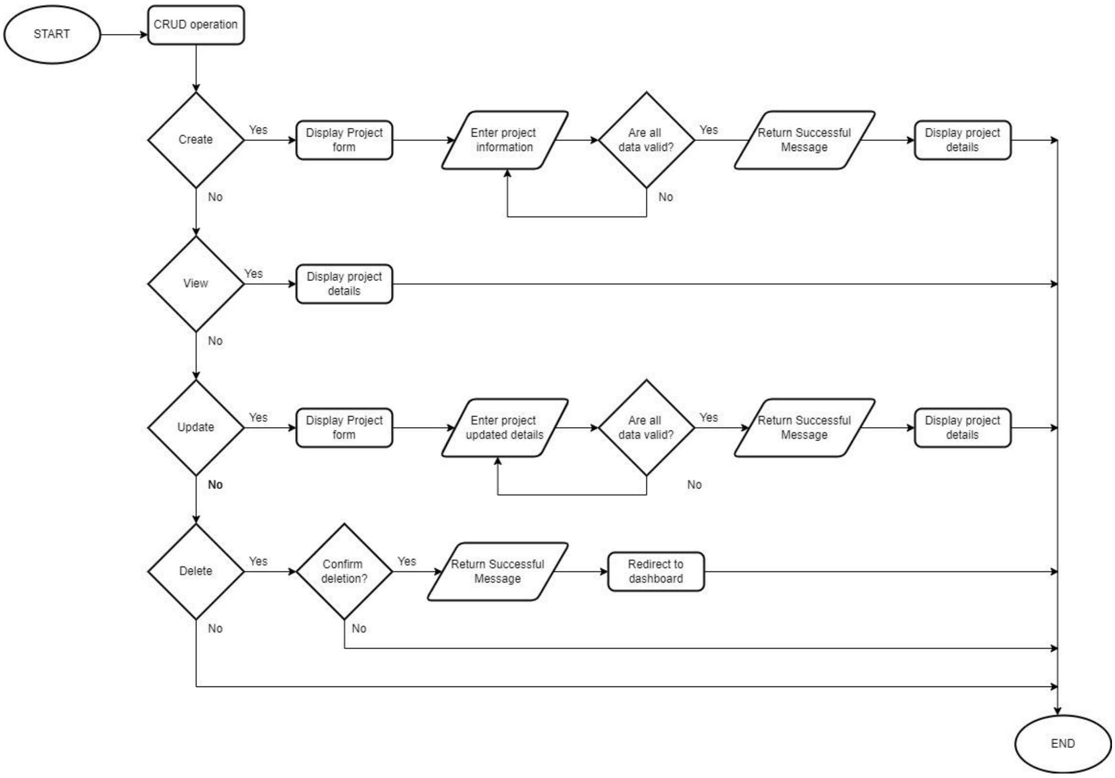

Figure 3.23 Flowchart for Manage project

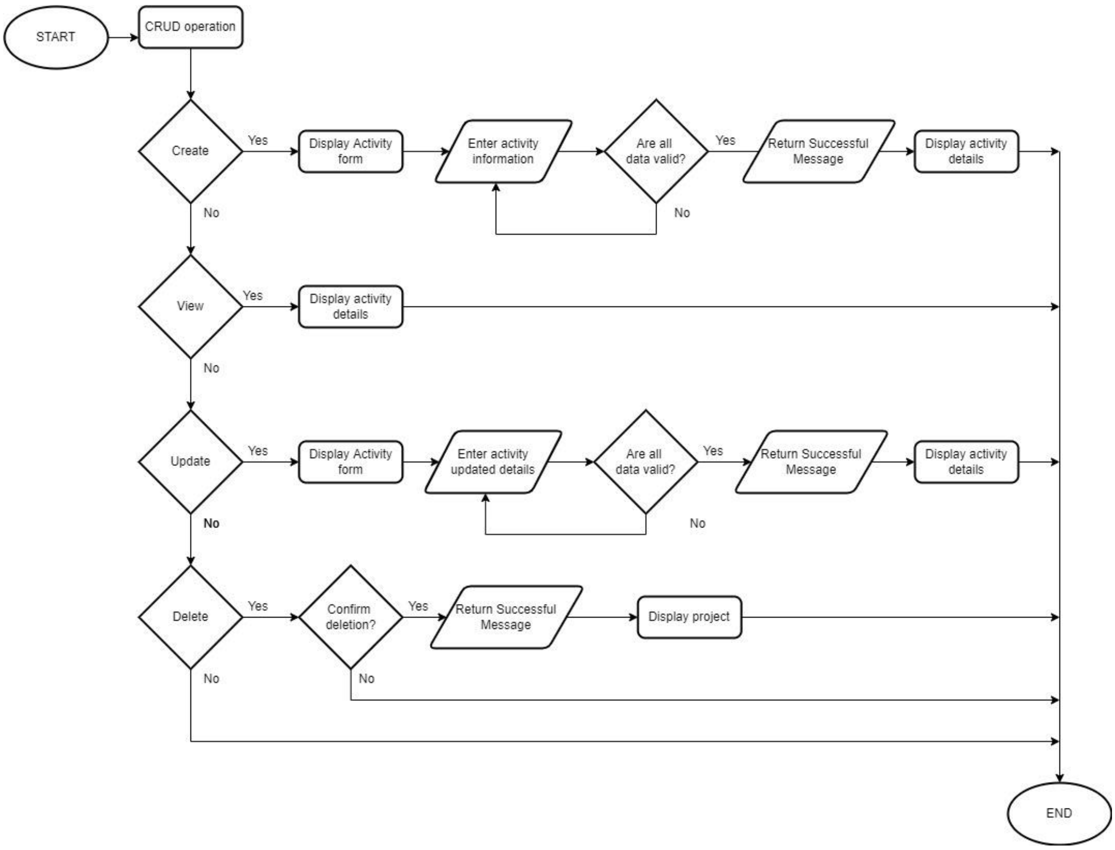

Figure 3.24 Flowchart for Manage Activity

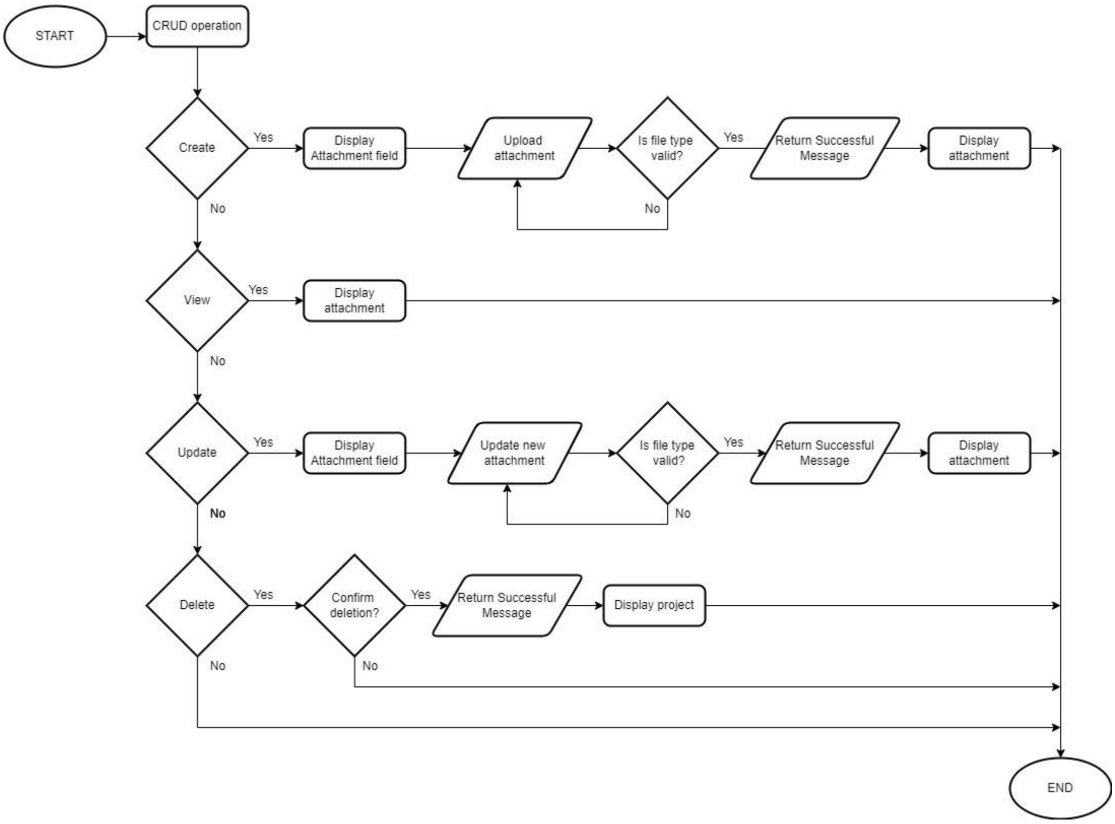

Figure 3.25 Flowchart for Manage Attachment

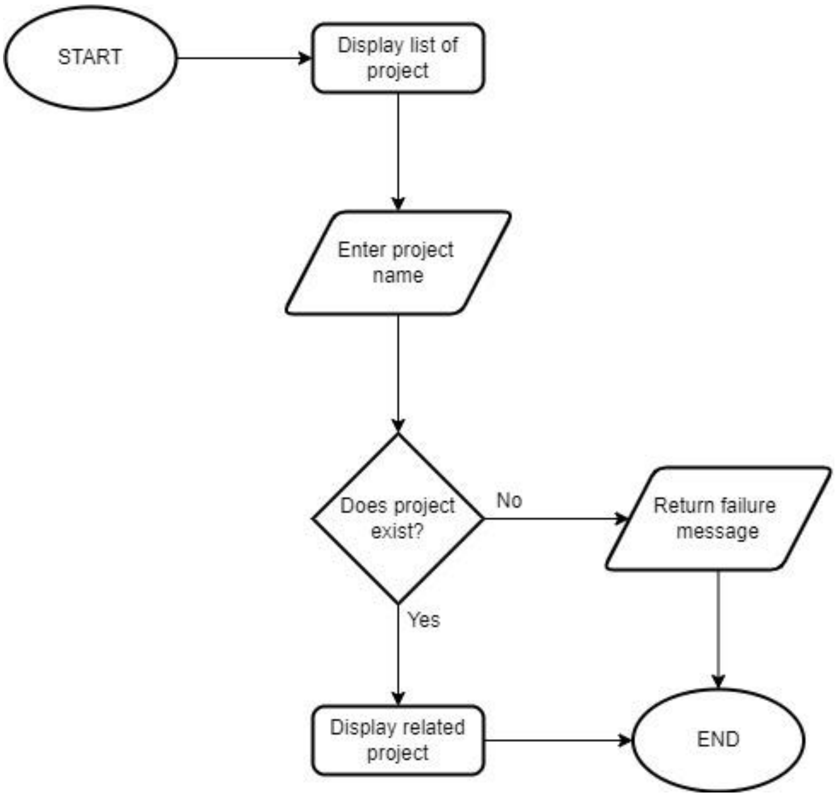

Figure 3.26 Flowchart for Search project

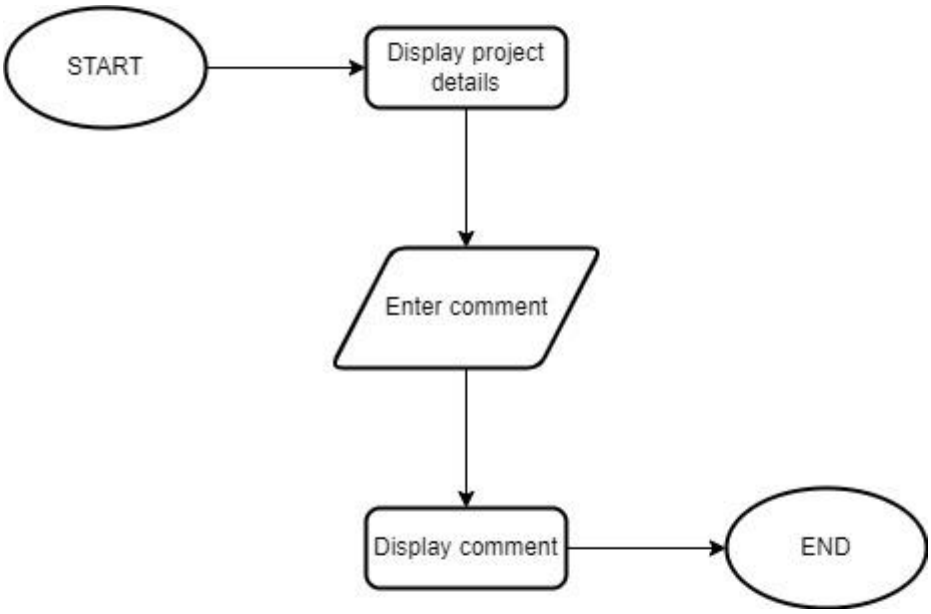

Figure 3.27 Flowchart for Add ccomment under project

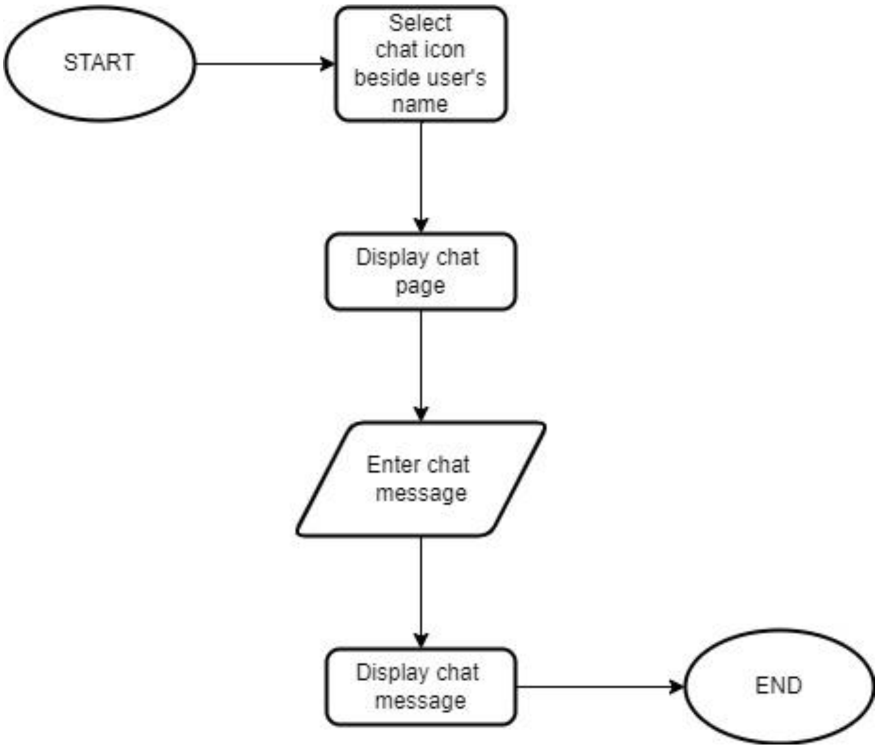

Figure 3.28 Flowchart for Chat with collaborator

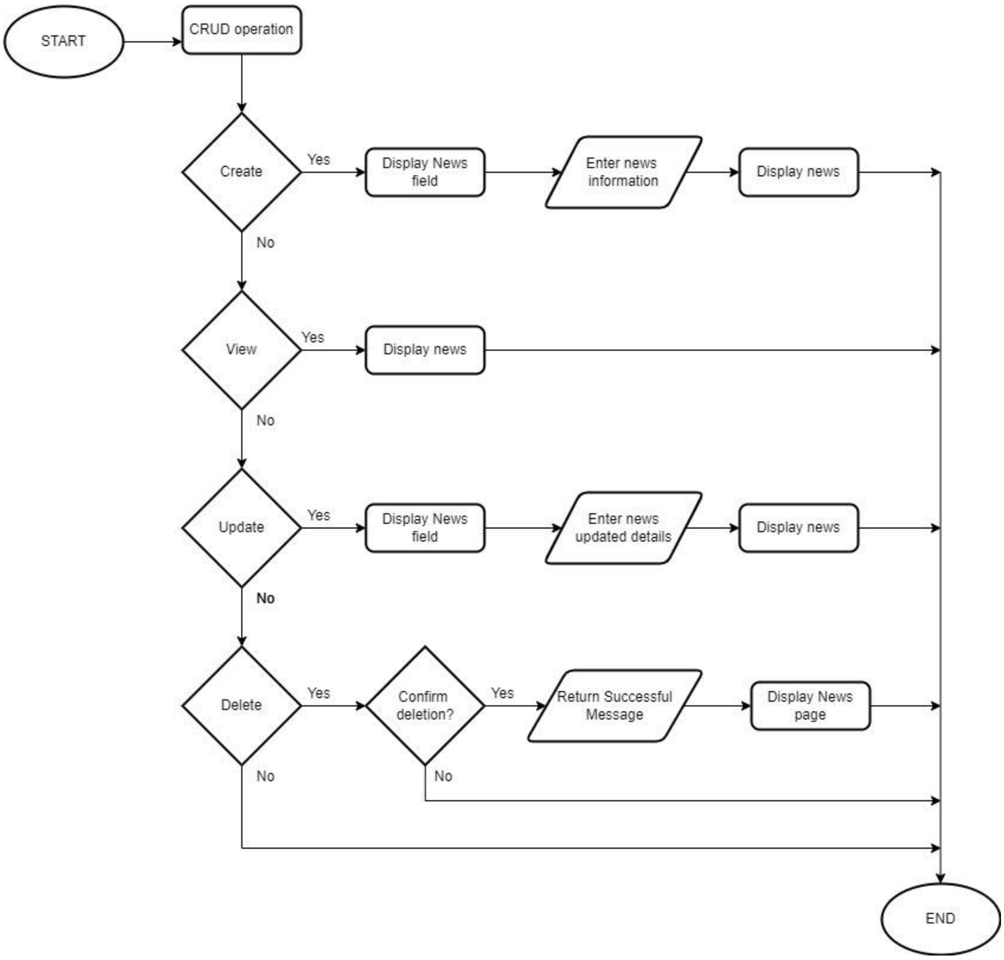

Figure 3.29 Flowchart for Post news

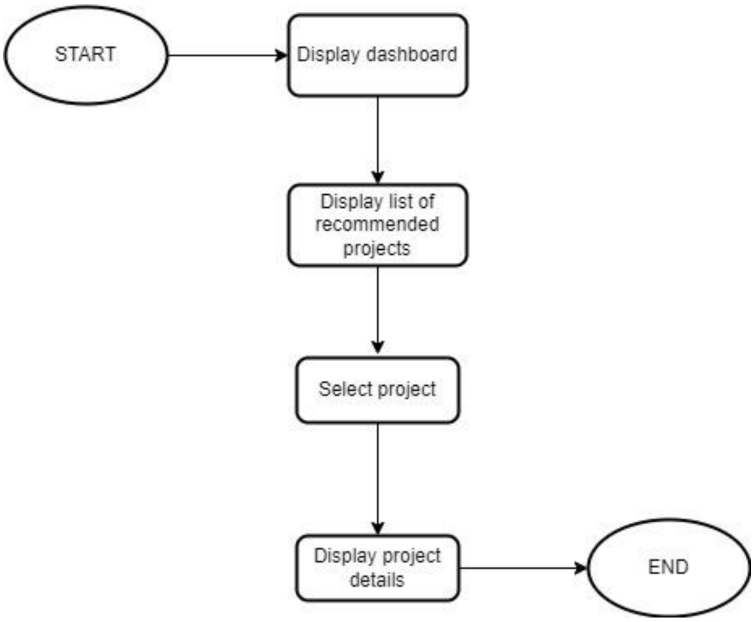

Figure 3.30 Flowchart for View project recommendation

3.6. Technology deployed

3.6.1. Hardware

Table 3.18 shows the hardware specification for developing the system:

Table 3.18 Hardware specification

Laptop Manufacturer	HP
Model	Pavilion 15-cs0xxx
Version	64-bit
Processor	Intel Core i5 8^{th} gen
RAM	12 GB
Operating System	Windows 10

3.6.2. Software

Table 3.19 shows the software that will be used for developing the project.

Table 3.19 Software specification

<table>
<tr><th>Types</th><th colspan="2">Description</th></tr>
<tr><td rowspan="2">Tools</td><td>Interface Design</td><td>Adobe XD</td></tr>
<tr><td>Web Application</td><td>• React.js as front-end framework
• Node.js as back-end JRE
• MySQL as database
• Visual Studio Code by Microsoft as IDE
• WAMP as server</td></tr>
<tr><td>Programming Languages</td><td>Web Application</td><td>• Front-end: HTML, CSS, JavaScript
• Back-end: JavaScript</td></tr>
</table>

4 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 next step is to design the prototype of the system to get more ideas on the flow of the system. After that, the building, developing and testing phase will be started immediately until finished.

REFERENCES

[1] A. M. Zamil, "Customer Relationship Management: A Strategy to Sustain the Organization's Name and Products in the Customers' Minds," *European Journal of Social Sciences*, vol. 22, no. 3, pp. 451-459, 2011.

[2] L. Frølund, F. Murray and M. Riedel, "Developing successful strategic partnerships with universities," *MIT Sloan management review,* vol. 59, no. 2, pp. 71-79, 2018.

[3] C. Nair, S. Chan and X. Fang, "A Case Study of CRM Adoption in Higher Education," in *Proceedings of the 2007 Information Resources Management Association International Conference*, 2007.

[4] M. S. Salleh and Z. M. Omar, "University-Industry Collaboration Models in Malaysia," *Procedia-Social and Behavioral Sciences,* vol. 102, pp. 654-664, 2013.

[5] Indeed Editorial Team, "Job Outlook for Careers in Computer Science," Indeed, 23 3 2021. [Online]. Available: https://www.indeed.com/career-advice/finding-a-job/job-outlook-for-computer-science. [Accessed 16 12 2021].

[6] "About Us," Zoho Corporation , [Online]. Available: https://www.zoho.com/aboutus.html. [Accessed 13 12 2021].

[7] S. Gauld, *Zoho CRM Tutorial for Beginners | Get Started with Zoho FREE ALL-IN-ONE CRM Software*, 2020.

[8] Salesforce.org, *Get Started with Salesforce for Community and Technical Colleges,* 2021.

[9] Mautic, "Overview of Mautic," Mautic, [Online]. Available: https://docs.mautic.org/en/overview-of-mautic. [Accessed 13 12 2021].

[10] D. Asanov, "Algorithms and methods in recommender systems," *Berlin Institute of Technology, Berlin, Germany,* 2011.

[11] S. Valencia, "An Introductory Recommender Systems Tutorial," Medium, 10 2 2017. [Online]. Available: https://medium.com/ai-society/a-concise-recommender-systems-tutorial-fa40d5a9c0fa. [Accessed 17 12 2021].

[12] S. Rose, D. Engel, N. Cramer and W. Cowley, "Automatic keyword extraction from individual documents," *Text mining: applications and theory,* vol. 1, pp. 1-20, 2010.