

**CUSTOMER RELATIONSHIP MANAGEMENT (CRM) SYSTEM
FOR CUSTOMER SERVICE MANAGEMENT**

BY

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ABSTRACT

This is a development-based project for a Customer Relationship Management (CRM) system for Customer Service Management. A CRM system is mainly used in businesses from small to large scale. A CRM system is a part of a module within the Enterprise Resources Planning (ERP) system, whereby it covers multiple functionalities from streamlining a company's organizational processes to automating them. A CRM system, however, is focused on improving the relationship between a company and its customers through the usage of various types of tools within the system such as sales process streamlining, product recommendation analysis and customer service ticket management.

In the real world within the business field, competition is inevitable, and a high customer churn rate is something hard to attain yet important for the growth and sustainability of a company. Customers are the source of success for a business since a business with a high customer churn rate affects the development of the company such that it may lead to the fall of the company if the customer base of the company cannot be secured. Besides, many existing CRM products are heavily focused on the pre-sales closing processes, while neglecting the after-sales process. Thus, this project aims to develop a CRM system, that focuses on customer service management.

This project aims to cover some problems within existing systems, which will be covered in Chapter 2 of this paper. The system will employ some basic functionalities within a CRM system such as user profiling that includes full-fledged CRUD operations, a chat bot functionality, ticket management system, and finally a user dashboard that centralizes the ticketing management process where analytics will be shown. Some tools and frameworks that will be employed in this project include ASP.Net Core, Blazor Server App, Entity Framework Core, Dapper, C#, SQL Server RDBMS, Azure Cognitive Services, Syncfusion Components and so on.

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LIST OF ABBREVIATIONS

CSR	Customer Service Representative
CSM	Customer Service Manager
CRM	Customer Relationship Management
CRUD	Create, Read, Update, Delete

Chapter 1 Introduction

This section expounds upon the introduction of the proposed CRM system that focuses on Customer Relationship Management. Subsequently, the problem statement and motivation behind the project will be elucidated upon. In this segment, the existing quandary and rationale for the necessity of this project will be explained upon. Following this, the objectives and project scope will be delineated, which state the intended final output and purpose of this project. The contribution part will also be explored, underscoring the salient aspects of this project that are most pertinent to users and their benefits. Finally, the report organization will be presented, which provides a succinct overview of each chapter that will follow in this report.

1.0 Project Background

According to [1], poor customer service is a topic that gets a lot of attention. From unethical contact centre operators that sell personal financial data to fines levied by industry authorities, there isn't a week that goes by without another media exposé. A single high-profile event may permanently harm a brand's reputation and lead to a drop in sales and stock prices.

Retaining existing customers is a goal strived by many companies to maintain revenue and profit for the company, given how important returning customers are in the long run for a company. According to [2], companies with very bad customer services in 18 countries that they have examined are putting \$3.6 trillion of sales at risk every year. Many companies in the digital era, be they small and medium-sized or large organizations have started to adopt digital tools to improve returning rates of customers. For instance, a Customer Relationship Management (CRM) system automates the procedures of following customers through the sales pipeline, maintaining critical customer information, and measuring your effectiveness in keeping customers delighted as well as analyzing a sales team's performance. Hence, a digital tool such as a CRM system is crucial to developing a good business process given how a company's customer service will be managed with ease. This project will propose a CRM system that targets the customer service management of a business process.

1.1 Problem Statement and Motivation

Every business has the dilemma of losing customers. Why was there such a high customer churn or low retention rate? A high customer churn rate can occur for a variety of reasons, including incorrect product pricing, a bad retail environment, a lack of product expertise, inefficient customer connection, and so on. Customer churn is caused by a variety of factors, one of which is poor customer service management. It is almost impossible to retain customer loyalty if the customer service that the customers receive is bad. It is normal to assume that customers as human beings, will prefer companies that treat them with warmth and provide better after-sale services, and this further extends to the reason why they will remain loyal to such businesses.

To tackle the high customer churn rate of a company, a method has to be taken to lower it. A Customer Relationship Management (CRM) system is an effective method to lower the customer defection rate. According to [3], keeping existing customers satisfied is much less expensive than attracting new ones. However, maintaining a degree of relationship with existing consumers that encourages them to stay with a firm is a dynamic and thorough task. As a result, a computerized CRM system may be vital to a company's success. However, how CRM systems are used may significantly impact the outcome. For instance, focusing on taking care of customer service management may help to reduce the customer churn rate. Besides, customer loss indicates that the company's earnings have decreased. In other words, lowering the customer churn rate and customer loss will boost the company's profit.

Therefore, a CRM system that focuses on customer service management is expected to be developed in this project, which aims to enhance the customer service management of a company. Hopefully, this can be a big step forward in improving the satisfaction of customers, while retaining existing customers for a company.

1.2 Motivation

Amid the Covid-19 pandemic, a series of national quarantine measures are implemented by the Malaysian government in response to the COVID-19 pandemic to reduce the spread of the virus. Given this situation, companies of all scales are to cope with the pandemic by conducting their business processes through a digital platform. According to [4], a customer's engagement with a firm, particularly in times of crisis, may have an instant and lasting impact on his or her feeling of trust and loyalty. As millions of people are furloughed and withdraw into solitary, how companies they frequent and rely on offer experiences and services that meet their new requirements with empathy, care, and concern will be a fundamental standard of their customer experience.

The traditional way of engaging with customer service of a company mostly include physical interactions; while in the pandemic, a surge in the higher needs for online customer service occurs, given how customers must resort to approaching customer service online as risking their health and safety by exposing themselves to the public is susceptible. CRM system serves as an effective digital tool to manage customer relations and promote profit growth of a business. However, a CRM system that does not emphasize customer service management results in fatal losses and a high customer churn rate.

While many existing CRM systems provide many functionalities such as reporting and analytics, automating emails and notifications, marketing and publicity, pipeline automation, workflow automation, document management, quotation management and forecasting, all these features focus on improving the marketing and sales-closing process of a company but not on the part of after-sales service and customers service which includes the convenience of customers, response speed, communications and so forth. Therefore, it is deemed crucial to have a CRM system that emphasizes customer service management or namely the after-sales process to reduce customer churn rates and retain satisfied existing customers.

1.2 Objectives

The main objective of this project is to foster customer service experience through the utilization of a CRM system to increase customer retention rates. The main objective can be separated into three parts which are:

The CRM system shall help the customer support team on managing customer support request tickets.

The CRM system shall provide a chatbot for system admin and customers to conduct online chat.

The CRM system shall provide a user dashboard for analytical reports regarding ticketing management that will allow the organization's manager to visualize analytical results related to ticketing management.

1.3 Project Scope and Direction

The final deliverables at the end of the project will be a CRM system that is customer-centric in which it will be focusing on customer service management within a CRM system. As the aim of the project is to increase customer retention and reduce customer churn rate, several customer-centric modules will be implemented. For instance, the system can handle customer support requests through the implementation of a ticketing system. This would smoothen the customer support process as ticketing allows tracking progress throughout the customer service process. Besides, the system will be able to provide communication with a platform such as a live chat system for direct interaction between customers and customer service agents. A live chat system will allow customers that require a fast response to receive their desired support. Besides, as the pandemic is still ongoing and physical interactions are not truly recommended, the implementation of a live chat bot function would allow customers to avoid being exposed to the COVID-19 virus since they need not connect with the customer support agents physically. When a business organization listens to the customers and adjusts according to their wishes, the customers will remain happy thus increasing the customer retention rate. Next, a dashboard module (analytical reports) will be implemented in the system to provide a better perspective for the company to keep track of the customer service process' status. The dashboard allows managers to visualize key metrics such as ticket status, ticket traffic over time, ticket count by categories and many more. Furthermore, customers will be given a user account, such that they can easily access the system and check their requests and status. Finally, the system will be a web application that can be accessed through most of the internet browsers in the market.

1.4 Contributions

This project would like to deploy a Customer Relationship Management (CRM) system for customer service management. This system allows the organization to manage the inquiries of customers (cases) through a central ticketing system. Authorized users can access the cases, the track progresses, view the communications or conduct other actions regarding the cases. Besides, the system aims to improve the communications between the customers and the customer service team. The system will provide a platform for customers to acquire instant information from a Chatbot. Besides, a dashboard for analytical reports regarding ticketing management will be implemented to provide a better perspective for the company to track the progress of customer service, especially the ticket management process, which would allow the managers and customer service team to visualize the process swiftly since they can track progress within a centralized platform. The user dashboard will mainly display analytical information such as ticket traffics, ticket statuses, ticket raised by category. This system equipped with these features could help a company to retain existing customers and reduce customer churn rates.

1.5 Background Information

In the past decades, along with the blooming of software development, various business tools have been developed to aid companies to smoothen business processes. One of the business tools that have gained wide attention and implementation is the Customer Relationship Management (CRM) System. A CRM system is used to streamline sales processes aiming to maintain a healthy relationship between customers and a company, which would increase customer retention and thus increase revenue.

Before defining CRM, it is of utmost importance to understand what a customer is. According to [5], customers can be categorized into four major categories, which are paying customers, employees, business associates, and suppliers/vendors. In CRM, the customer definition comprises both internal and external customers. The definition gets more complex regarding their different industries and how they operate their business functions. According to [6], an internal customer is a client who works for the firm and does not pay for the goods or services. Internal customers are workers, for instance, employees, suppliers/vendors, or stakeholders who rely on each other to accomplish their duties.

In general, a CRM software system is a tool that helps businesses acquire and retain customers. A CRM system is equipped with various powerful tools that can be utilized for various purposes. For instance, a CRM system is usually a system equipped with a hierarchical authorization such that different users can have access to different functionalities and data. Other examples include CRUD operations for customer-related data, analytical tools, tracking, event management tools, forecasting and many more.

1.6 Report Organization

Chapter 1 presents a comprehensive introduction to the report, highlighting the research problem or topic under study. It delineates the research objectives, scope, and questions while offering a succinct background of the subject matter. Chapter 2 delves into a review of existing CRM systems, shedding light on previous accomplishments and limitations of similar systems. This chapter also identifies the strengths and weaknesses of current systems and proposes solutions to address their limitations. In Chapter 3, a brief explanation of the methodology employed in the development of this system is provided as well as the system requirements related diagrams such as Use Case diagrams, Use Case Description, and Activity Diagrams.

Subsequently, Chapter 4 focuses on the design aspects of the CRM system, encompassing system architecture, user interface design, and database design. This chapter clarifies the design choices made and the reasoning behind them while incorporating detailed diagrams and flowcharts to visualize the system design. Chapter 5 enumerates the hardware and software tools utilized in the development of the proposed project, detailing the setup process for the development environment. This chapter also includes system operations with accompanying screenshots and discusses the challenges encountered during implementation.

Chapter 6 pertains to the testing phase, showcasing test cases and their respective outcomes. Lastly, Chapter 7 offers a summary of the problem statement, motivation, and objectives previously described, evaluating their successful accomplishment. This chapter also provides recommendations for enhancing the system in the future.

Chapter 2 Literature Review

Along with technological advancement in the 21st century, many types of Customer Relation Management (CRM) systems have been developed using different kinds of technologies and include different functionalities to solve customer churn problems. In this section, customer relationship management and three existing CRM systems for customer service management will be studied. Since this project aims to develop a CRM system that focuses on customer service management, thus the review of existing CRM systems will mainly focus on how the system handle customer enquires such as cases, how communication between staff and customers is conducted, and the tools implemented to visualize data. Later, a better solution suggested for this project will be discussed.

2.1 Customer Relation Management (CRM) System for Customer Service Management

2.1.1 Definition of CRM

CRM stands for Customer Relationship Management and was first used in the early 1990s. According to [7], CRM is the process of managing customer relationships. Customer service, sales, forecasting, and the study of trends and behaviours are all part of the organization's perspective [16]. All in all, a CRM system improves the customer experience. A CRM system provides a way to store all information regarding the customer interaction history such as phone calls, email, social media interaction and many more either on a cloud server or on a company's on-premises server. Besides, a CRM system is responsible for internal tasks such as managing a sales pipeline, dealing with customer enquiries, managing calendars, assign and managing tasks to team members [8]. The system utilizes a centralized platform to keep track of customer relations-related workflow, customer details, sales processes and many more, which contributes to a smoothened customer service and a more direct experience [9].

2.1.2 Definition of Customer Service Management

According to [10], customer service is the direct interaction between a consumer conducting buying activity and a representative of a company that is selling the product. Good customer service is crucial to business success, which ensures the loyalty of an existing customer. According to [11], when a company grows, maintaining a consistently outstanding customer service experience will turn complicated, thus this is where customer service management helps.

Customer service management is how a company runs its customer service operation and makes sure that the service is always good, which increases customer retention. Some parts of customer service management include improving support processes, fostering effective communication, and measuring how well service works. Also, it is important to know that the Customer Service Management module is a part of a CRM system. While a CRM system is intended to create sales, it may also be used to manage sales and marketing operations. Besides, a CRM system is a reactive digital tool to approach customer service—it tracks cases and assists in the management of important customer data, but it struggles to give a comprehensive, end-to-end answer to customer issues [12]. The customer service management module within the CRM removes the limitation by improving customer engagement. According to [13], customers expect a smooth process from engagement to delivery, and they wish their requests or complaints to be addressed within a reasonable timeline. Customer Service Management enables this by bringing together all relevant teams so that problems can be swiftly recognized, and execute solutions, with outside departments brought in as needed.

2.1.3 Customer Loyalty and Customer Retention

The term "loyalty" refers to a customer's commitment to your company and its products. Customers will return for business consistently, despite being without the greatest product, pricing, or delivery service at the said moment.

Customer Loyalty is the outcome of having had previous positive encounters with someone and having that person return to you several times because of those experiences [3]. These little pieces of information help businesses if the unique situation and information of the customers such as their order history and purchasing patterns can be recognized swiftly. CRM systems are responsible for measuring the success of your client's history against loyalty [3]. These tools may help companies track these behaviours, encourage the customers to buy more, introduce them to other things that the company sells, and encourage them to spread awareness of the company. It is important to note that excellent service is the key that encouraging customers to stay loyal to the businesses with whom they do business. Businesses will have a short-term connection with customers if they receive bad service demands that are unmet. This unfavourable outcome will also spread through word of mouth, perhaps harming businesses more than imaginable.

Customer Retention, on the other hand, is defined as a company's capability to turn their existing customers into returning or repeating customers and prevent them from turning into a competitor [14]. Customer retention is a topic developed for many theories, programs and practices among researchers, analysts, and consultants. Businesses increasingly easily disclose their client retention strategies. Customers' demographics are tracked and responded to as part of most solutions. In short, client retention revolves around the customers and the customer's experience.

2.2 Previous work on CRM system for Customer Service Management.

In this subsection, existing works regarding the CRM system for Customer Service Management will be reviewed. For instance, the customer support cases and ticket management, conversational tools, and the dashboard to visualize customer service progresses implemented in the system will be discussed.

2.2.1 HubSpot CRM

HubSpot CRM is an essential aspect of the HubSpot ecosystem. With it, small and large businesses alike can attract more visitors, turn them into paying customers, generate more leads, and close more sales. The system targets small businesses and it adopts a simple user interface design to allow users to adapt to it fast.

2.2.1.1 Customer support cases and ticket management

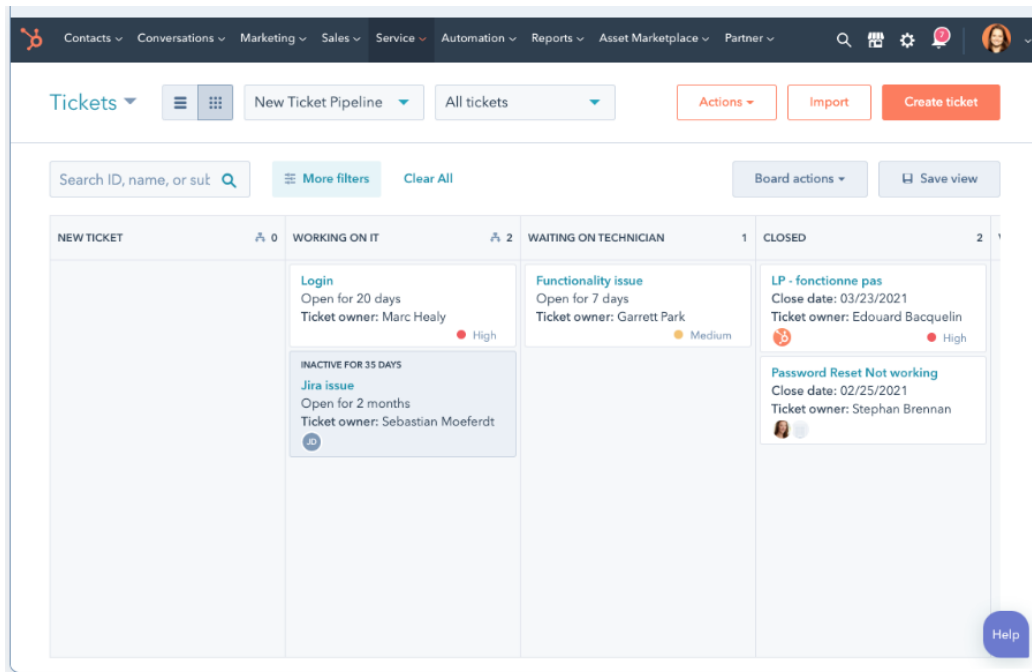


Figure 0-2-1 All-in-One ticketing system in HubSpot CRM

The HubSpot CRM adopts an all-in-one ticketing system that provides contexts for every conversation. The system prioritizes requests, meets SLAs, and creates a nice experience for everybody. Service Hub is based on HubSpot's CRM, delivering a 360-degree view of customers.

The image shows a 'Create ticket' form with the following fields and options:

- Ticket name ***: Text input with placeholder 'Create a ticket from a conversation'.
- Pipeline ***: Dropdown menu with selected option '[*] Customer Onboarding'.
- Ticket status ***: Dropdown menu with selected option 'Client Set-up'.
- Priority**: Radio button selected for 'Medium'.
- Category**: Tagged input with 'General inquiry' and 'Product issue' tags.
- Ticket owner**: Dropdown menu with selected option 'Marcus Andrews'.
- Source**: Empty text input field.

Buttons at the bottom: 'Create' (solid orange), 'Create and add another' (outlined orange), and 'Cancel' (outlined orange). A close button (X) is highlighted in the top right corner.

Figure 0-2-2. Create Ticket

In the HubSpot CRM ticketing system, a shared inbox keeps track of all the tickets in a centralized manner. Several features such as notes taking, tag adding, and keeping track of updates are implemented to ensure everyone is synchronized on the same page. Besides, more information sections regarding the ticket can be recorded such as priority, category, and ticket status to ensure the customer receives a reply promptly. This is useful to ensure the tickets are organized. Besides, the ticketing system in HubSpot allows the user to create and route tickets automatically, enter the customer data into the Customer Service Management module, or escalate the issues as required. This feature helps the customer service team to focus on solving customer issues rather than wasting time trying to manage spreadsheets and systems since all the ticketing details are centralized and automatized.

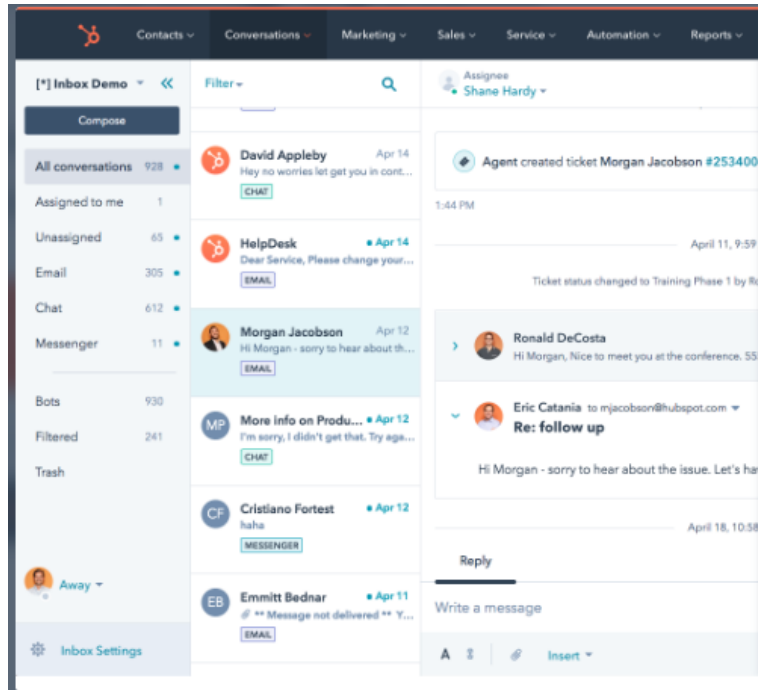


Figure 0-2-3. Shared Inbox

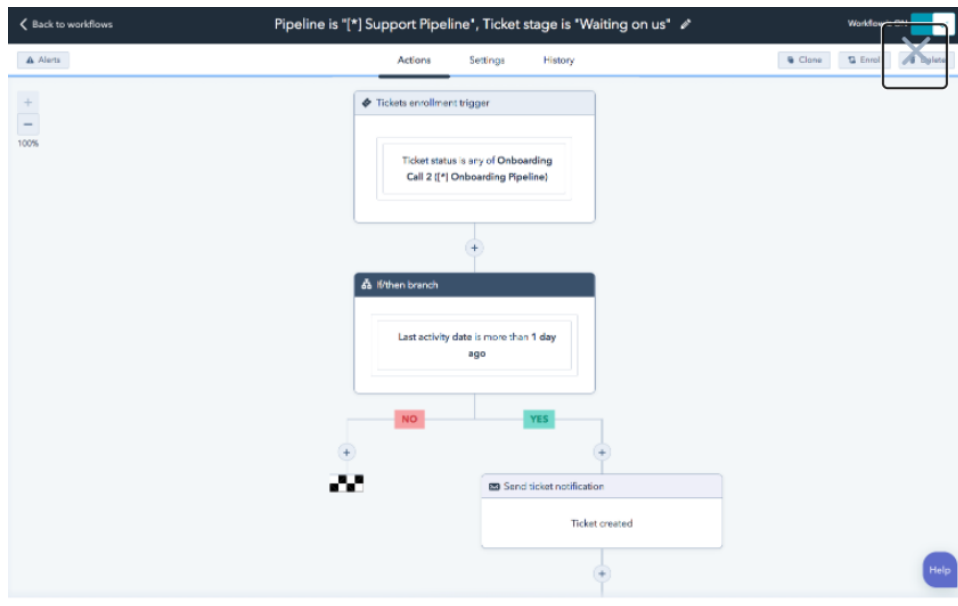


Figure 0-2-4. Routing tickets

2.2.1.2 Conversational tools in HubSpot CRM

HubSpot CRM adopts a live chat feature in its system. It allows customers to start a live chat with the staff and inquire about information the moment they land on the company's website. The CRM also allow the company to customize the chat widget so that it matches the company brand logo and creates a targeted welcome message for different web pages on the company's website. The customer chat can also be responded to through the CRM's conversations inbox, Slack or the HubSpot mobile application.

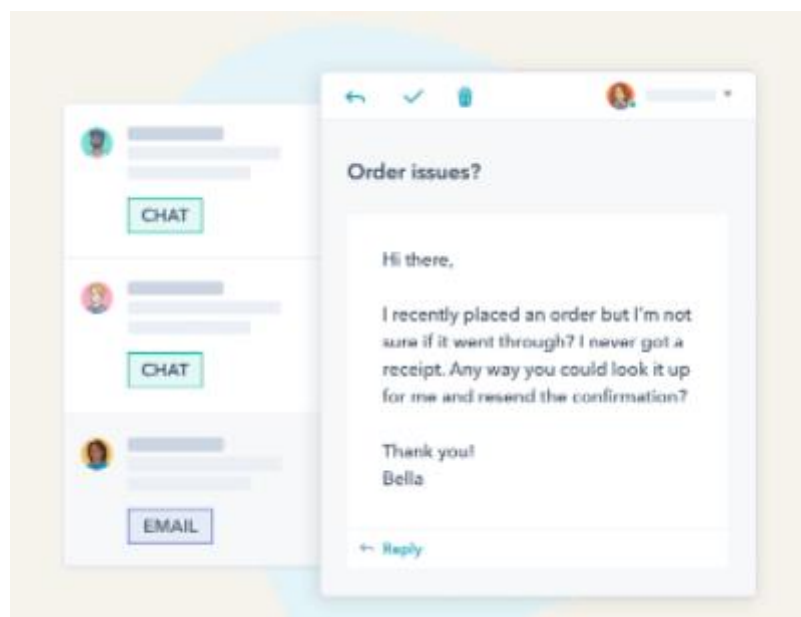


Figure 0-1. Live Chat Function

Besides, the emails can be written and sent via the built-in emailing system, while using pre-made templates to ease and smoothen the customer service process.

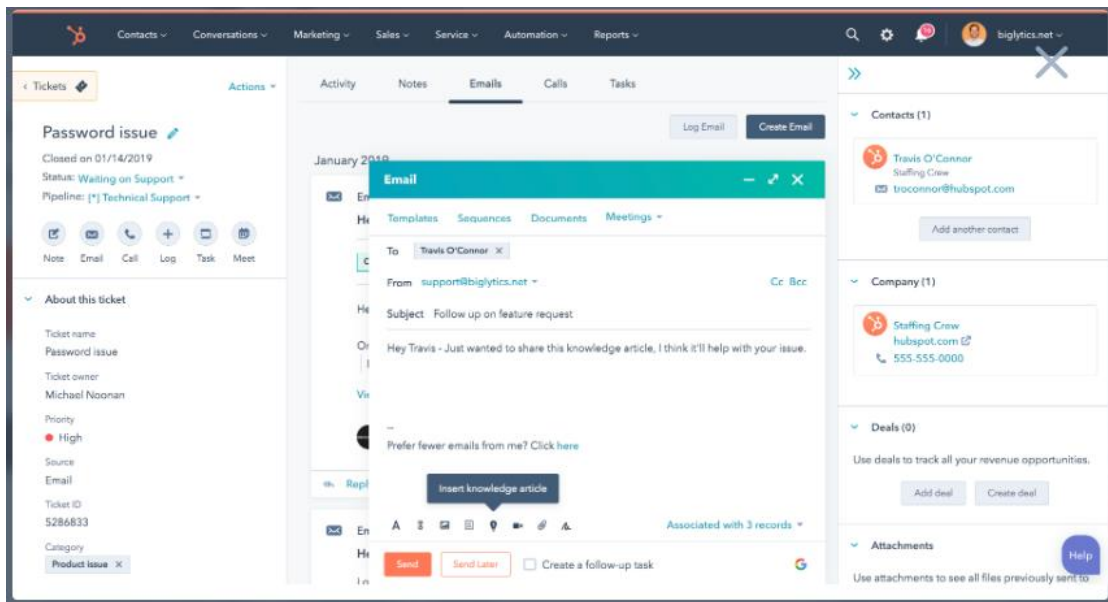


Figure 0-2. Built-in emailing system and pre-made templates.

2.2.1.3 Dashboard implementation to track customer service processes.

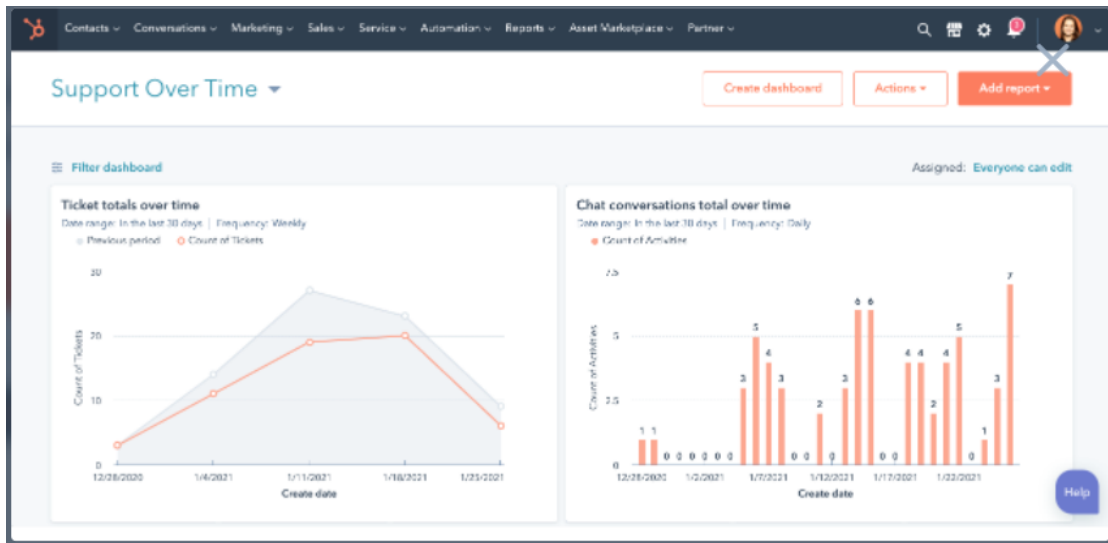


Figure 0-3. Dashboard in the HubSpot CRM

In the HubSpot CRM system, a dashboard can be created to manage the tickets. The manager or authorized staff can view major customer complaints through the built-in graph function as well as track agent performance. Furthermore, many built-in tools analytics tools can measure details such as contact volume, response time and other essential customer experience metrics. Custom benchmarks can also be created in the system and measure ongoing improvements in the customer experience.

2.2.2 Zoho Desk CRM

The business software company, Zoho has been operating since 1996 [17]. Zoho remains one of the most popular platforms in the CRM market as it provides a classic full-fledged CRM tool that would aid business growth. Zoho Desk, however, is a web-based help desk application within the Zoho CRM to manage customer support activities.

2.2.2.1 Customer support cases and ticket management

The ticket management system in the Zoho Desk CRM system collects and organises consumer emails from a single email account. It enables a help desk representative to quickly answer and log customer calls. Besides, it allows customer service representatives to listen to and respond to consumer input on social media platforms like Facebook and Twitter.

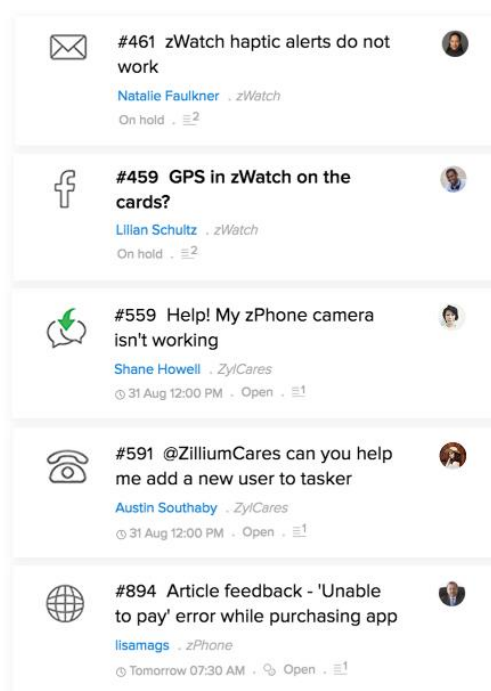


Figure 0-4. Ticket management system that organizes consumer emails from a single email account.

Besides, Zoho CRM implements omnichannel customer service software, which the customer service team may instantly connect to the contact points, including email, phone, social media,

web forms, and live chat. Tickets can be opened and recorded through these contact points, without having to resort to only one mode of communication.

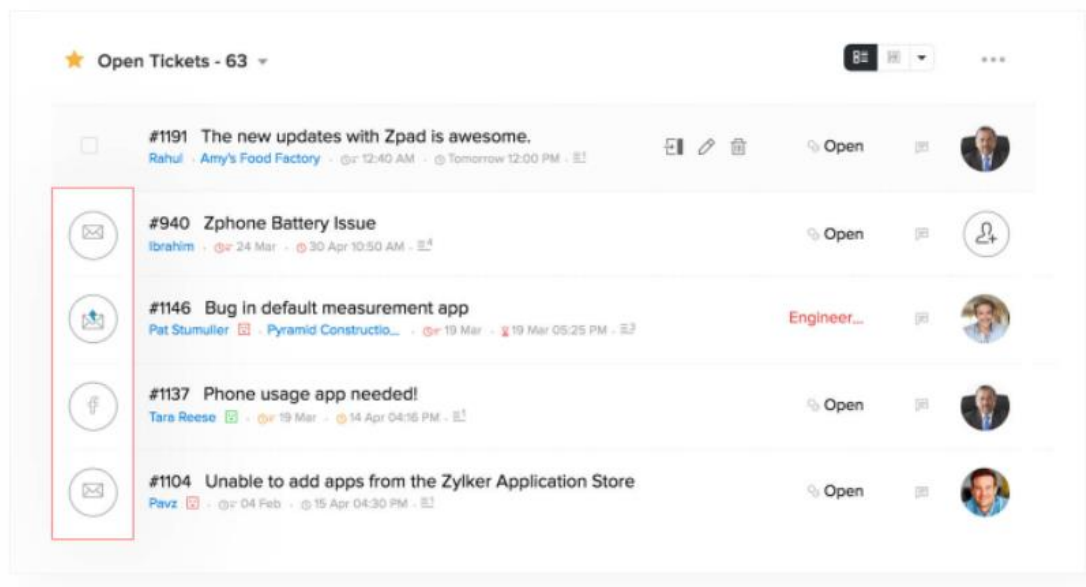


Figure 0-5. Shows that customers from various channels can be connected via an omnichannel.

The Zoho CRM also allows the creation of assignment rules to route the right tickets to the right departments automatically. This allows for a smoother process in managing tickets, as well as promotes efficiency since the staff can focus on critical tasks. The assignment of tickets based on criteria will ensure that the tickets are handled by the most suitable agents in the support team, this allows the customers to receive the best possible solutions within the shortest possible time.







Rule Name	Description
Network Issues - zPhone/zPad	
Criteria	Assign To
Product Name is zPhone	 Network Engineers
	Team Members
	 Don Evans  James Carter
	 Don Evans  Jo Yung  Mark Daniel
<hr/> <div style="display: flex; align-items: center;"> Add target <div style="border: 1px solid #ccc; width: 150px; height: 20px; margin-right: 10px; display: flex; align-items: center; justify-content: center;"> + </div> <div style="border: 1px solid #ccc; width: 150px; height: 20px; display: flex; align-items: center; justify-content: center;"> + </div> </div>	

Figure 0-2-6. Creation of assignment rules to route the right tickets to the right departments.

2.2.2.2 Conversational tools in Zoho CRM

Zoho Desk implements embeddable chat widgets to allow instant connection between the customer and the customer service team if they can't find what they seek in the Help Center. Customers can get in touch with customer service support rapidly and this ensures happiness.

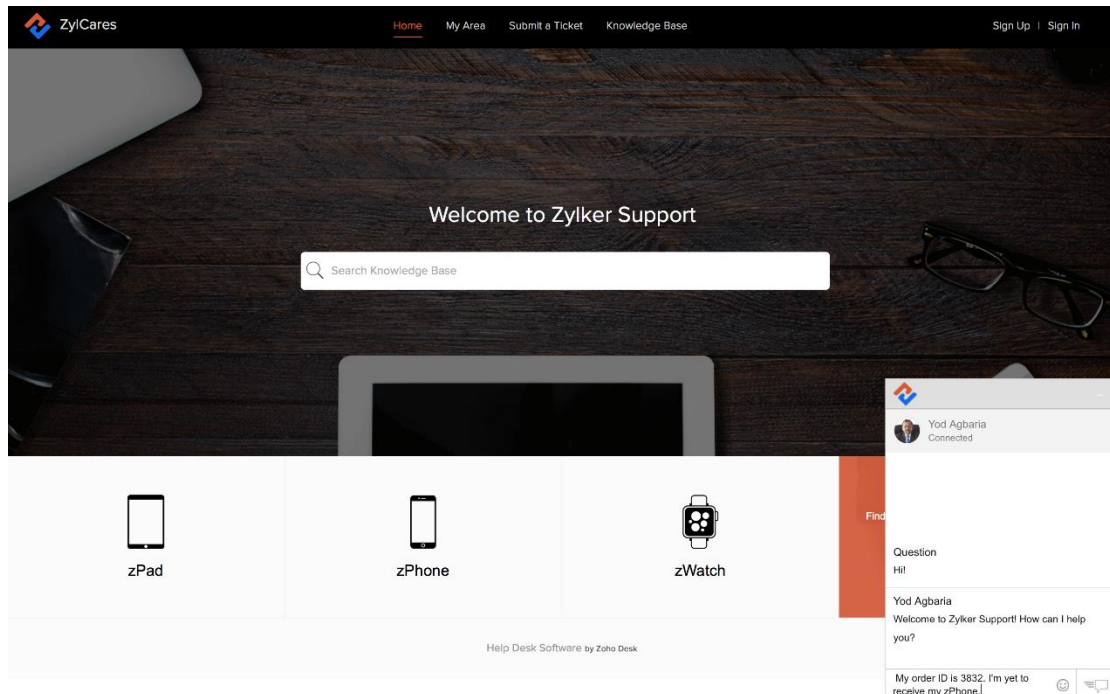


Figure 0-7. Embeddable Chat Widget.

Moreover, Zoho Desk provides a rather effective solution for customer service management, in which the agents can convert the chat conversation into a ticket and save all the contexts within the chat system if the customer's problem requires a longer time to solve.

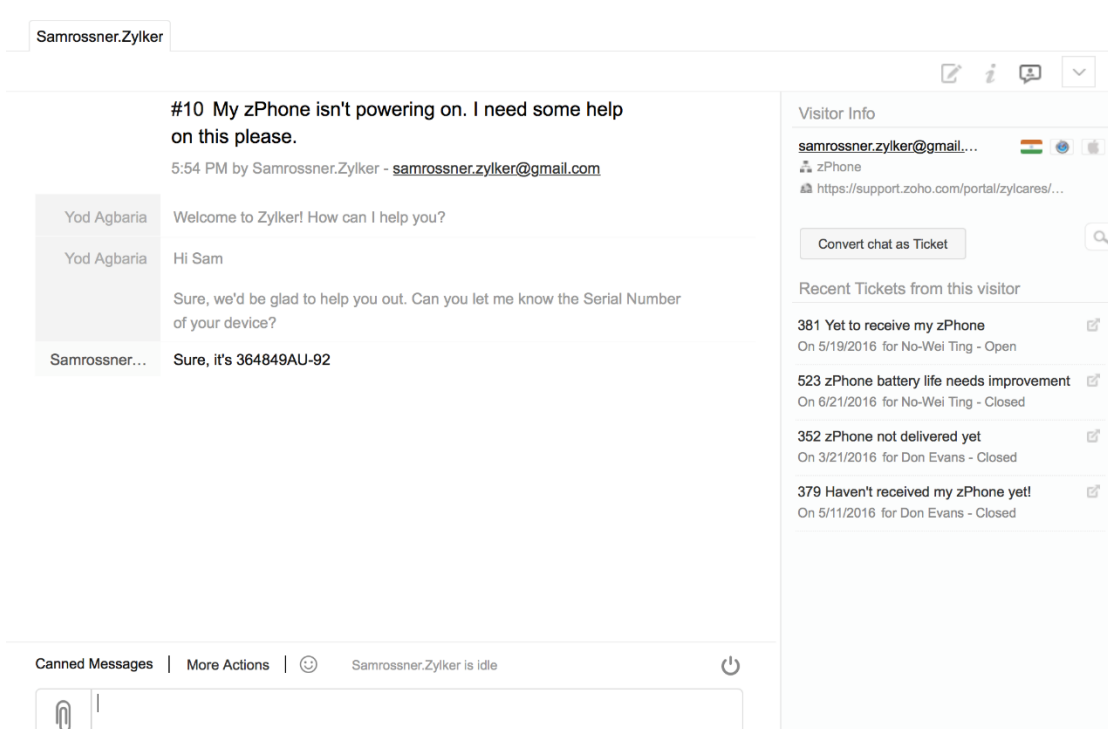


Figure 0-8. The “Convert chat as Ticket” button is available on the right to convert the chat conversation into a ticket.

The Zoho Desk implements an AI-powered support assistant to chat with customers, identify the sentiments behind every ticket and conduct relevant solutions from knowledge base articles. Over time, the AI will learn and improve its accuracy in targeting problems and providing better solutions to customers.

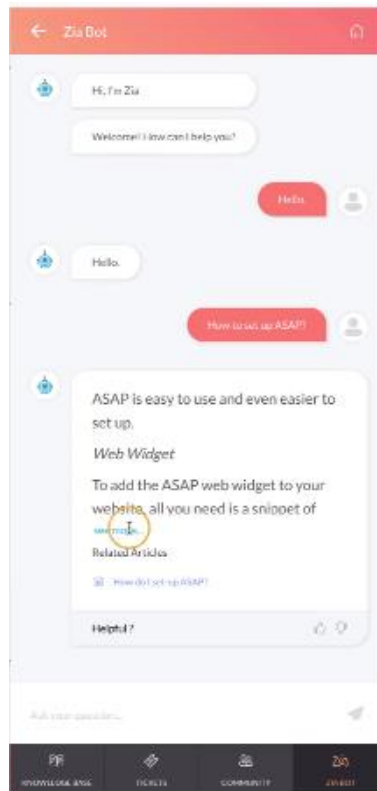


Figure 0-9. AI-powered chatbot.

2.2.2.3 Dashboard implementation to track customer service processes.

The Zoho CRM adopts a dashboard system to visualize key metrics in a customer service process. The dashboard allows managers to visualize key metrics such as ticket traffic, customer happiness ratings, most threaded tickets, unassigned tasks, online and offline agents and many more. This way, the dashboard aids managers and authorized users to visualize metrics that are trending downwards and intervene quickly. Managers may also use Zoho Desk to schedule reports to arrive in their mailbox regularly, allowing them to maintain track of all functions, evaluate data, and make the best decisions at the correct moment.

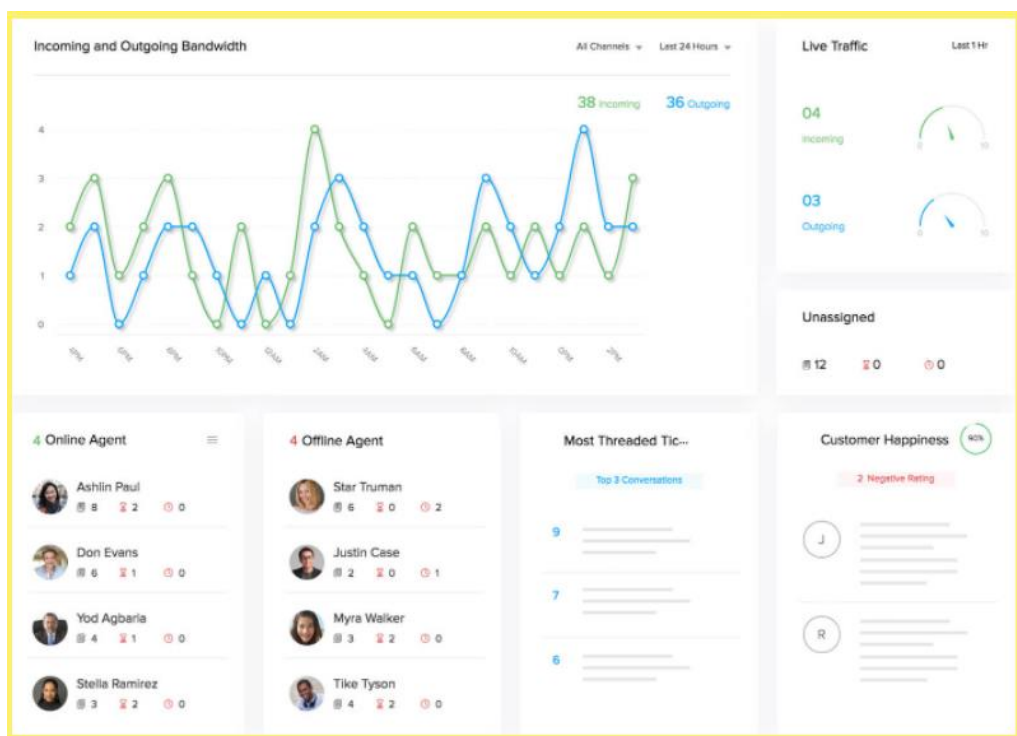


Figure 0-10. Dashboard system to visualize key metrics in a customer service process.

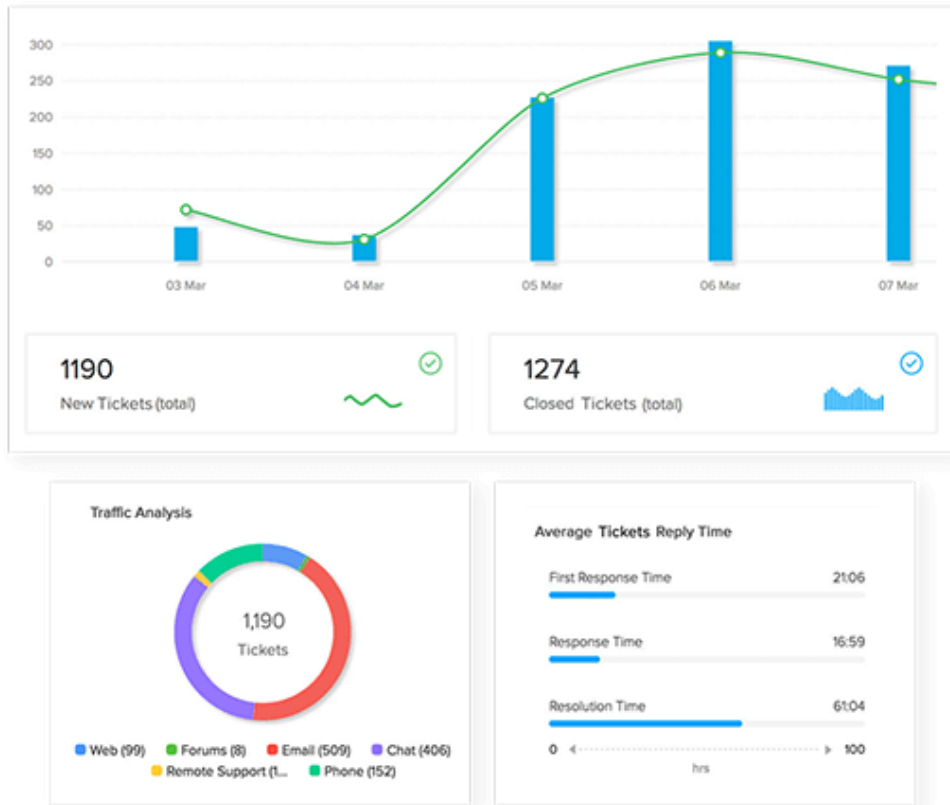


Figure 0-11. Dashboard system to perform analytics in a customer service process.

2.2.3 Pipedrive CRM

The Pipedrive CRM is a CRM system that utilizes cloud technology that is so unique such that it is developed by a sales team [18]. The system comes in various plans with different prices but without a free plan.

Deals Forecasting (Analytical Tool)

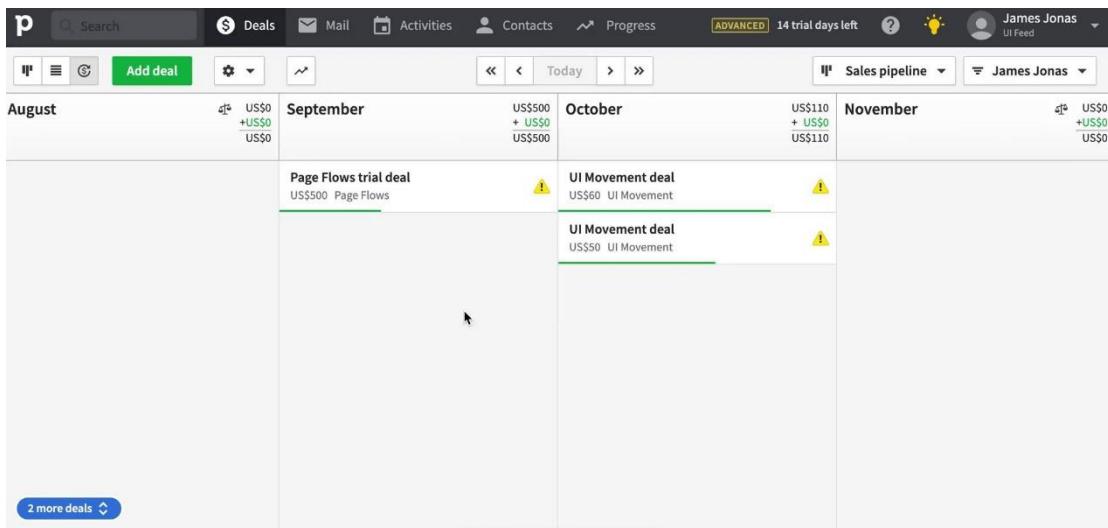
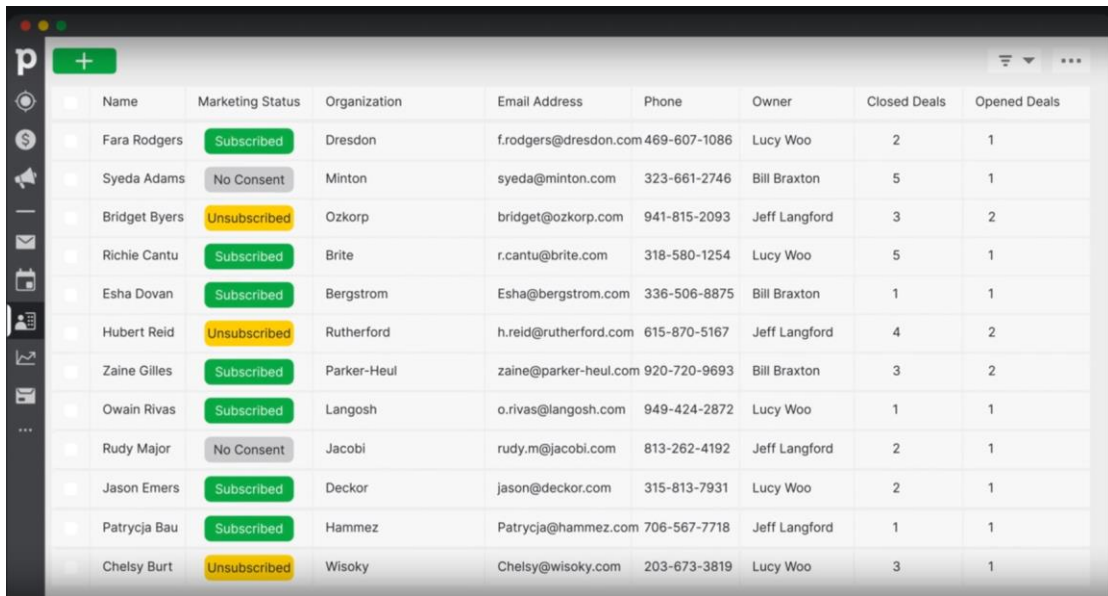


Figure 0-12. Deals Forecasting Page on Pipedrive CRM.

The Pipedrive CRM offers a functionality whereby the user can conduct forecasts based on previous deals. This is an analytical tool that is useful for companies to make predictions and improve sales and revenue whereby the targeted customers can be identified and reached which allows the company to thrive.

Email Marketing Tool



Name	Marketing Status	Organization	Email Address	Phone	Owner	Closed Deals	Opened Deals
Fara Rodgers	Subscribed	Dresdon	f.rodgers@dresdon.com	469-607-1086	Lucy Woo	2	1
Syeda Adams	No Consent	Minton	syeda@minton.com	323-661-2746	Bill Braxton	5	1
Bridget Byers	Unsubscribed	Ozkorp	bridget@ozkorp.com	941-815-2093	Jeff Langford	3	2
Richie Cantu	Subscribed	Brite	r.cantu@brite.com	318-580-1254	Lucy Woo	5	1
Esha Dovan	Subscribed	Bergstrom	Esha@bergstrom.com	336-506-8875	Bill Braxton	1	1
Hubert Reid	Unsubscribed	Rutherford	h.reid@rutherford.com	615-870-5167	Jeff Langford	4	2
Zaine Gilles	Subscribed	Parker-Heul	zaine@parker-heul.com	920-720-9693	Bill Braxton	3	2
Owain Rivas	Subscribed	Langosh	o.rivas@langosh.com	949-424-2872	Lucy Woo	1	1
Rudy Major	No Consent	Jacobi	rudy.m@jacobi.com	813-262-4192	Jeff Langford	2	1
Jason Emers	Subscribed	Deckor	jason@deckor.com	315-813-7931	Lucy Woo	2	1
Patrycja Bau	Subscribed	Hammez	Patrycja@hammez.com	706-567-7718	Jeff Langford	1	1
Chelsy Burt	Unsubscribed	Wisoky	Chelsy@wisoky.com	203-673-3819	Lucy Woo	3	1

Figure 0-15. Email Marketing Tool in Pipedrive CRM.

The Pipedrive CRM offers an emailing module within the system that helps the company to streamline its marketing processes. The emailing module offers functionalities that allow the company to conduct analytics, filter and customise the email layout. The system supports most types of email platforms which is convenient.

Dashboard Implementation

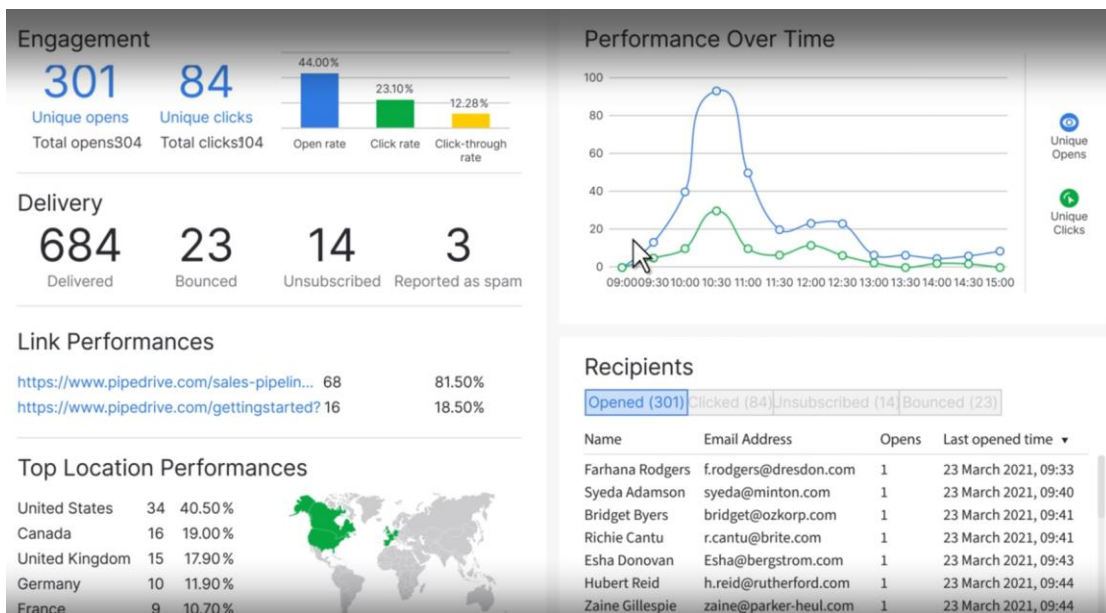


Figure 0-16. User Dashboard in Pipedrive CRM.

The built-in customizable user dashboard allows the user to perform analytics. This improves the efficiency of the sales process since critical decisions can be made by simply checking out the dashboard. The email marketing campaign mentioned also can be linked to this dashboard to observe the analytical results of the campaign such as audience engagement, delivery, clicks and so forth. This allows the sales team to identify their targeted prospects and conduct further actions strategically.

Conversational Tools in Pipedrive CRM

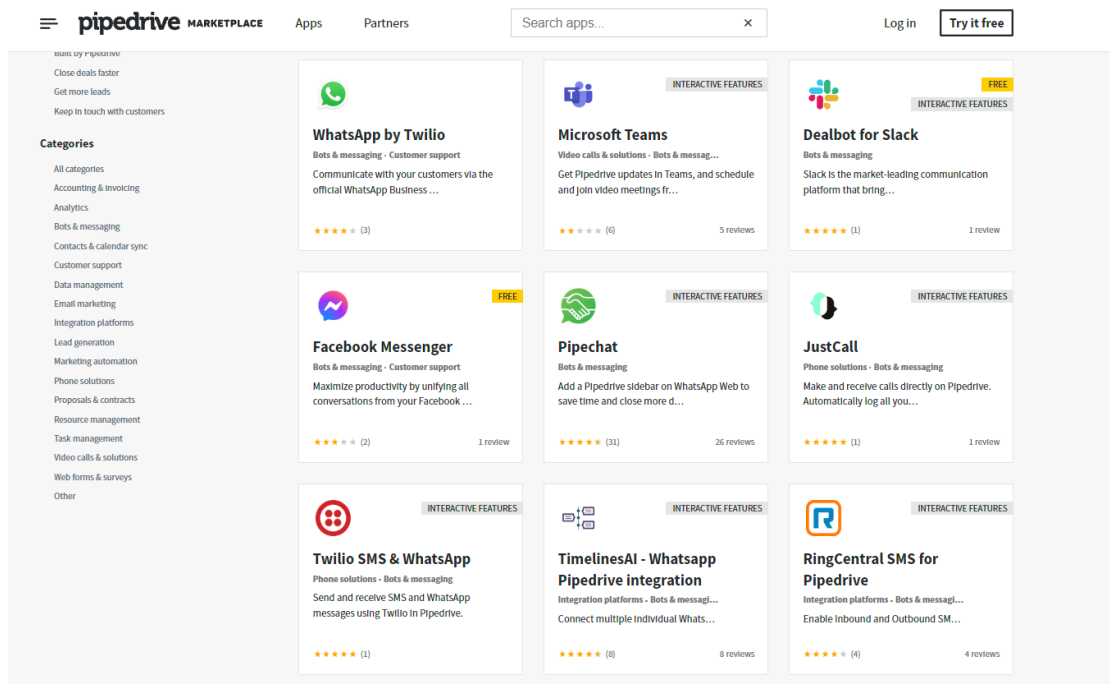


Figure 0-17. Screenshot of third-party applications and Plugins for Pipedrive CRM

The Pipedrive CRM allows the user to implement various types of chatbots and messaging tools from third-party applications. For instance, WhatsApp, Microsoft Teams and Facebook Messenger are some of the most widely used communication platforms in the world. The implementation of third-party resources allows the synchronizing of those chat data to be presented in the Pipedrive CRM which allows data centralizing. This is a powerful tool that most companies can utilize since most people in the world today have a smartphone with one of those applications installed on their phones.

2.3 Limitation of Previous Studies

In this subsection, the limitations of each reviewed system will be discussed. A table will be used to summarize the limitations of each of the reviewed systems.

Table 2.3.1 Limitations of the previously studied systems

Previous Studies	Limitations
HubSpot CRM system	<ul style="list-style-type: none">• Lack of AI-powered Chatbots• Not suitable for a large sales team
Zoho CRM system	<ul style="list-style-type: none">• User Interface design too bland• More complicated to use
Pipedrive CRM system	<ul style="list-style-type: none">• Lacks built-in ticket management system• No free plan available.

HubSpot CRM system

- Lack of AI-powered Chatbots.

In the technological advancement era, the utilization of AI in managing simple customer service processes can be crucial to the company's performance and efficiency. While HubSpot utilizes many functional features to allow better communication and response between the customer and agents, a lack of an AI-powered chatbot should be a nice addition to the system.

- Not suitable for a large sales team.

As the HubSpot CRM is designed to attract small to medium-sized organizations, its simpler features and less robust system design is not ideal for larger organizations.

Zoho CRM system

- User interface design is too bland

Although Zoho offers many functionalities, the user interface design is rather considered bland and unattractive. In the system, feature descriptions are not properly indicated and not concise enough. Besides, the system adopts mainly white colour in its design. This will reduce the user's interest to utilize its functionalities, thus wasting its professional features.

- More complicated to use

Unlike HubSpot CRM, the Zoho CRM system is designed to accommodate large enterprise organisations. To accommodate large enterprise organisations, the system requires more complex functionalities and customizability. Hence, this makes the Zoho CRM system a more complicated system for untrained users to grasp its functionalities in a short time, and more training are required to allow new users to learn it quickly.

Pipedrive CRM system

- Lacks built-in ticket management system

A CRM system focuses on the customer relationship between a company and its customers. However, the Pipedrive CRM does not have a built-in ticket management system. Although the CRM system allows customizing and implementation of third-party Apps to complete the ticket managing task, it is better to have a built-in ticket managing system since the implementation of third-party applications might cause some issues related to privacy and difficulty.

- No free plan available.

While there are many other CRM system providers available in the market, the Pipedrive CRM offers no free plan for users. A free plan is important in this era to attract new users.

2.4 Proposed Solutions

This project aims to propose a CRM system for customer service management that would increase the retention rate of the users and reduce churn rates by introducing several modules that are customer-centric in the system. For instance, modules such as ticket management systems for customer support cases, chatbot for instant communication, and a dashboard to visualize customer service processes will be implemented. The ticket management system will be implemented to manage the tickets properly and ensure that no customers support case is neglected or overlooked. The implementation of communication tools would include a live chat system via a Chatbot that utilizes Natural Language Processing (NLP), to ensure smooth communication between the customer and the agents, which would retain existing customers and reduce the churn rate. Then, a dashboard system will be implemented to visualize and conduct analytics over the customer service processes.

Besides, to tackle the problems of existing works in the reviewed systems, a simple user interface will be implemented, while maintaining crucial functionalities, depending on the extent and size of the system's usage. While the user interface shall remain simple, it has to be concise in design when it comes to function descriptions and so forth to prevent confusion.

Chapter 3 System Methodology/Approach

(Chapter 3 (SRS)- Use case diagram - explain use cases using use case description, Activity diagram)

3.1 Design Specifications

3.1.1 Methodology Applied

After a significant amount of research, the incremental development model was chosen for several reasons. Firstly, it allowed for the development process to be broken down into smaller, more manageable stages, with each stage building on the previous one. This approach was particularly useful as it allowed for changes to be made and tested at each stage [15], reducing the risk of major issues later on. This is especially applicable to the scenario of the development of this project, where there are multiple components within the system. Additionally, this model allowed for more flexibility in the development process, as changes could be made more easily and new requirements could be incorporated as the project progressed. Finally, the incremental model allowed for a more iterative approach to development, with constant feedback and adjustments made throughout the process. This ensured that the final product was better suited to the needs of the end-users, as their feedback was taken into account at every stage [15].

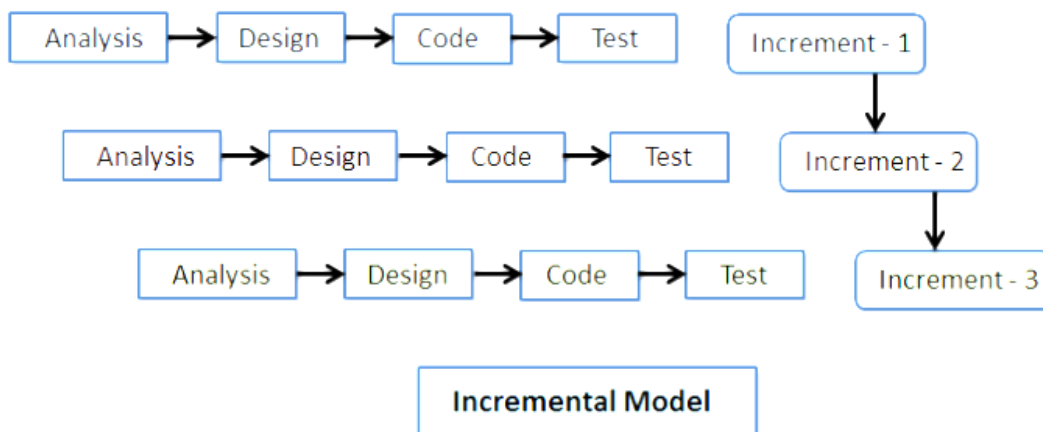


Figure 0-13 incremental Model system development methodology [15].

Analysis Phase

- Research will be conducted to study the existing CRM systems
- The requirement and specifications of the software are gathered.

Design Phase

- The module and its functions are designed according to the increment number.

Code Phase

- The coding for each module is done according to the increment number.

Test Phase

- The system will be tested accordingly.

3.2 Use Case Diagram

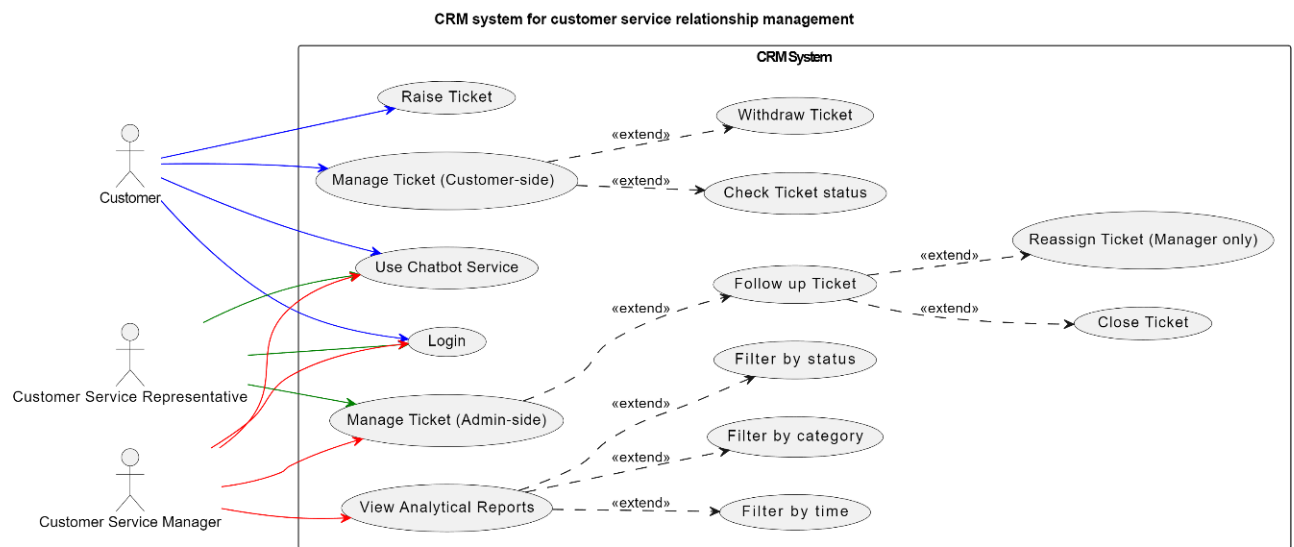


Figure 3-2-1 Use Case Diagram of the CRM System

3.3 Product Features

The table below lists the functions that will be implemented in the CRM System.

Feature ID	Feature	Description	Accessible Roles
F001	Login	Users log in to the system using their credentials	Customer, Customer Service Representative, Customer Service Representative, Customer Service Manager
F002	Raise Ticket	Customers can raise a ticket to report an issue or request assistance	Customer
F003	Manage Ticket (Customer-side)	The customer views all their tickets and performs actions such as withdrawing a ticket or checking the ticket status.	Customer
F004	Manage Ticket (Admin-side)	The customer service representative or manager views all tickets and performs actions such as following up, closing or reassigning a ticket (Manager only).	Customer Service Representative, Customer Service Manager
F005	View Analytical Reports	The customer service manager filters and views analytical reports based on time, category, and status.	Customer Service Manager
F006	Use Chatbot Service	The system users interact with the chatbot to perform actions such as raising a ticket or checking ticket status.	Customer, Customer Service Representative, Customer Service Representative, Customer Service Manager

Table 3-3-1 Table shows the CRM System Features List.

3.4 Use Case Description and Activity Diagram

3.4.1 [F001] Login

3.4.1.1 Use Case Description

Use Case ID	UC001	Version	1.0
Use Case Name	Login		
Purpose	This use case allows a user to access the CRM system by entering their login credentials.		
Actor	Customer, Customer Service Representative, or Customer Service Manager		
Trigger	User navigates to the login page and enters their login credentials.		
Precondition	The user has registered for an account and has a valid username and password.		
Relationships	N/A		
Scenario Name	Step	Action	
Main Flow	1	User navigates to the login page.	
	2	System presents the user with a login form.	
	3	User enters their username and password.	
	4	System verifies the user's credentials.	
	5	System validates the credentials.	
	6	System displays the main dashboard upon successful login.	
Sub Flow	N/A	N/A	

Alternative Flow – Display Login Error	3.1	User inputs invalid email and password.
	3.2	System validates the email and password.
	3.3	System displays error message.
	3.4	Back to Main Flow Step 2.
Rules	-	
Author	Lian Shunding	

Table 3-4-1 Use Case Description for UC001.

3.4.1.2 Activity Diagram

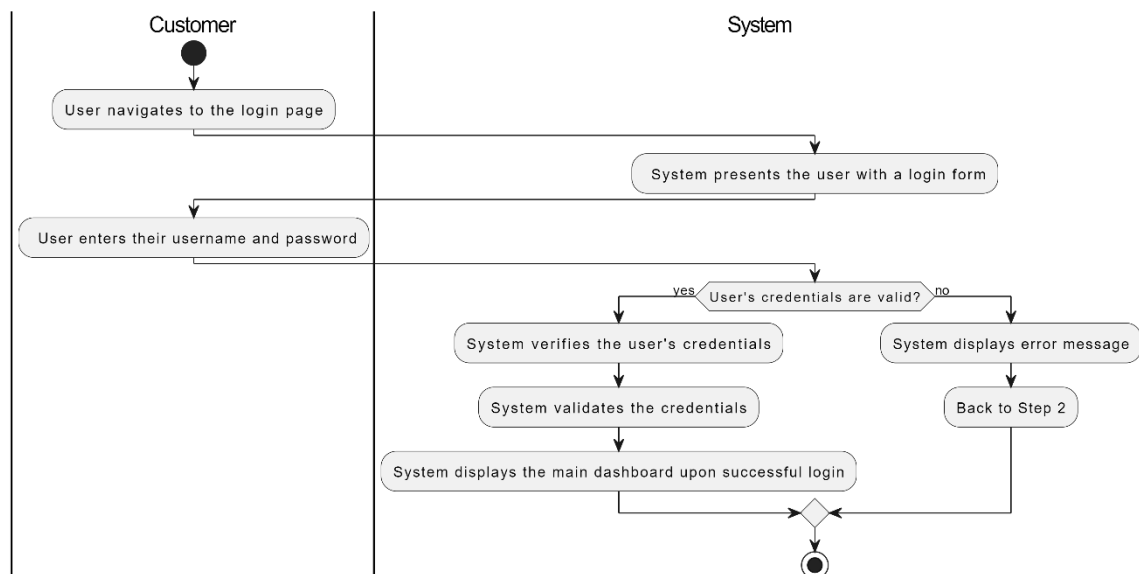


Figure 3-4-1 Activity Diagram of UC001

3.4.2 [F002] Raise Ticket

3.4.2.1 Use Case Description

Use Case ID	UC002	Version	1.0
Use Case Name	Raise Ticket		
Purpose	This use case allows a customer to raise a new ticket for a support issue.		
Actor	Customer		
Trigger	Customer wants to raise a new ticket for a support issue.		
Precondition	Customer is logged in to the system.		
Relationships	N/A		
Scenario Name	Step	Action	
Main Flow	1	The customer selects the "Raise Ticket" option from the menu.	
	2	The system displays the "Raise Ticket" screen.	
	3	The customer enters the required information such as category, description, and priority.	
	4	The customer submits the ticket.	
	5	The system validates the input and creates a new ticket with a unique ID.	
	6	The system sends an email notification to the person-in-charge of the ticket category.	
	7	The system displays a confirmation message to the customer.	
Sub Flow	N/A		

Alternative Flow – Required Information Missing	4.1	The customer does not fill in all the required information.
	3.2	The system displays an error message.
	3.3	The customer is prompted to fill in the missing information and resubmit the ticket.
Rules	-	
Author	Lian Shunding	

Table 3-4-2 Use Case Description for UC002.

3.4.2.2 Activity Diagram

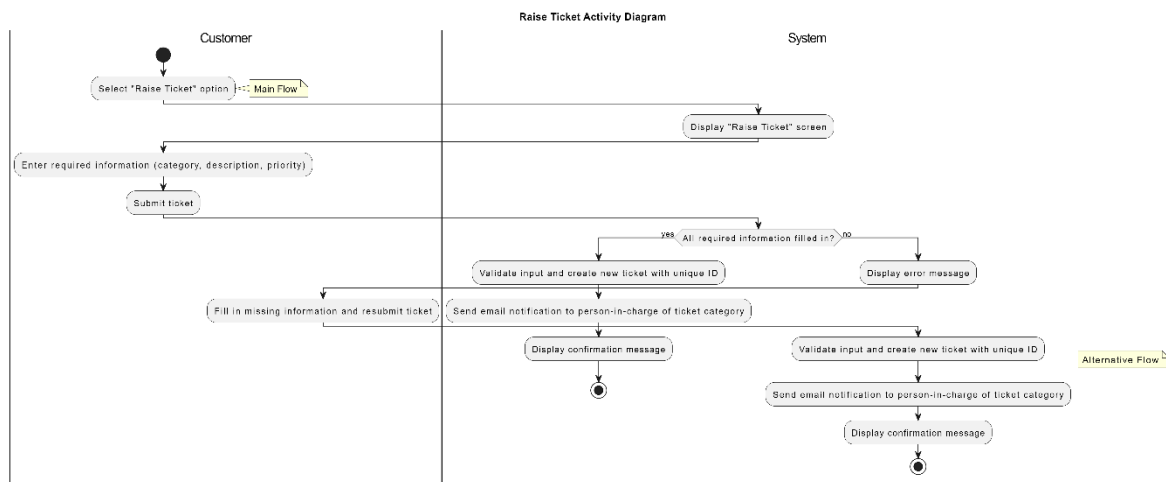


Figure 3-4-2 Activity Diagram of UC002

3.4.3 [F003] Manage Ticket (Customer-side)

3.4.3.1 Use Case Description

Use Case ID	UC003	Version	1.0
Use Case Name	Manage Ticket (Customer-side)		
Purpose	This use case allows the customer to manage their tickets. The customer can view all their tickets, check ticket status, withdraw tickets, and follow up on tickets.		
Actor	Customer.		
Trigger	The customer wants to manage their ticket(s).		
Precondition	The customer is logged in to the system.		
Relationships	Extend (1): Check Ticket Status Extend (2): Withdraw Ticket		
Scenario Name	Step	Action	
Main Flow	1	The Customer logs into the CRM system and selects the "Manage Ticket (Customer-side)" option.	
	2	The system displays a list of open tickets with options to check status and withdraw the ticket.	
	3	The customer selects a ticket to view the details.	
	4	The system displays the ticket details, including status, category, description, and updates.	
	5	The Customer selects an appropriate option.	
	6	The system saves the changes and updates the ticket status accordingly.	

Sub Flow- Check Ticket Status	5.1	The customer selects the "Check Ticket Status" option.
	5.2	The system allows them to add a follow-up comment.
Sub Flow- Withdraw Ticket	5.3	The customer selects the "Withdraw Ticket" option.
	5.4	The system prompts the customer for confirmation.
	5.5	The customer confirms the withdrawal.
	5.6	The system updates the ticket status to "Withdrawn."
Alternative Flow	5.4a	The customer cancels the withdrawal request.
	5.4b	The system returns to the ticket details screen.
Rules		-
Author		Lian Shunding

Table 3-4-3 Use Case Description for UC003.

3.4.3.2 Activity Diagram

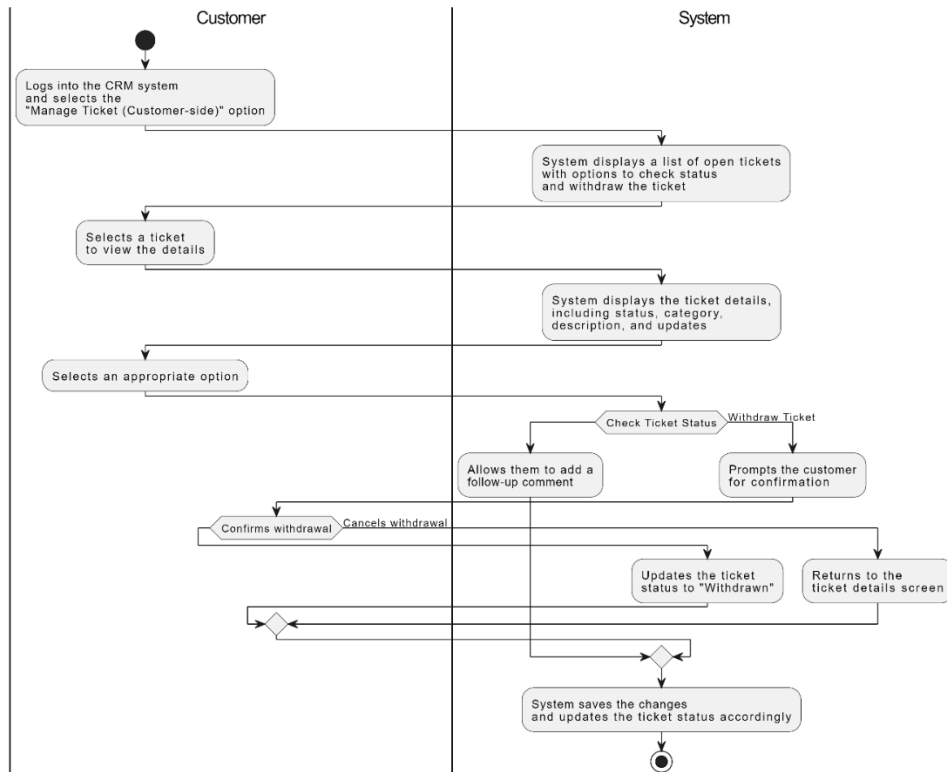


Figure 3-4-3 Activity Diagram of UC003

3.4.4 [F004] Manage Ticket (Admin-side)

3.4.4.1 Use Case Description

Use Case ID	UC004	Version	1.0
Use Case Name	Manage Ticket (Admin-side)		
Purpose	Allow a customer service representative or manager to manage tickets on the admin side, including follow up, closing, and reassigning.		
Actor	Customer Service Representative, or Customer Service Manager		
Trigger	The CSR or CSM logs into the CRM system and selects the "Manage Ticket (Admin-side)" option.		
Precondition	The CSR or CSM must have appropriate login credentials and authorization to access the admin-side ticket management features.		
Relationships	Extend (1): Follow Up Ticket Extend (2): Close Ticket Extend (3): Reassign Ticket		
Scenario Name	Step	Action	
Main Flow	1	The CSR or CSM logs into the CRM system and selects the "Manage Ticket (Admin-side)" option.	
	2	The system displays a list of open tickets with options to follow up, close, or reassign the ticket.	
	3	The CSR or CSM selects a ticket to manage.	
	4	The system displays the ticket details and options to follow up, close, or reassign the ticket.	
	5	The CSR or CSM selects the appropriate option.	
	6	The system saves the changes and updates the ticket status accordingly.	

Sub Flow- Selects Follow Up	5.1a	The CSR or CSM selects the "Follow up" option.
	5.1b	The system allows them to add a follow-up comment.
Sub Flow- Selects Reassign	5.2a	The CSM selects the "Reassign" option.
	5.2b	The system allows them to select a new person in charge of the ticket.
Sub Flow – Selects Close	5.3a	The CSR or CSM selects the "Close" option.
		The ticket status turns to "Closed".
Alternative Flow	N/A	
Rules		-
Author		Lian Shunding

Table 3-4-4 Use Case Description for UC004.

3.4.4.2 Activity Diagram

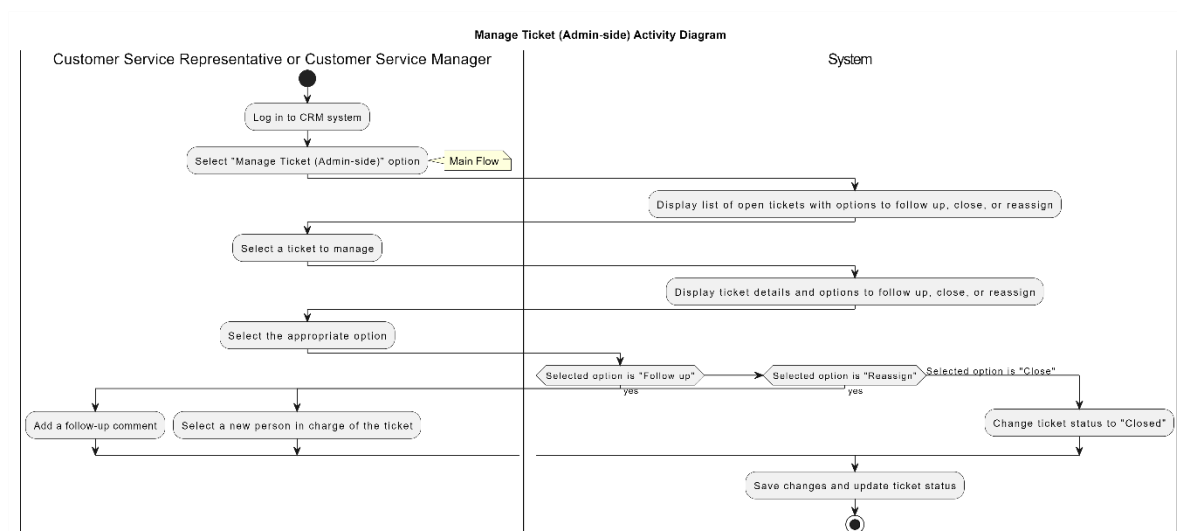


Figure 3-4-4 Activity Diagram of UC004

3.4.5 [F005] View Analytical Reports

3.4.5.1 Use Case Description

Use Case ID	UC005	Version	1.0
Use Case Name	View Analytical Reports		
Purpose	This use case allows the Customer Service Manager to view analytical reports.		
Actor	Customer Service Manager		
Trigger	The CSM wants to view analytical reports.		
Precondition	The CSM is logged in to the system.		
Relationships	Extend (1): Filter by Time Extend (2): Filter by Category Extend (3): Filter by Status		
Scenario Name	Step	Action	
Main Flow	1	The CSM clicks on Dashboard page.	
	2	The system generates reports on the Dashboard page.	
	3	The CSR or CSM selects the appropriate option.	
	4	The chart will refresh and regenerate analytical output according to user input.	
	5	The CSM views the report.	
Sub Flow – Filter By Time	3.1	The CSM selects filter by time	
Sub Flow – Filter By Category	3.2	If the CSM selects filter by category, the chart will refresh and regenerate analytical output according to user input.	

Sub Flow – Filter By Status	3.3	If the CSM selects filter by status, the chart will refresh and regenerate analytical output according to user input.
Alternative Flow – Data Not Found	3.1	The Chart will refresh and show NO DATA AVAILABLE.
Rules		-
Author		Lian Shunding

Table 3-4-5 Use Case Description for UC005.

3.4.5.2 Activity Diagram

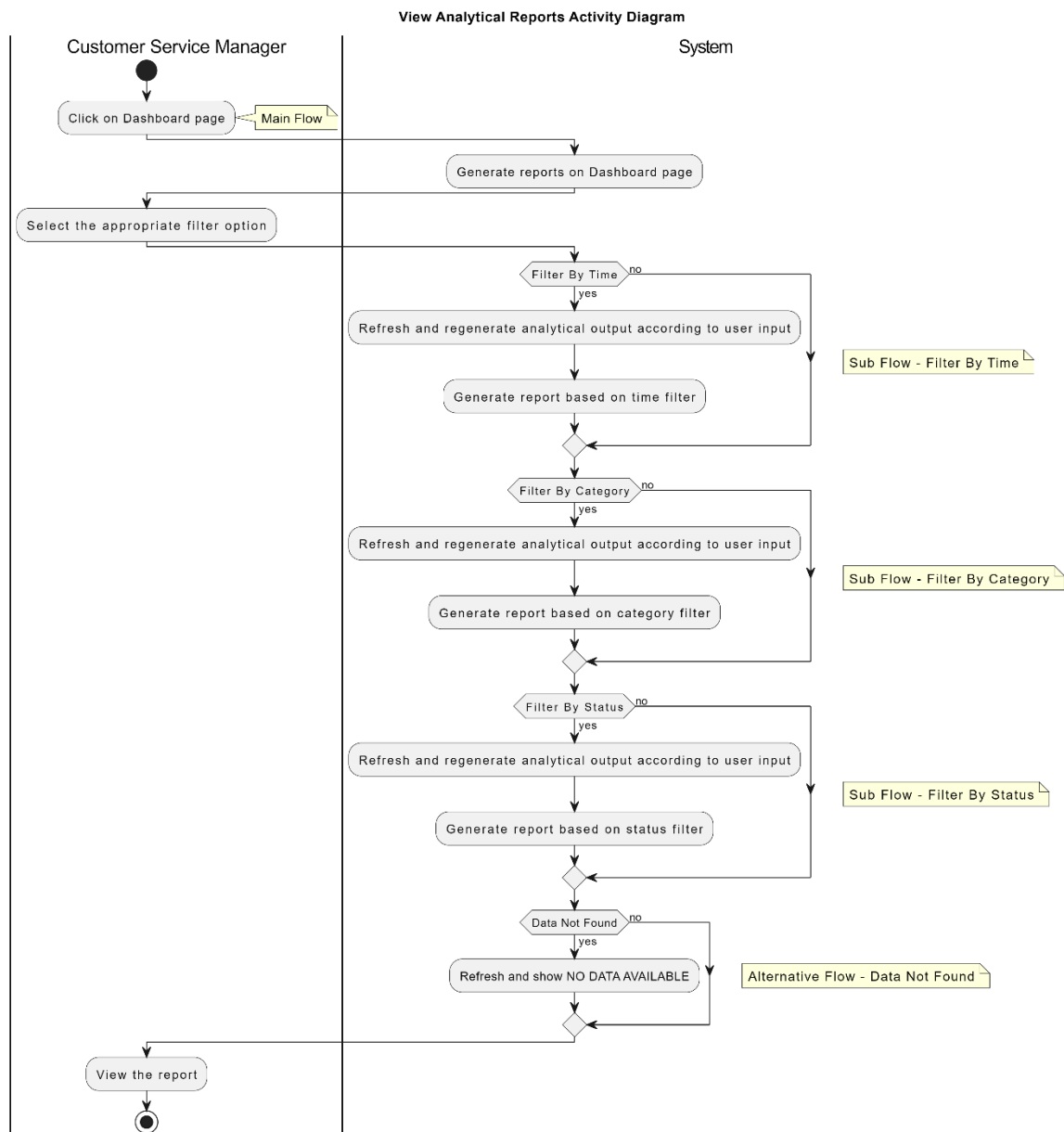


Figure 3-4-5 Activity Diagram of UC005

3.4.6 [F006] Use Chatbot Service

3.4.6.1 Use Case Description

Use Case ID	UC006	Version	1.0
Use Case Name	Use Chatbot Service		
Purpose	Allow customers, CSR, and CSM to interact with a chatbot for assistance with common issues or questions.		
Actor	Customer, Customer Service Representative, or Customer Service Manager		
Trigger	The user selects the "Use Chatbot Service" option in the CRM system.		
Precondition	The user must have access to the CRM system and a compatible device to interact with the chatbot.		
Relationships	N/A		
Scenario Name	Step	Action	
Main Flow	1	The user selects the "FAQs" option in the CRM system.	
	2	The system displays the FAQs and chatbot interface and prompts the user to ask a question or describe the issue.	
	3	The user types in the question or issue.	
	4	The chatbot provides a response or asks for more information.	
	5	The user continues to interact with the chatbot until their issue is resolved or they choose to end the chat session.	
Sub Flow	N/A		
Alternative Flow – Chatbot do not possess the knowledge	3.1	User enters question that is out of the scope of the Chatbot's knowledge.	

	3.2	Chatbot Prompts Error Message.
Rules	-	
Author	Lian Shunding	

Table 3-4-6 Use Case Description for UC006.

3.4.6.2 Activity Diagram

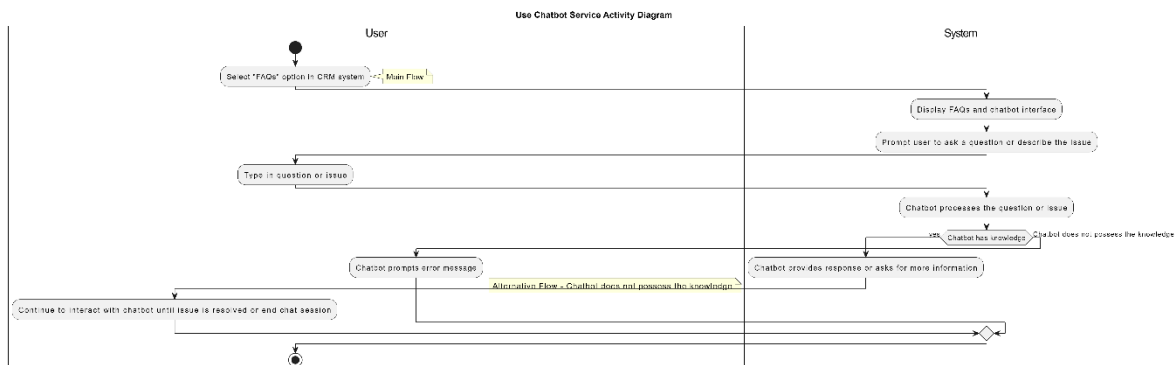


Figure 3-4-6 Activity Diagram of UC006

CHAPTER 4 SYSTEM DESIGN

4.1 System Architecture Diagram

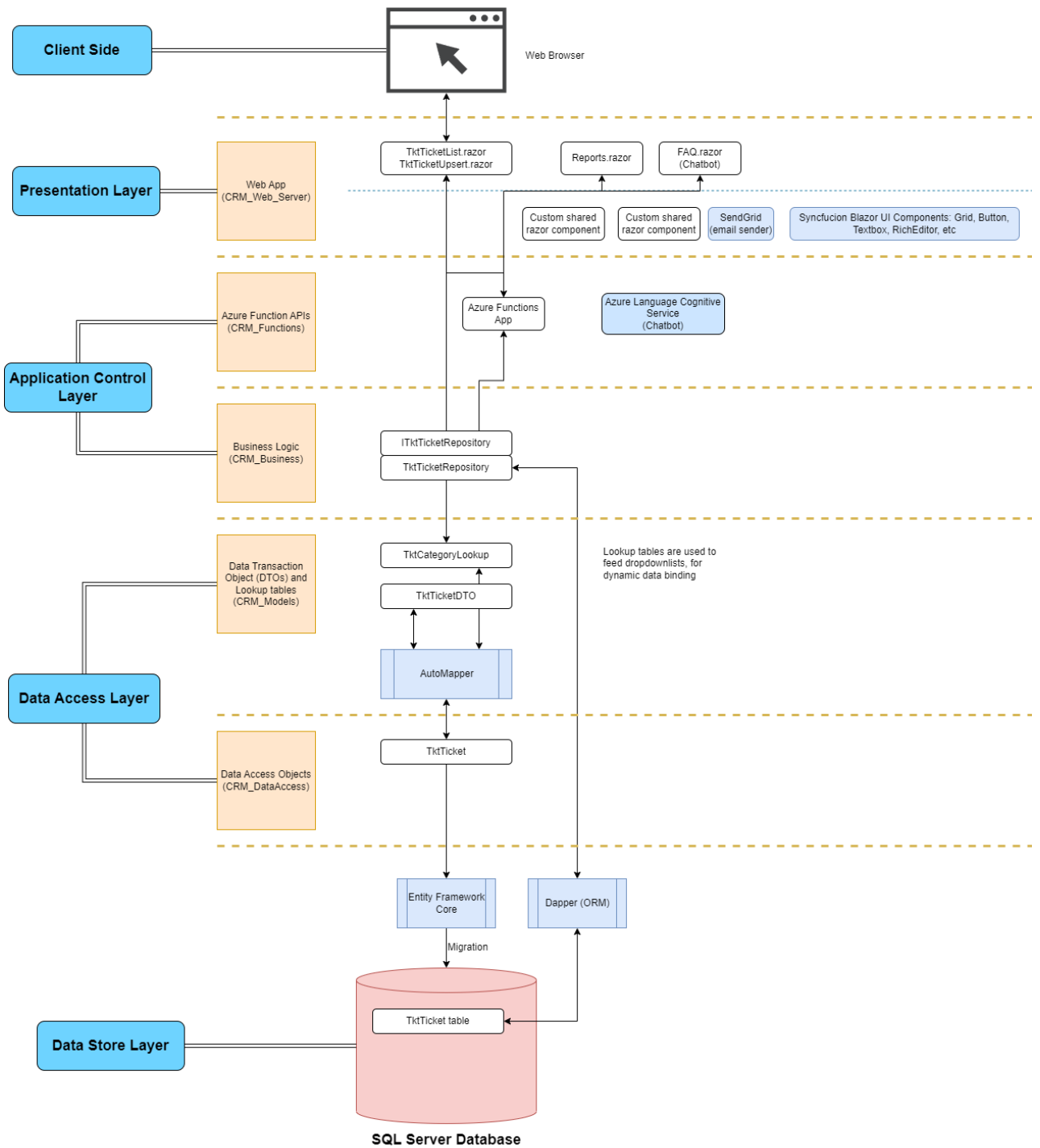


Figure 4-1-1 shows the System Architecture Design of the CRM system developed.

The System Architecture of the developed CRM system consists of five different layers, each serving a unique purpose and function within the CRM system.

The first layer, the Client Side, is responsible for presenting the user interface of the system, including the display of data and the receipt of user input. For example, `TktTicketList.razor` is a component of the Presentation Layer.

The second layer, the Presentation Layer, contains the front-end components of the system, including web pages, views, and UI components. This layer facilitates the representation of data to the user and handles user interaction with the system. It contains Syncfusion components and razor pages such as `TktTicketList.razor` which is responsible for displaying all the Ticket records and functionalities, and `TktTicketUpsert.razor` which is responsible for capturing input data when a ticket is raised.

The third layer, the Application Control Layer, houses the Business Logic of the CRM system, as well as the Function APIs. Business Logic is responsible for executing the essential operations of the CRM system, such as the processing of data and the execution of business rules. For example, interfaces and repositories are part of the Business Logic Layer. For instance, the business logics of how the data are processed are defined in `TktTicketRepository.cs`, and `ITktTicketRepository.cs` serves as the interface between the Control Layer and Presentation Layer to promote abstraction of the code. The Function APIs are used to facilitate communication between the Presentation Layer and the Data Access Layer. An example of a Function API used in the CRM system is the Azure Language Cognitive Service, which feeds the input to the Chatbot in `FAQ.razor`.

The fourth layer, the Data Access Layer, is responsible for managing data access and storage in the CRM system. This layer comprises data transaction objects and lookup tables, which are used to manage data transactions and optimize data access. Additionally, this layer includes data access objects or models, which are used to interact with the SQL Server Database. For example, `TktCategoryLookup.cs` and `TktTicketDTO.cs` are part of the Data Access Layer. The `Lookup.cs` files in the system are utilized to ensure dynamic data binding is implemented. `AutoMapper` is utilized to communicate between the Data Access Layer and the Business Logic Layer.

The fifth and final layer, the Data Store Layer, is responsible for managing the storage of data in the CRM system. This layer uses entity framework core and `dapper` to communicate between the Data

Access Layer and the SQL Server Database. The Data Store Layer plays a crucial role in maintaining data integrity, security, and ensuring efficient access to stored data.

In summary, the System Architecture Diagram comprises several distinct layers, each serving a vital function in the CRM system's operation. These layers work in tandem to ensure the system operates efficiently and securely, providing users with an intuitive and effective platform for managing customer relationships. Examples of components and tools used in each layer are provided to illustrate their functions within the system.

4.2 Data Design

4.2.1 ERD Diagram

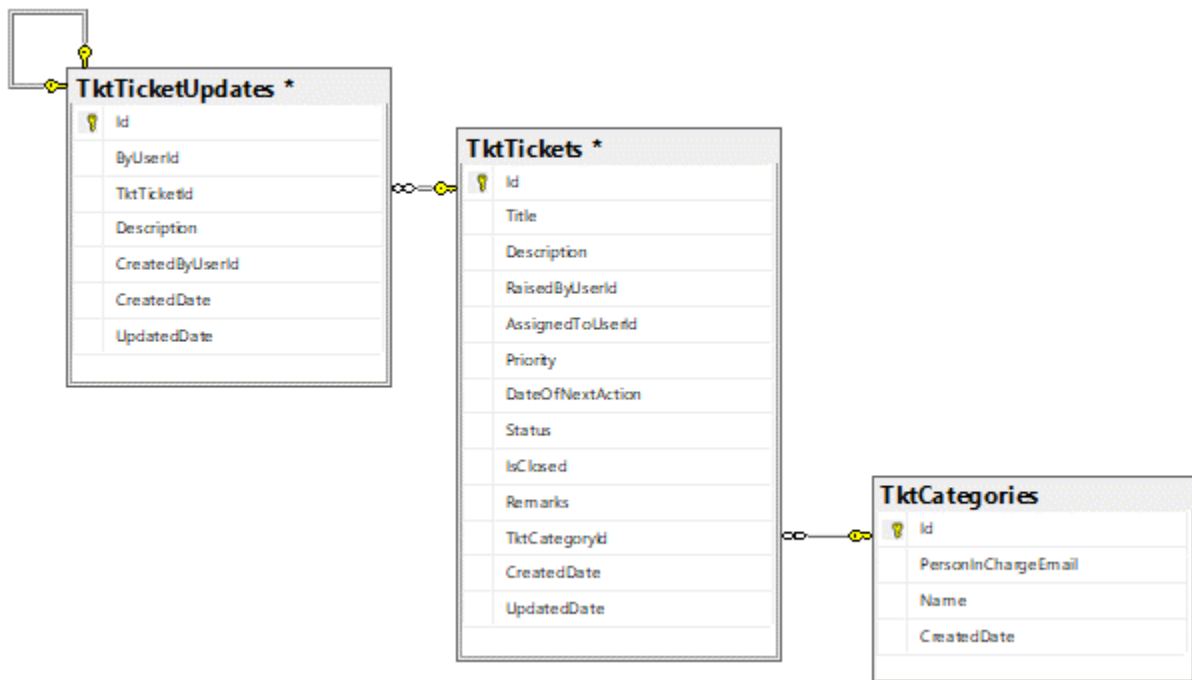


Figure 4-2-1 ERD Diagram of Ticketing Management Module

The ERD (Entity-Relationship Diagram) above depicts a system for tracking support requests through the use of tickets. The TktTickets table serves as the main entity in the system, representing each ticket with a unique identifier and containing data about its associated category, current status, priority level, and assigned user. The TktCategories table provides a way to group similar tickets together and assign a person in charge to each category. Finally, the TktTicketUpdates table tracks changes to each ticket, including comments, status updates, and modification history. Together, these three tables create a comprehensive system for managing support requests and providing efficient support to users.

4.2.2 Data Dictionary

In the Ticketing Management Module, three entities are defined to contain the details needed. They are TktTickets, TktCategories, and TktTicketUpdates. These three tables work together to provide a comprehensive ticketing system that allows users to create and track their support requests, while also providing support staff with the tools they need to efficiently manage and resolve those requests. The TktTickets table serves as the main repository for all ticket-related data, while the TktCategories table provides a way to organize and group tickets by type. The TktTicketUpdates table helps to track the progress of each ticket and provides a detailed history of all follow ups made to it.

4.2.2.1 TktTickets

This table contains the data of tickets, including their unique identifiers, titles, descriptions, priority levels, current status, and associated categories. The table also tracks the users who raised and are assigned to work on each ticket, as well as any scheduled next actions and whether the ticket has been closed or not.

Field Name	Keys	Data Type	Nullable	Description
Id	PK	int(10)	NOT NULL	A unique identifier for each ticket.
Title		nvarchar(-1)	NOT NULL	The title of the ticket.
Description		nvarchar(-1)	NULL	A description of the issue or problem associated with the ticket.
RaisedByUserId		uniqueidentifier(16)	NULL	The user who raised the ticket.
AssignedToUserId		uniqueidentifier(16)	NULL	The user who is assigned to work on the ticket.
Priority		int(10)	NULL	The priority level of the ticket.
DateOfNextAction		datetime2(7)	NULL	The date when the next action on the ticket is scheduled to occur.

Status		nvarchar(450)	NULL	The current status of the ticket.
IsClosed		bool	NOT NULL	A flag that indicates whether the ticket has been closed.
Remarks		nvarchar(-1)	NULL	Additional comments associated with the ticket.
TktCategoryId	FK	int(10)	NOT NULL	The category or type of ticket.
CreatedDate		datetime2(7)	NULL	The date when the ticket was created.
UpdatedDate		datetime2(7)	NULL	The date when the ticket was last updated.

Table 4-2-1 Data Dictionary for TktTickets

4.2.2.2 TktCategories

This table stores the different categories or types of tickets that can be created in the system. Each category is identified by a unique identifier and a name, and is associated with a person in charge of that category. The table also tracks when each category was created.

Field Name	Keys	Data Type	Nullable	Description
Id	PK	int(10)	NOT NULL	A unique identifier for each ticket category.
PersonInChargeEmail		uniqueidentifier(16)	NULL	The email address of the person in charge of the category. For EmailSender API to notify admin.
Name		nvarchar(-1)	NOT NULL	The name of the category.
CreatedDate		datetime2(7)	NOT NULL	The date when the category was created.

Table 4-2-2 Data Dictionary for TktCategories

4.2.2.3 TktTicketUpdates

This table tracks the updates made to each ticket, including any comments or changes in status. Each update is identified by a unique identifier and associated with the ticket it refers to. The table also tracks the user who created each update, when it was created, and when it was last updated.

Field Name	Keys	Data Type	Nullable	Description
Id	PK	int(10)	NOT NULL	A unique identifier for each ticket update.
ByUserId		uniqueidentifier(16)	NULL	The unique identifier of the user who created the update.
TktTicketId	FK	int(10)	NULL	The foreign key reference to the ticket associated with the update.
Description		nvarchar(-1)	NULL	A description of the update, such as a comment or status change.
CreatedByUserId		uniqueidentifier(16)	NULL	The unique identifier of the user who created the update record.
CreatedDate		datetime2(7)	NULL	The date when the update record was created.
UpdatedDate		datetime2(7)	NULL	The date when the update record was last updated.

Table 4-2-3 Data Dictionary for TktTicketUpdates

4.3 Component Diagrams

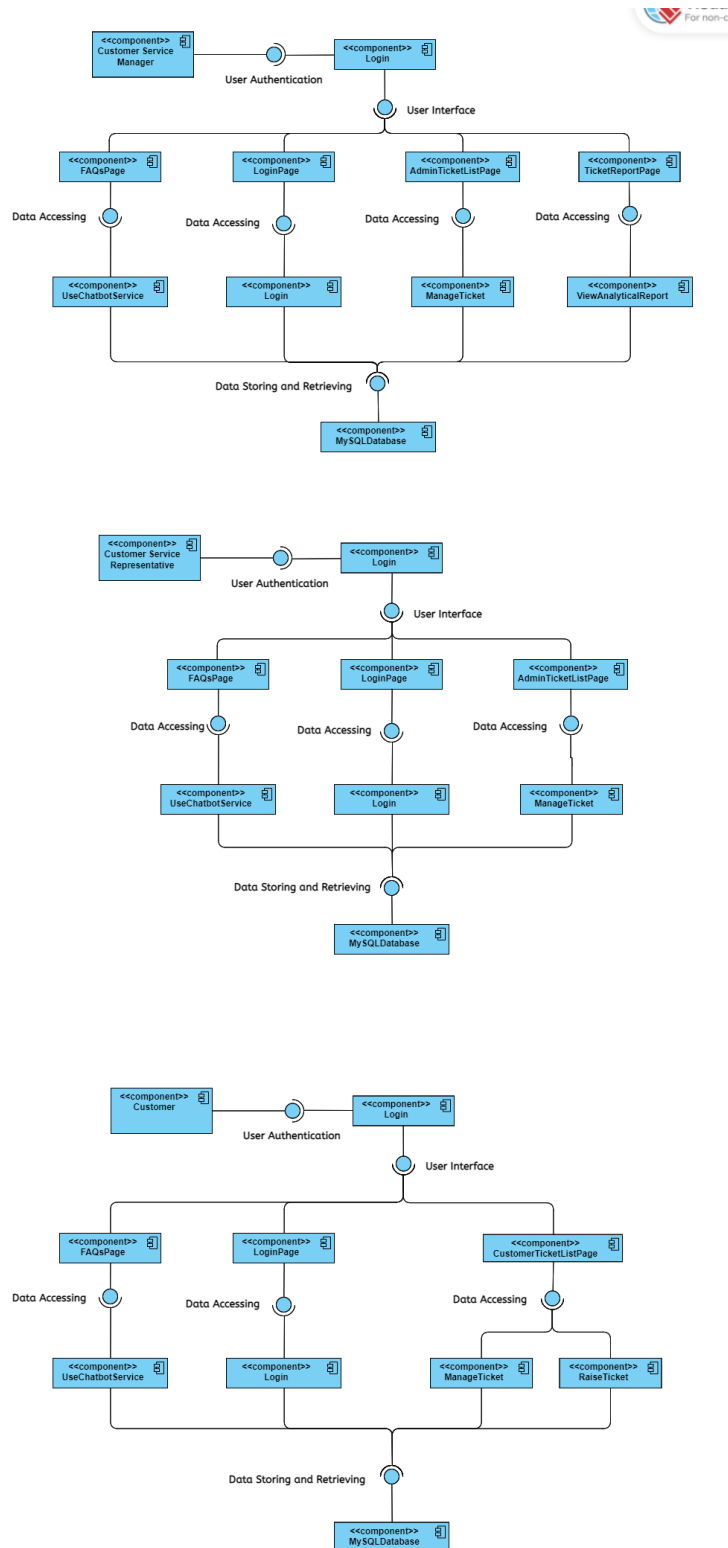


Figure 4-3-1 shows system component diagrams

4.4 User Interface Design

4.4.1 Wireframe of Dashboard containing Analytical Reports.



Figure 4-4-1 Wireframe of Dashboard containing Analytical Reports.

The Ticket Reports Page wireframe is a visual representation of the reporting features available to Customer Service Managers (CSMs). The page provides a graphical view of various metrics related to the tickets, such as the number of open and closed tickets, ticket status, and ticket categories. Additionally, the wireframe includes filters that allow CSMs to drill down into the data and generate custom reports.

4.4.2 Wireframe of Manage Ticket (Admin-side).

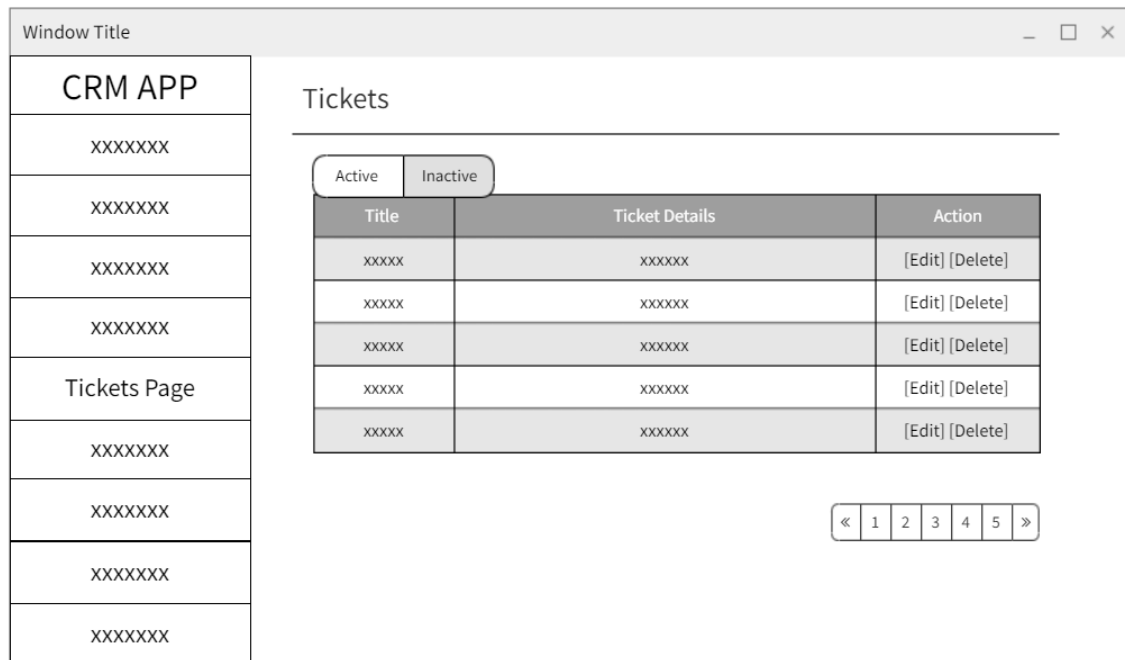


Figure 4-4-2 Wireframe of Manage Ticket (Admin-side).

The Manage Ticket (Admin-side) wireframe is a page accessible by Customer Service Representatives (CSR) or Managers, allowing them to manage open tickets, including following up, closing, or reassigning the tickets. The page displays a list of open tickets with options to perform the necessary actions, and the CSR or CSM can select a ticket to manage and make the appropriate changes. The page provides an efficient way for the CSR or CSM to manage tickets and ensure timely resolution of customer issues.

4.4.3 Wireframe for Raise Ticket

The wireframe shows a window titled "Window Title" with a header "CRM APP" and a sub-header "Ticket's Create". The form is divided into two columns. The left column contains a vertical list of ten placeholder boxes, each labeled "xxxxxxx". The right column contains the following fields: "Ticket Title:" with a text input box; "Category:" with a text input box; "Description:" with a larger text area; "Created By:" with a text input box; "Date:" with a text input box; "Status:" with a text input box; and "Upload File:" with a "Choose File" button.

Figure 4-4-3 Wireframe for Raise Ticket.

The "Raise Ticket" wireframe allows customers to submit a new support ticket by filling out a form with required information such as category, description, and priority. After submitting the ticket, the system will validate the input and create a new ticket with a unique ID. A confirmation message will be displayed to the customer.

4.4.4 Wireframe for Chatbot Interface within FAQs

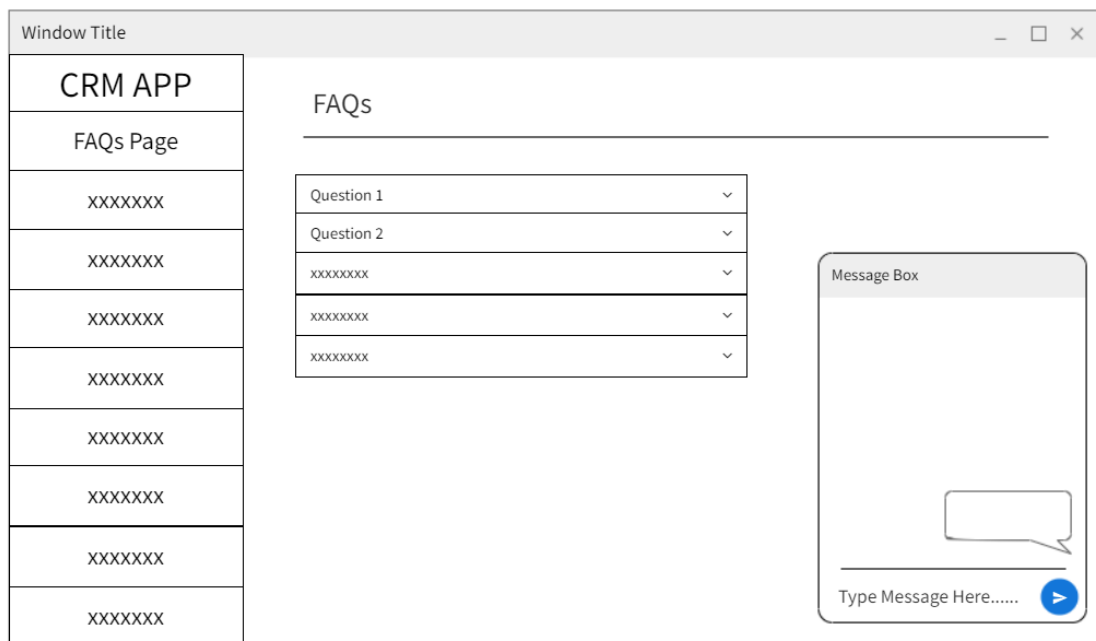


Figure 4-4-4 Wireframe for FAQs page with Chatbot.

The chatbot interface is a feature available in the FAQ page. Customers, Customer Service Representatives, and Customer Service Managers can interact with the chatbot to ask questions or describe issues. The chatbot processes the input and provides responses or prompts for more information if needed.

CHAPTER 5 System Implementation

5.1 Hardware Setup

The system hardware will include an HP Omen 15 2018 laptop to develop the CRM system.


Hardware	Specification
<p data-bbox="204 546 486 573">HP Omen 15 2018 Laptop</p>  <p data-bbox="284 1050 719 1077"><i>Figure 5-1-1. HP Omen 15 2018 Laptop</i></p>	<ul data-bbox="874 546 1361 949" style="list-style-type: none">• Graphics processor: NVIDIA GEFORCE GTX 1050• Processor: Intel Core i7 8750H (8th Gen)• Operating system: Windows 11 Home Basic• Operating System Type: 64-bit• RAM type: DDR4• RAM speed: 2133MHz• Memory Capacity: 16GB

Table 5-1-1 System Hardware

5.2 Software Setup

Various types of system software are applied in the development of this system, which includes various programming languages, development tools and frameworks.

5.2.1 Programming Languages

1. HyperText Markup Language (HTML)

HTML, or HyperText Markup Language, is the standard markup language for texts that are intended to be viewed on a web browser, and markup language comprises a set of markup tags.

2. Cascading style sheets (CSS)

CSS is the language used to stylize an HTML document as it describes how the HTML elements should be displayed. For instance, HTML elements like background colour, padding size and button size are defined through CSS.

3. C-Sharp (C#)

C# is a popular general-purpose programming language. It includes using static and strong typing and it is object-oriented. It is mainly used to define functions in classes within the project.

4. Structured Query Language (SQL)

SQL is a standardized programming language for managing relational databases and conducting numerous operations on the data contained within them. For instance, it is used to perform CRUD operations; search, add, delete and update the data in the database.

5. Relational Database Management System (RDMBS)

RDBMS is a database management system (DBMS) that stores data in a row-based table structure that connects related data components. The security, accuracy, integrity, and

consistency of the data are all maintained by RDBMS functions. This is not the same as a DBMS's file storage.

5.2.2 Development Tools

1. Visual Studio Code

The coding platform that is used for this project. It contains libraries and frameworks such as Blazor, ASP .Net Core and many more. It is developed by Microsoft.

2. Microsoft SQL Server Management Studio (SSMS)

The integrated environment for handling any SQL tools. It is mainly used to monitor the CRUD operations within the SQL script in the backend of a project.

5.2.3 Frameworks & Development Platform

1. Blazor Server

The framework used in this project. It allows developers to code web apps using only C# and HTML, which removes the need for JavaScript. It is also a hosting model.

2. Active Server Pages. Network Enabled Technology (ASP.Net Core)

The successor to ASP .Net, which is also developed by Microsoft. It is a framework that is widely used for web development. It is supported in various Operating Systems.

3. Entity Framework (EF Core)

The Entity Framework is an integral part of the .NET framework. It is used to map SQL operations from C# to the SQL Script.

4. Dapper

Dapper is an object-relational mapping (ORM) tool designed for the .NET platform. It allows developers to efficiently map database objects to their corresponding classes, reducing the amount of boilerplate code needed for data access. Additionally, it includes features such as

support for asynchronous queries and automatic parameterization of SQL queries, making it a popular choice for high-performance database access in .NET applications.

5. .NET core identity framework

The .NET Core Identity framework provides authentication and authorization capabilities for web applications, allowing users to securely login and access protected resources. It includes features such as user and role management, password hashing and storage, and support for external identity providers.

5.2.4 Libraries

1. AutoMapper

AutoMapper is an object mapping library for .NET applications that helps to eliminate tedious and repetitive code by automatically mapping properties between objects. It allows for faster and more efficient development and helps to reduce the risk of errors caused by manual mapping.

2. Syncfusion Components

Syncfusion is a set of UI components and tools for building web and mobile applications. It offers a wide range of features including data visualization, data manipulation, file format conversion, and more, with a focus on performance and ease of use. It is mainly utilized for the front-end or presentation layer.

5.2.5 APIs/ Services

1. SendGrid

SendGrid is a cloud-based email delivery platform that provides reliable email delivery, scalability, and real-time analytics. It allows businesses to send transactional and marketing emails, and track the results with detailed email reporting and analytics. SendGrid is commonly used for sending email newsletters, promotional campaigns, password reset emails, and other types of automated emails.

2. Azure Cognitive Services

Azure Cognitive Services is a cloud-based suite of powerful APIs and services that enables developers to build intelligent applications. It includes vision, language, speech, and search services that can be easily integrated into various applications for enhanced functionality. It is widely used in machine learning, natural language processing, and computer vision applications.

5.3 Settings and Configurations

In this part of the report, the setup and configurations made to build the system is explained.

5.3.1 Microsoft Visual Studio 2022

1. Create a new Blazor Server project

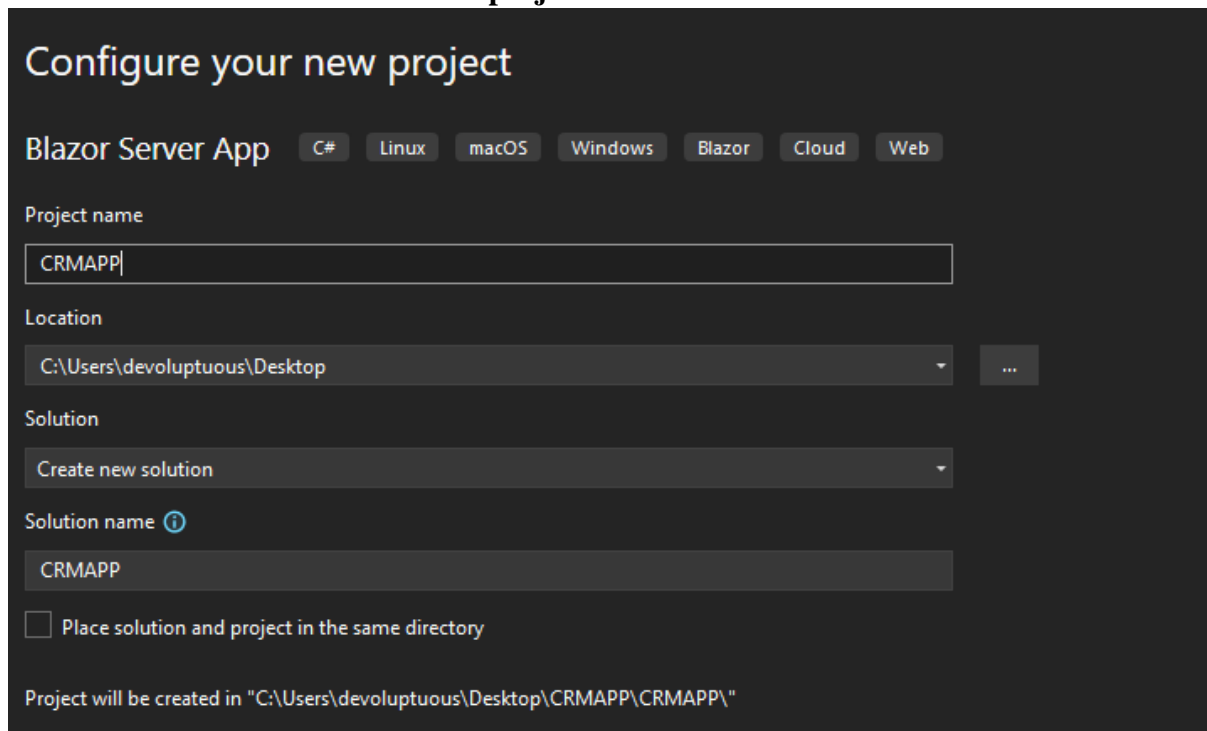


Figure 5-3-1 Create New Project

2. Based on the System Architecture Design, Define the Project Folders.

The defined projects include:

- **CRM_Data_Access**

In this project folder, the data access objects are declared. This includes the dependency packages such as NuGet Packages and Frameworks responsible for database manipulation are stored in here. The class models are also defined and stored in here,

which will be responsible for defining the database structure through Entity Framework Core. The migration file logs created by Entity Framework Core are also stored in here.

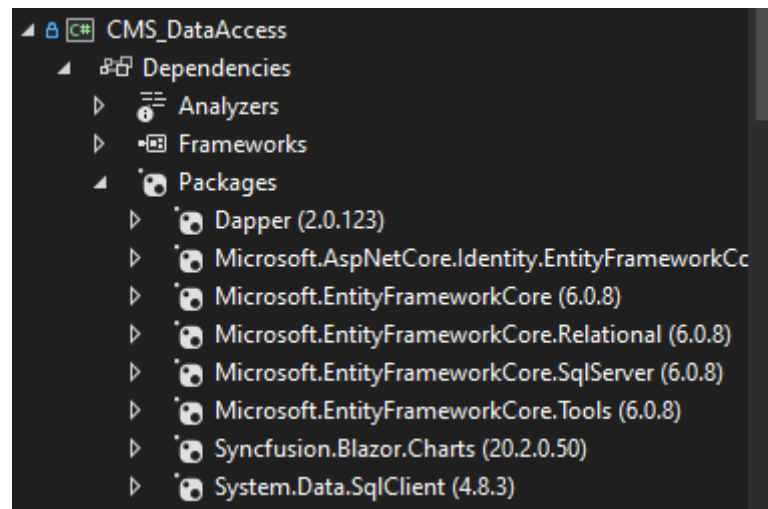


Figure 5-3-2 showing the dependency packages stored.

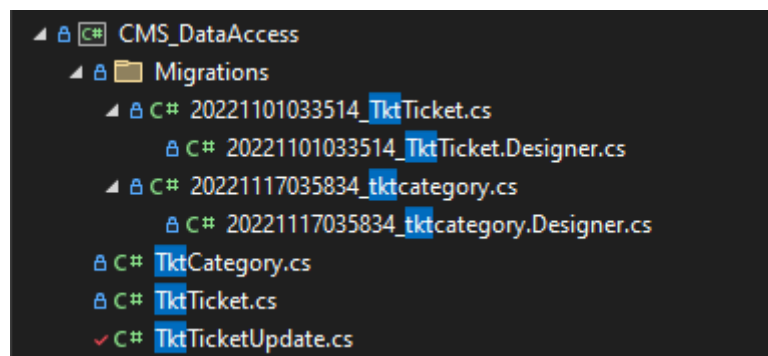


Figure 5-3-3 shows the base models of the Class models.

- **CRM_Models**

This project folder is responsible for containing Data Transfer Objects (DTOs) and Lookup Tables. Since the data bindings in the most part of the system are done dynamically, Lookup tables are needed to pass Data through the use of key constraints, such as Primary Key (PK) and Foreign Key (FK). The DTOs are responsible for accessing the data from the data store layer, where the control (business logic and function APIs) will access using the DTOs instead of directly accessing the base models in Data Access layer. This promotes security preventing direct access of the base model classes, thus minimizing the risk of data breaches. This can

help protect both the system and its users from potential security threats. The code content is the similar to the base model class.

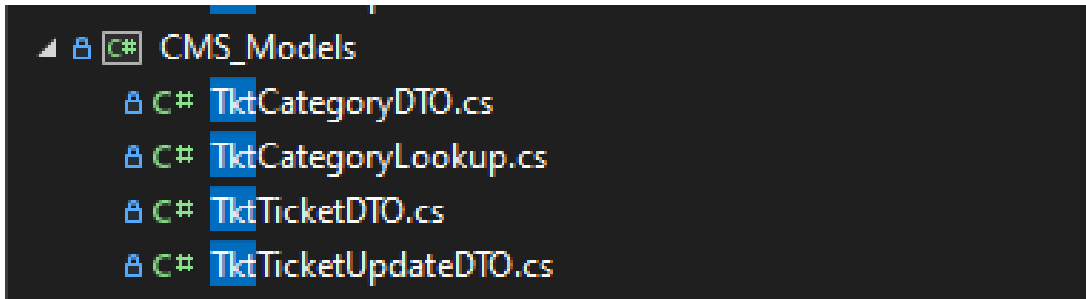


Figure 5-3-4 The DTOs and Lookup class files stored in Models project folder.

```
1 using CMS_DataAccess;
2 using System;
3 using System.Collections.Generic;
4 using System.ComponentModel.DataAnnotations.Schema;
5 using System.ComponentModel.DataAnnotations;
6 using System.Linq;
7 using System.Text;
8 using System.Threading.Tasks;
9 using Microsoft.EntityFrameworkCore;
10
11 namespace CMS_Models
12 {
13     public class TktTicketDTO
14     {
15         [Key]
16         public int Id { get; set; }
17
18         [Required(ErrorMessage = "Title cannot be empty!")]
19         [MinLength(5, ErrorMessage = "Please enter at least 5 characters.*")]
20         [MaxLength(100, ErrorMessage = "Maximum 100 characters only")]
21         public string Title { get; set; }
22
23         [Required(ErrorMessage = "Description cannot be empty!")]
24         [MinLength(10, ErrorMessage = "Please enter at least 10 characters.*")]
25         [MaxLength(2000, ErrorMessage = "Maximum 2000 characters only")]
26         public string? Description { get; set; }
27
28         public Guid? RaisedByUserId { get; set; }
29         public Guid? AssignedToUserId { get; set; }
30
31         public int? Priority { get; set; } = 2;
32
33         public DateTime? DateOfNextAction { get; set; } // for reminder/notification
34         public string? Status { get; set; } = "Open"; // status text, eg., "Pending approval..."
35         public bool IsClosed { get; set; } = false;
36
37         [MinLength(10, ErrorMessage = "Please enter at least 10 characters.*")]
38         [MaxLength(200, ErrorMessage = "Maximum 200 characters only")]
39         public string? Remarks { get; set; } = string.Empty; //used for stating reason on withdraw
40         // cannot set [Req] since only some tickets will be withdrawn
41
42         [Required]
43         public int TktCategoryId { get; set; }
44         [ForeignKey("TktCategoryId")]
45         public TktCategory TktCategory { get; set; }
46
47         public DateTime? CreatedDate { get; set; }
48         public DateTime? UpdatedDate { get; set; }
49     }
}
```

Figure 5-3-5 Example of code structure in TktTicketDTO.cs file.

- **CRM_Business**

The business project folder in the CRM system contains important files that handle the business logic of the application, including the repository which defines the CRUD (Create, Read, Update, Delete) operations and the IRepository interface which serves as a contract for the repository to adhere to. This allows for separation of concerns and promotes modularity in the application, making it easier to maintain and modify in the future. The NuGet Packages and API functions responsible for Business logics are also stored here.

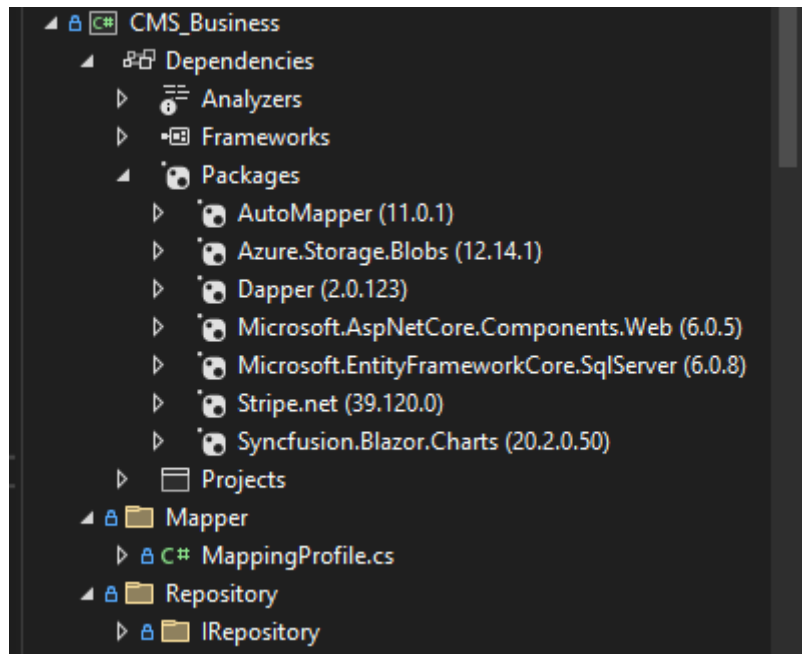


Figure 5-3-6 Folders and Packages stored in this Business project folder.

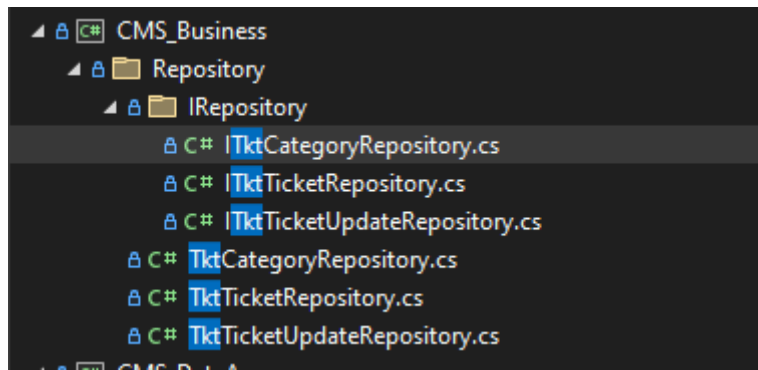


Figure 5-3-7 Shows the Repositories and Repository Interfaces for system business logic.

- **CRM_Functions**

This project folder stores the connected services. This project folder is usually not used for the coding of the system.

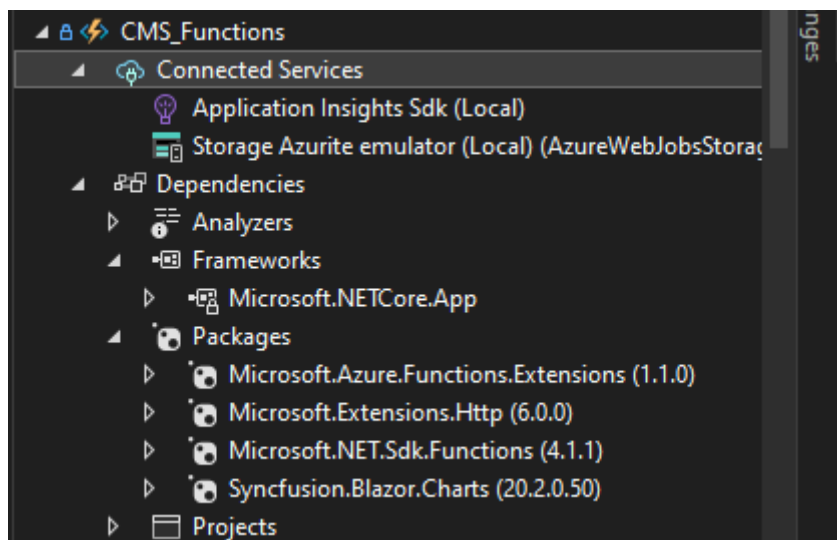


Figure 5-3-8 Shows the connected services and dependencies.

- CRM_Web_Server

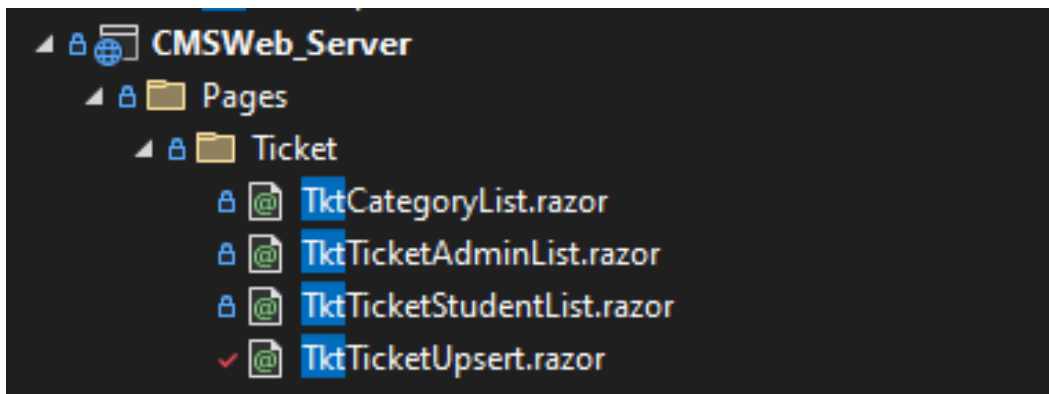


Figure 5-3-9 The razor pages in Web Server Project Folder

The Web Server project folder is responsible for the presentation layer of the system. This folder includes the Syncfusion components and the SendGrid package, which allows for easy and efficient email communication with customers. The Syncfusion components provide the necessary tools for creating modern and user-friendly UIs, while the SendGrid package allows for seamless integration with the email service provider to send emails for report purposes. Overall, this folder is critical in providing an engaging and effective user interface for the CRM system. The razor pages of each modules are stored separately within their own folder declared in the pages folder.

3. Download NuGet Packages needed using NuGet Package Manager Console.

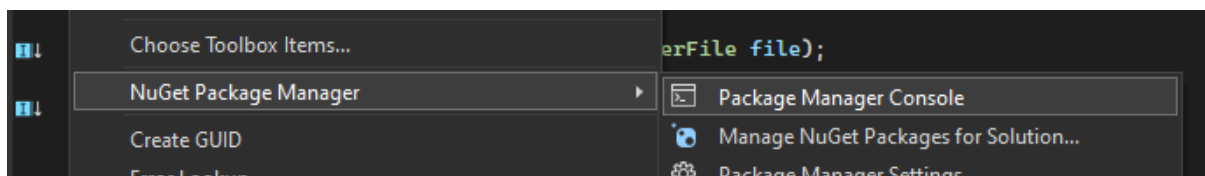


Figure 5-3-10 Shows where the Package Manager Console is located.

The NuGet packages are installed through the NuGet Package Manager, which can be accessed from “Tools” in Microsoft Visual Studio 2022. The Package Manager Console will be

responsible for running commands related to the frameworks or services installed. For instance, database updates are made through the Package Manager Console.

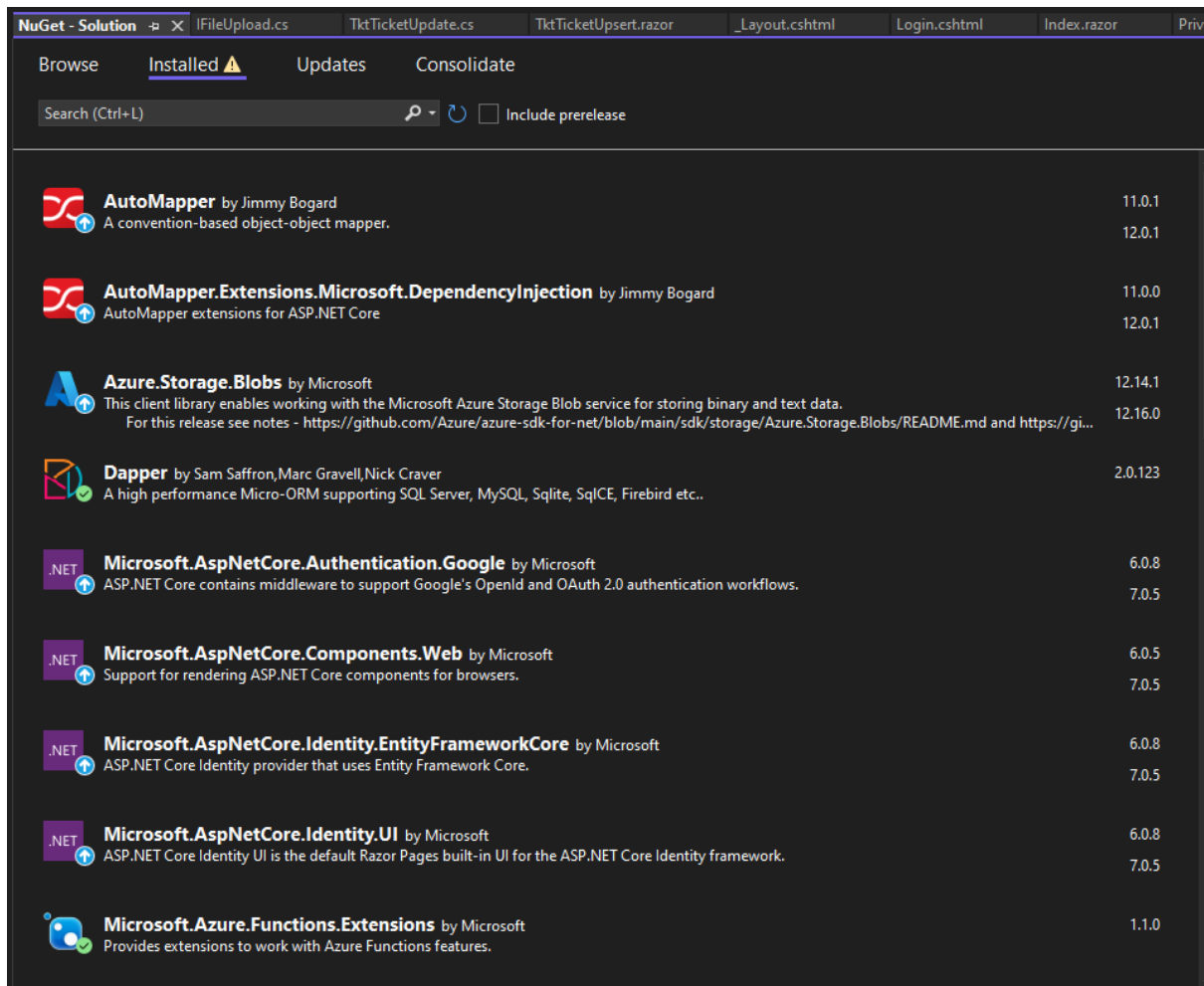


Figure 5-3-11 NuGet Packages installed part 1










	Microsoft.EntityFrameworkCore.Tools by Microsoft Entity Framework Core Tools for the NuGet Package Manager Console in Visual Studio.	6.0.8 7.0.5
	Microsoft.Extensions.Http by Microsoft The HttpClient factory is a pattern for configuring and retrieving named HttpClients in a composable way. The HttpClient factory provides extensibility to plug in DelegatingHandlers that address cross-cutting concerns such as service location, load balancing, and reliability. The default HttpClient factor...	6.0.0 7.0.0
	Microsoft.NET.Sdk.Functions by Microsoft Build SDK for Azure Functions	4.1.1 4.2.0
	Microsoft.VisualStudio.Web.CodeGeneration.Design by Microsoft Code Generation tool for ASP.NET Core. Contains the dotnet-aspnet-codegenerator command used for generating controllers and views.	6.0.8 7.0.6
	SendGrid by Elmer Thomas, Twilio DX Team C# client library and examples for using Twilio SendGrid API's to send mail and access Web API v3 endpoints with .NET Standard 1.3 and .NET Core support.	9.28.1
	Stripe.net by Stripe, Jayme Davis Stripe.net is a sync/async .NET 4.6.1+ client, and a portable class library for the Stripe API. (Official Library)	39.120.0 41.14.0
	Syncfusion.Blazor.Buttons by Syncfusion Inc. This package provides the functionality to utilize the features of Syncfusion Blazor Button, Checkbox, Radio Button, Chips, Toggle Switch Button and Icons.	20.2.0.50 21.1.41
	Syncfusion.Blazor.Charts by Syncfusion Inc. This package provides the functionality to utilize the features of Syncfusion Blazor Charts component and more.	20.2.0.50 21.1.41
	Syncfusion.Blazor.Grid by Syncfusion Inc. This package provides the functionality to utilize the features of Syncfusion Blazor DataGrid component and more.	20.2.0.50 21.1.41

Figure 5-3-12 NuGet Packages installed part 2

5.3.2 Database Operations

1. Install version SQL Server 2016 Express Edition
2. Install SQL Server Management Studio to handle the SQL Server.



Figure 5-3-13 Shows Microsoft SQL Server Management Studio 19 is installed.

3. Create a new database for the CRM Blazor server project.

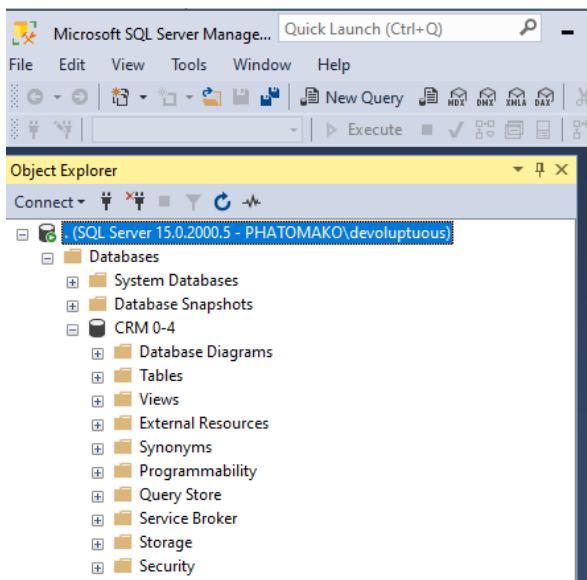


Figure 5-3-14 Shows the database is created

4. Install the Entity Framework Core NuGet Packages.

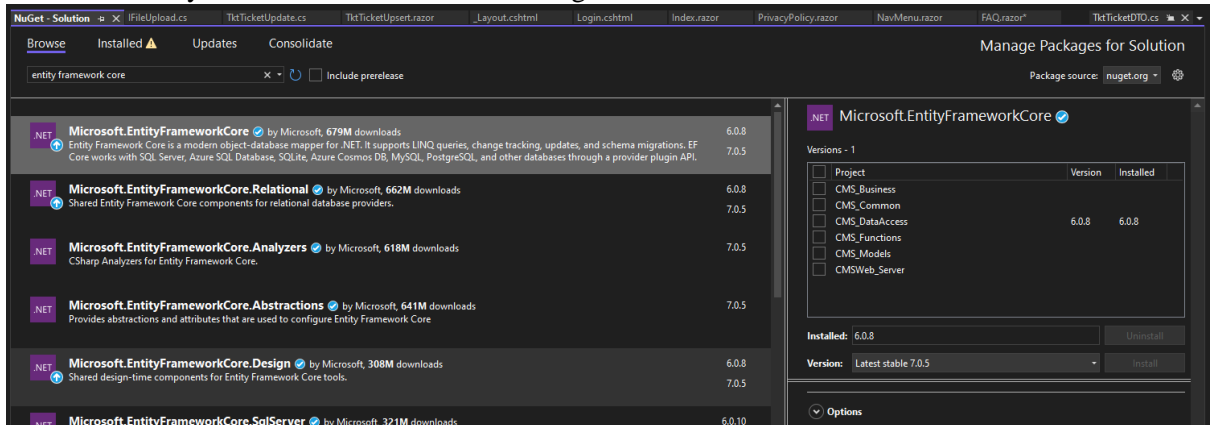


Figure 5-3-15 Shows the EF Core can be downloaded from NuGet Package Manager

5. Create Model class, which in the case of my project, is Data Access Project folder that will contain all the base models to define the tables.

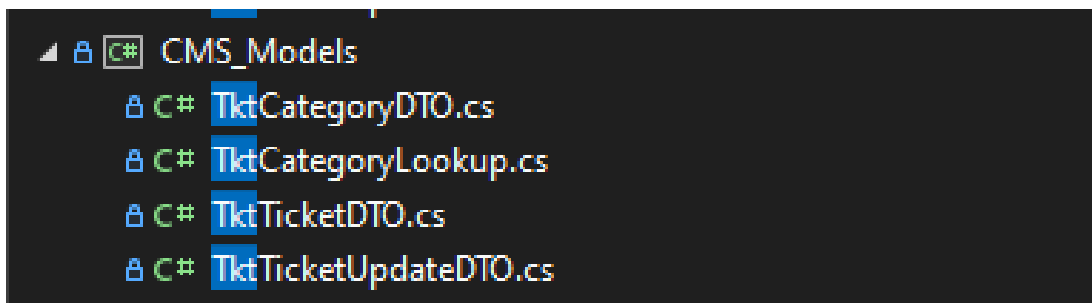


Figure 5-3-16The models created.

6. Add connection string to the appsettings.json file that points to the database created.

```

appsettings.json
Schema: https://json.schemastore.org/appsettings.json
1 {
2   "Logging": {
3     "LogLevel": {
4       "Default": "Information",
5       "Microsoft.AspNetCore": "Warning"
6     }
7   },
8   "AllowedHosts": "*",
9   "ConnectionStrings": {
10    //--- FOR AZURE CRM-TICKET ---
11    //DefaultConnection: "Data Source=vacms.database.windows.net;Initial Catalog=
12
13    //--- FOR LOCAL HOST ---
14    "DefaultConnection": "Server=localhost;Database=CRM_0-4;Trusted_Connection=true",
15    //DefaultConnection: "Data Source=\\LOCALEXPRESS2016;Initial Catalog=
16    Connect Timeout=30;Encrypt=False;TrustServerCertificate=False;Applicat
17
18    //---DONT TOUCH THE ONES BELOW---
19    //DefaultConnection: "Data Source=vacms.database.windows.net;Initial Catalog=CRM-0-4;User ID=
20    Password=
21    Connect Timeout=30;Encrypt=True;TrustServerCertificat
22
23    //---AZURE FILE UPLOAD---
24    "AzureConnectionString": "DefaultEndpointsProtocol=
25    MicrosoftAzureStorageAccountName=
26    MicrosoftAzureStorageAccountKey=
27    MicrosoftAzureStorageAccountEndpoint=
28    MicrosoftAzureStorageAccountContainerName=
29    MicrosoftAzureStorageAccountContainerKey=
30    MicrosoftAzureStorageAccountContainerEndpoint=
31    "AzureConnectionString": "DefaultEndpointsProtocol=
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```

Figure 5-3-17 The connection strings in appsettings.json. The secrets and ids are censored.

7. Run the command “Add-Migration Initial Create” for the initial migration in NuGet Package Manager Consoles.
8. Run the command “Update-Database” to apply the migration in NuGet Package Manager Consoles.
9. Inject an instance of the Models through the DTOs in the business logic files and perform CRUD operations on the database.

```

@page "/tktticketadminlist"
@inject ITktTicketRepository _tkTicketRepository
@inject ITktCategoryRepository _tkCategoryRepository
@inject IUserRepository _userRepository

```

Figure 5-3-18 Razor page of ticket for admin, where the instance is injected in the headings.

5.3.3 Chatbot Configurations

In the development of the chatbot for the CRM project, Azure Bot Service and Azure Cognitive Services were utilized. The process involved the following steps:

1. Firstly, Azure Bot Service was set up by creating a new bot resource, selecting the appropriate programming language and template, and deploying the bot to Azure.

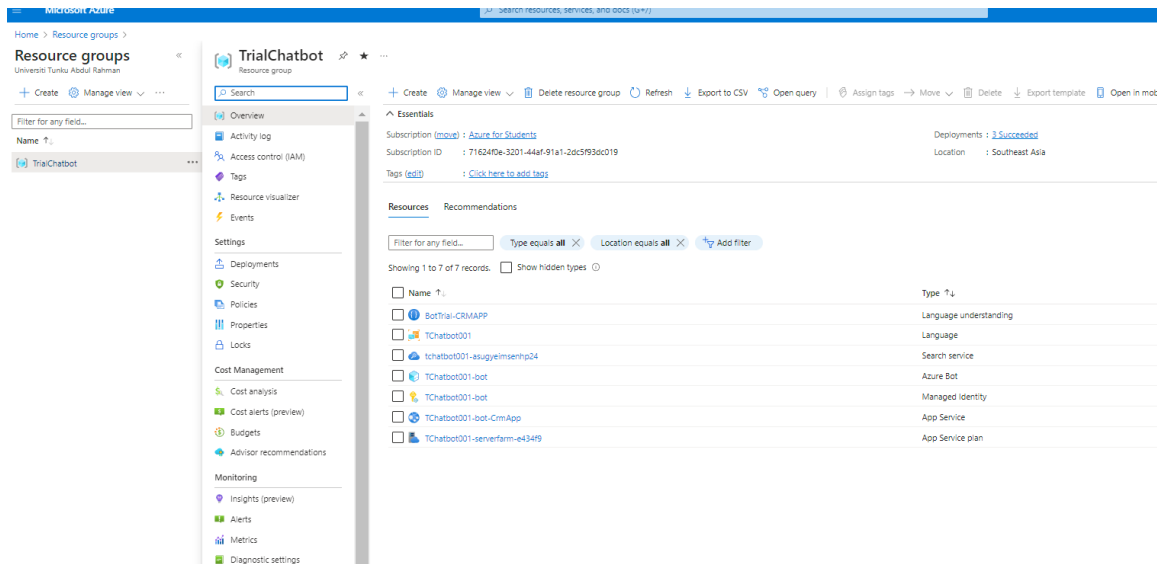


Figure 5-3-19 Resource Group details of the chatbot.

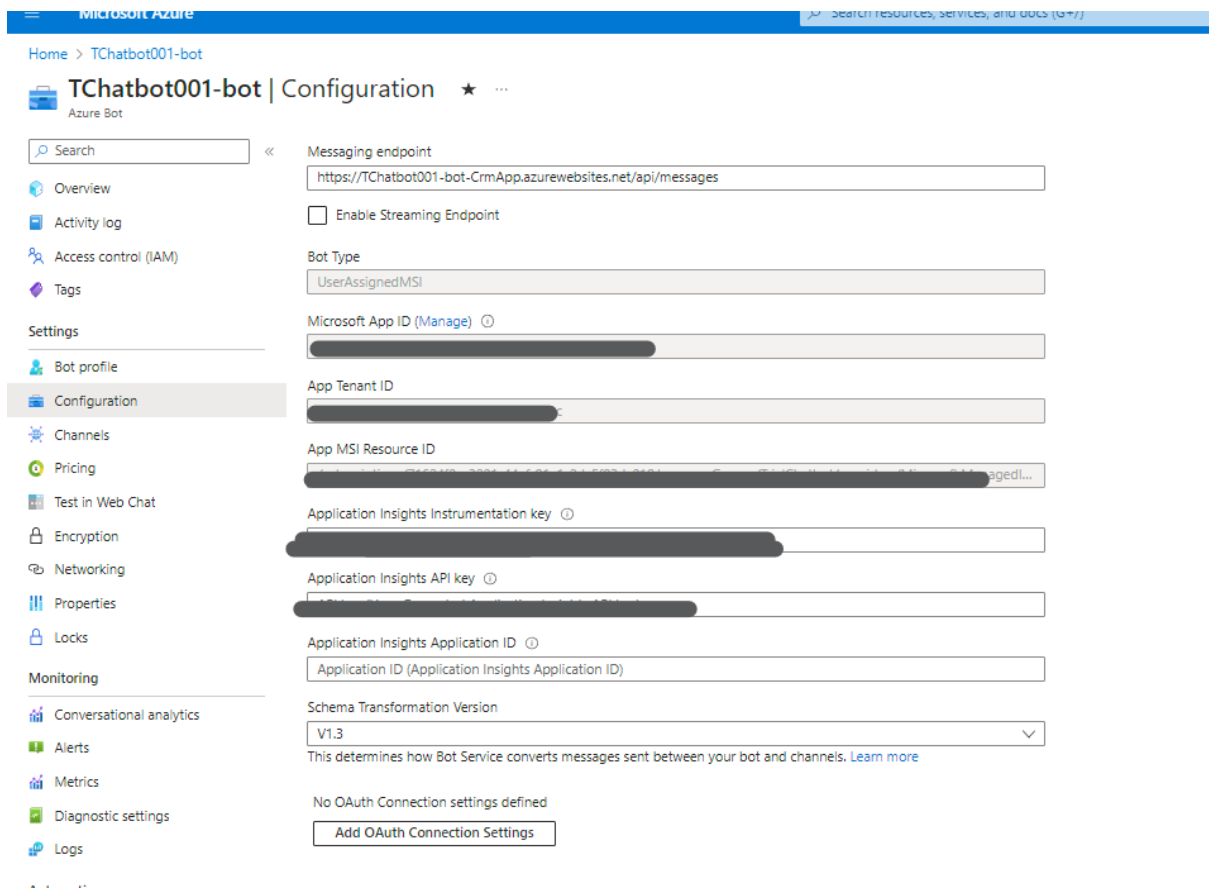


Figure 5-3-20 Configurations of the Chatbot

2. Secondly, Azure Cognitive Services were configured by creating a new resource and selecting the necessary API services, such as Language Understanding (LUIS) and QnA Maker.

3. In the third step, LUIS was integrated by creating a LUIS app, training it with intents and entities, and publishing the app to obtain the LUIS endpoint.

4. Subsequently, the QnA Maker knowledge base was built by populating it with question and answer pairs, training it, and publishing it for access via an endpoint.

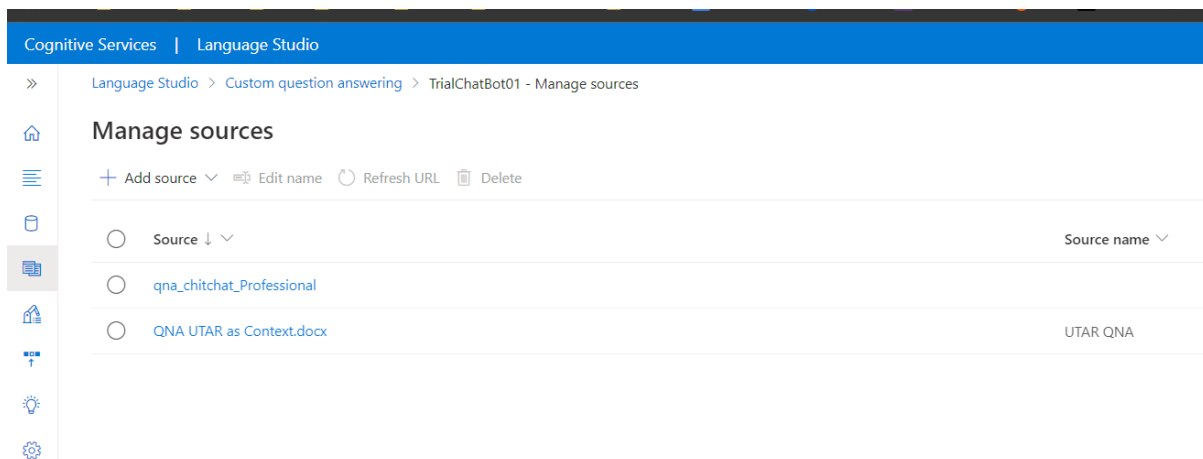


Figure 5-3-21 Sources to train the chatbot.

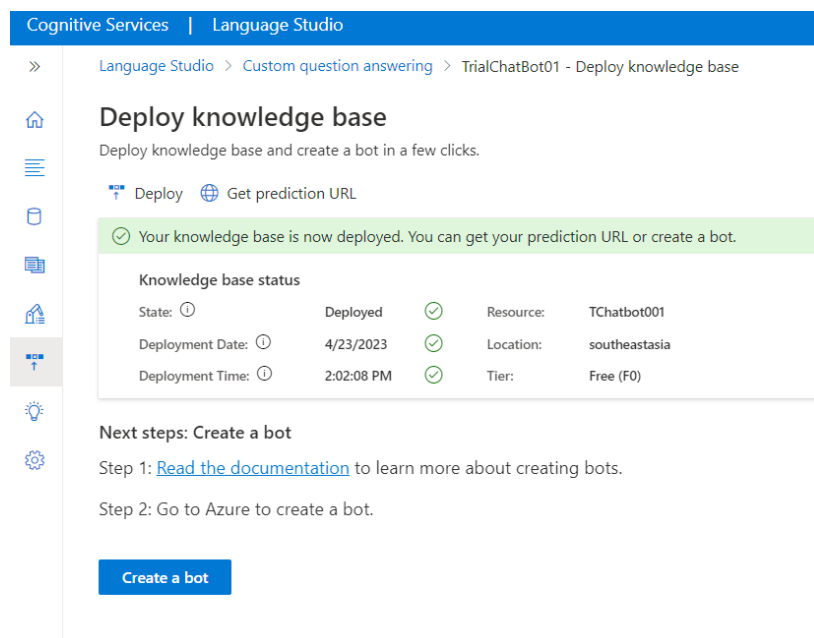


Figure 5-3-22 Knowledge Base deployed after training.

5. The chatbot logic was then developed using the chosen programming language, connecting it to LUIS and QnA Maker using API keys and endpoints.

6. Finally, the chatbot was tested and deployed using Azure portal's built-in testing tools. Adjustments were made as needed before deployment to the desired channels.

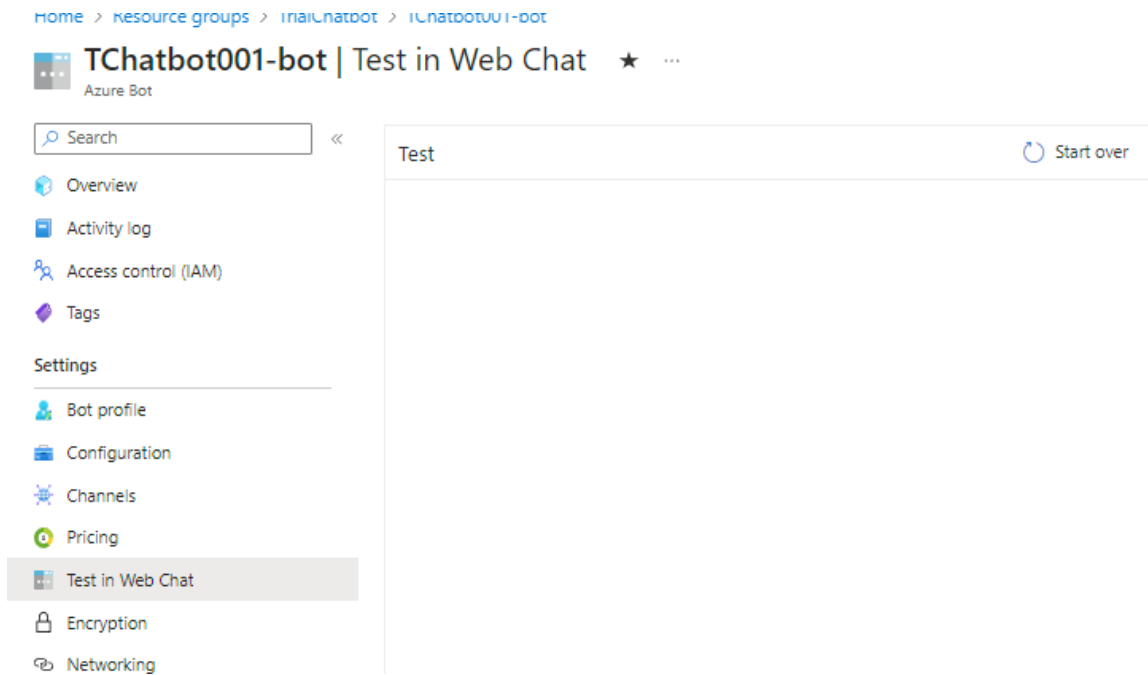


Figure 5-3-23 Testing using built-in Web Chat.

By following this process, a chatbot was successfully developed for the CRM project, leveraging the capabilities of Azure Bot Service and Azure Cognitive Services to enhance the user experience.

5.4 Implementations and System Operation

5.4.1 Register, Login and Logout

The login module is a crucial component of the CRM system, as it provides users with a secure method of accessing the system. The login module includes registration and logout functionalities, allowing users to create and manage their accounts as well as log out of the system. The module utilizes the .NET Identity Framework, which provides a set of tools for managing user authentication and authorization. By using the .NET Identity Framework, the login module is able to ensure that only authorized users are able to access the system, enhancing the system's security. The login module is built using Blazor, a web application framework that allows developers to create interactive user interfaces using C# and HTML. With Blazor, developers can create responsive and efficient user interfaces, providing users with an intuitive and effective platform for managing customer relationships.

The screenshot shows the login interface of the CRM APP. At the top, there is a blue header with 'CRM APP' on the left and 'Register Login' on the right. The main content area is titled 'Log in' and is divided into two sections. The first section, 'Use a local account to log in.', contains an email input field with 'dedingo19@gmail.com', a password input field with masked characters, a 'Remember me?' checkbox, and a blue 'Log in' button. Below the 'Log in' button are three links: 'Forgot your password?', 'Register as a new user', and 'Resend email confirmation'. The second section, 'Use another service to log in.', features a blue 'Google' button.

Figure 5-4-1 Login

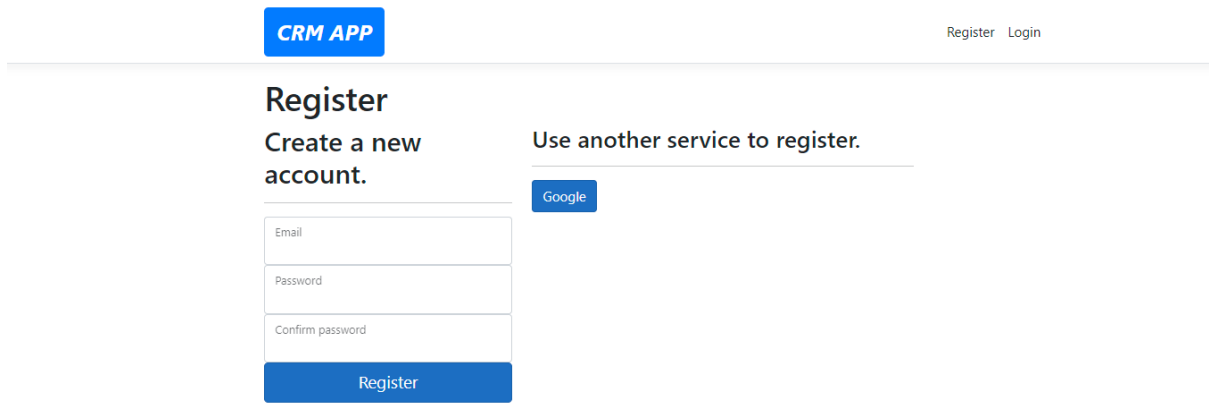


Figure 5-4-2 Register

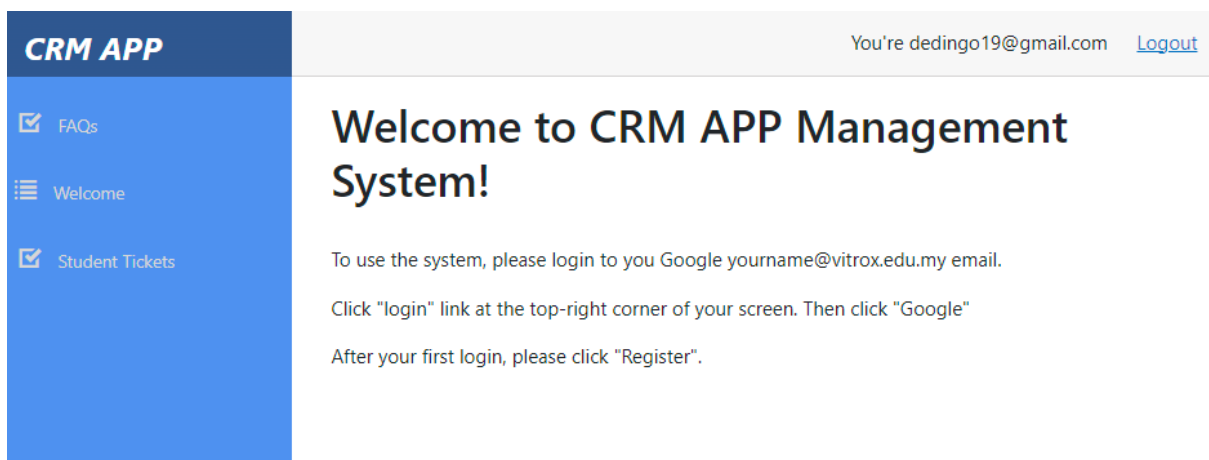


Figure 5-4-3 Logout on top right corner.

5.4.2 Raise Ticket

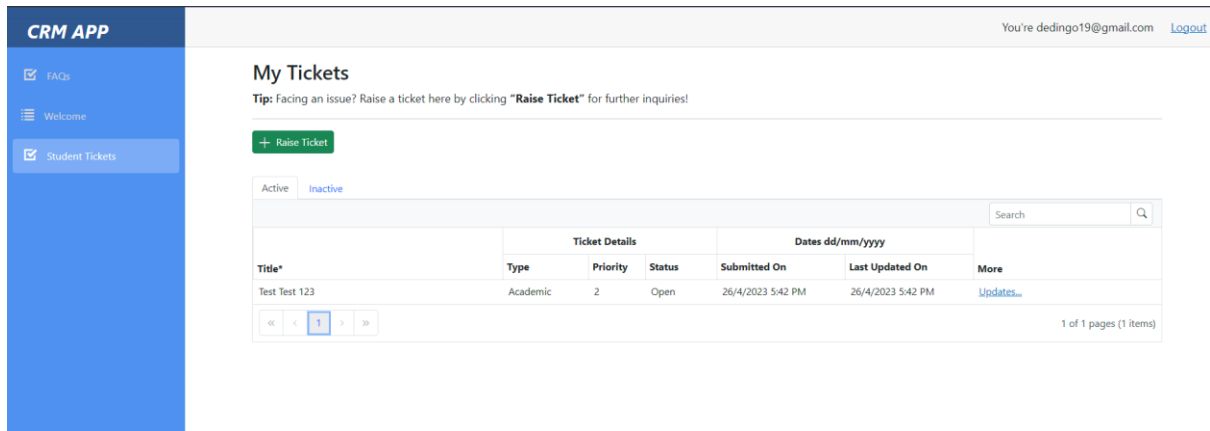


Figure 5-4-4 Customer-side Ticket Management page.

The customer can access this page to view ticket lists. To raise ticket, the customer can click on “Raise Ticket” button. The user will be prompted to the Ticket Upsert page.

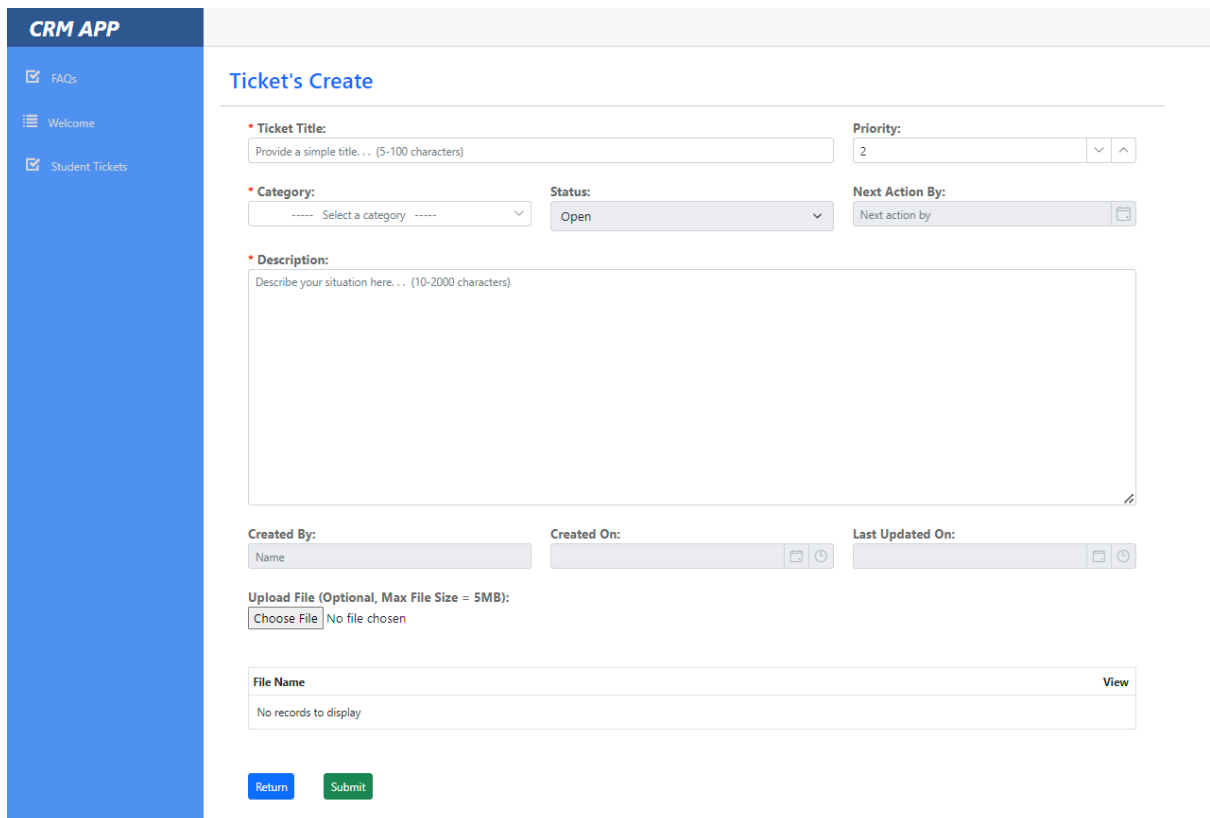


Figure 5-4-5 Ticket Upsert (Create) Page.

The customer can click submit once filled in all the required information. If there is any missing compulsory information, the user will be prompted error.

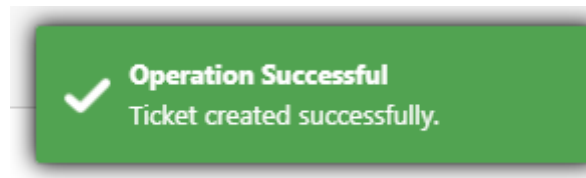


Figure 5-4-6 Shows Successful message if the ticket is created successfully.

5.4.2 Manage Ticket (Customer-side)

By clicking “Updates” in the ticket list, the customer can view the details of the raised ticket. The customer can choose to withdraw it or view updates from the admin. A short reason is required to withdraw so that spamming of tickets can be avoided, since there will be a lot more steps to be done. Also the reason of withdrawal is kept in the database which can be retrieved later. Note that the customers are not allowed to edit the information submitted, to ensure data integrity.

CRM APP

FAQs
Welcome
Student Tickets

Ticket's Updates

* Ticket Title: Test Test 123 Priority: 2

* Category: Academic Status: Open Next Action By: Next action by

* Description: aloha manola

Created By: Name Created On: 26/4/2023 5:42 PM Last Updated On:

Upload File (Optional, Max File Size = 5MB):
Choose File No file chosen

File Name	View
No records to display	

[Return](#) [Withdraw](#)

Updates:

No.	Updated by	Description	Updated on
No records to display			

Figure 5-4-7 Ticket Details and Updates Page

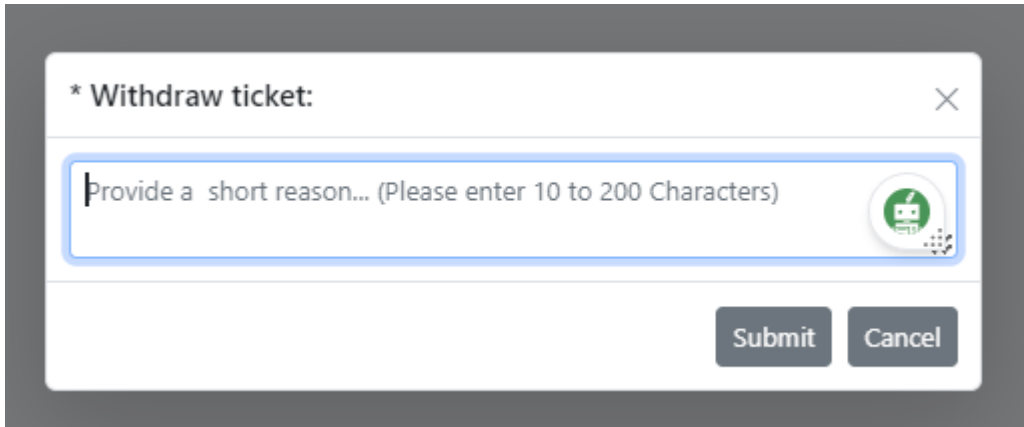


Figure 5-4-8 User required to enter a reason to withdraw.

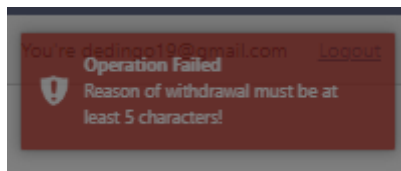


Figure 5-4-9 Error message if reason of withdrawal is lesser than 5 characters.

5.4.3 Manage Ticket (Admin-side)

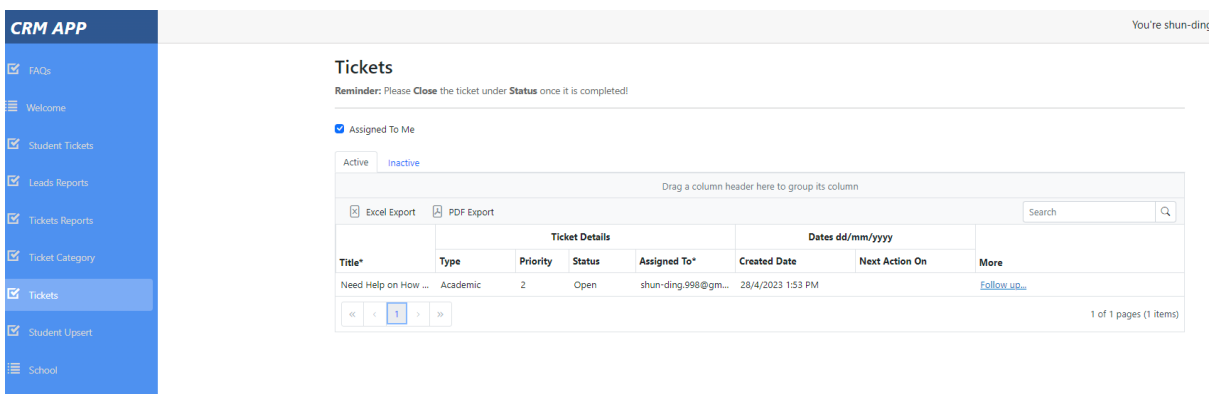


Figure 5-4-9 Admin List of the Tickets.

The admin can do filtering by tickets assigned to the admin, sorting, searching, PDF export, Excel export and many more.

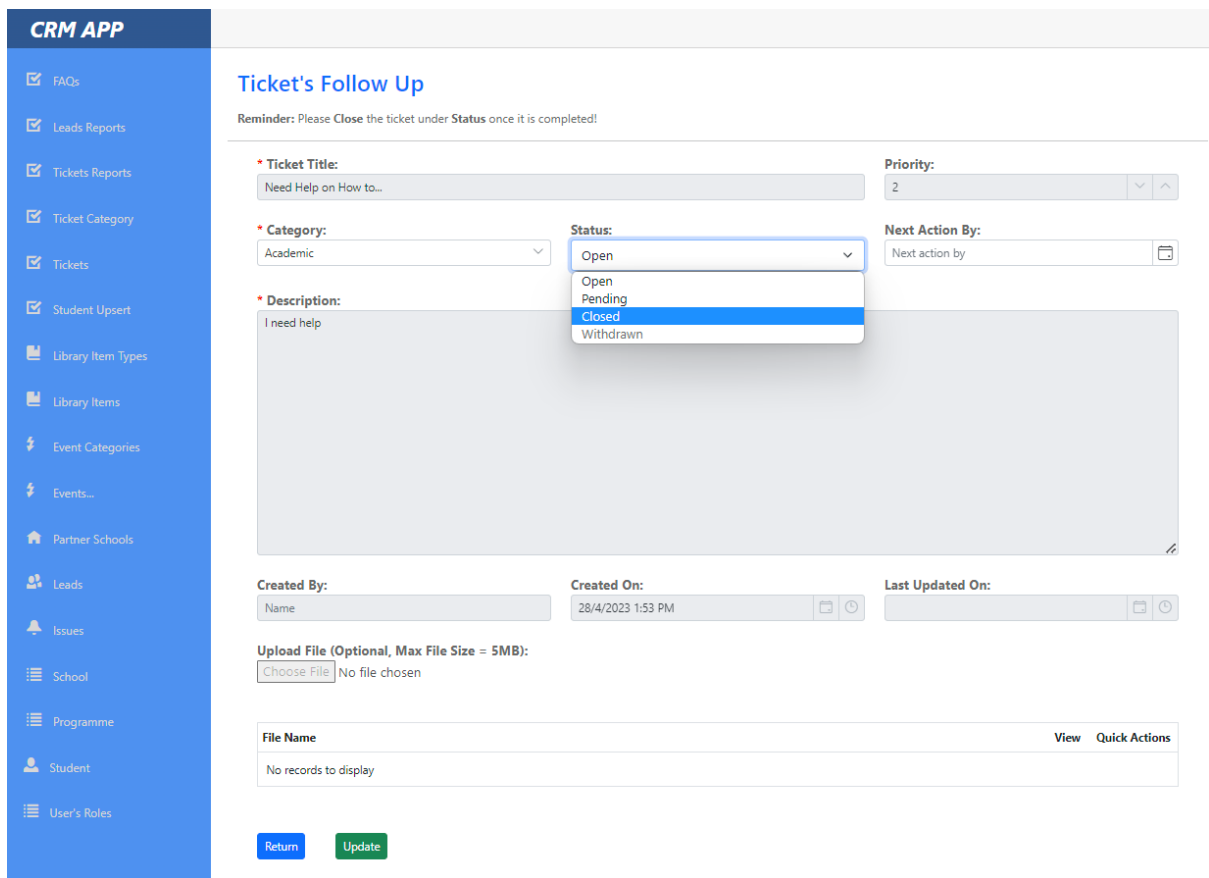


Figure 5-4-10 Follow Up Ticket Page for admin

The admin can update the status by choosing the from the status drop down list. The withdrawn option is not selectable by admin, since in logic, only customers can withdraw their tickets. The admin nor manager cannot edit the data, but can choose to update the status and next action by fields.

Updates:

The screenshot displays a web interface for managing updates. At the top, there are buttons for '+ Add', 'Update', 'Cancel', 'Excel Export', and 'PDF Export', along with a search bar. Below this is a table with the following columns: 'No.', 'Updated by', 'Description', 'Updated on', and 'Quick Actions'. The 'Updated by' column shows a dropdown menu with the email 'tr_shunding.lian@vitrox.c...'. The 'Description' column features a rich-text editor with a toolbar containing options for bold (B), italic (I), underline (U), paragraph, bulleted list, numbered list, table, link, and unlink. The text in the editor reads 'Noted. Will update you soon'. The 'Updated on' column shows a date '28/4/2023 1...' with a calendar icon. The 'Quick Actions' column contains a refresh icon and a close icon. A page number '27' is visible at the bottom right of the table area.

Figure 5-4-11 Updates can be added by the CSR or CSM.

The CSR can do follow-ups by adding updates to the ticket. Once the first update is added, the ticket's status automatically turns into pending. Also by utilizing Synfusion Components, a rich-text textbox can be used to enhance the follow-up experience, where important fields can be styled to bold, or even insert tables. If the user has the role of manager, the manager can update the Ticket Category, which reassigns to another CSR.

Ticket's Follow Up

Reminder: Please Close the ticket under Status once it is completed!

*** Ticket Title:** **Priority:**

*** Category:** **Status:** **Next Action By:**

Academic
Admission
Facility
Finance
General
Testing

Created By: **Created On:** **Last Updated On:**

Upload File (Optional, Max File Size = 5MB):
 No file chosen

File Name	View	Quick Actions
No records to display		

Figure 5-4-12 Manager can reassign ticket.

5.4.4 View Dashboard for Analytical Reports

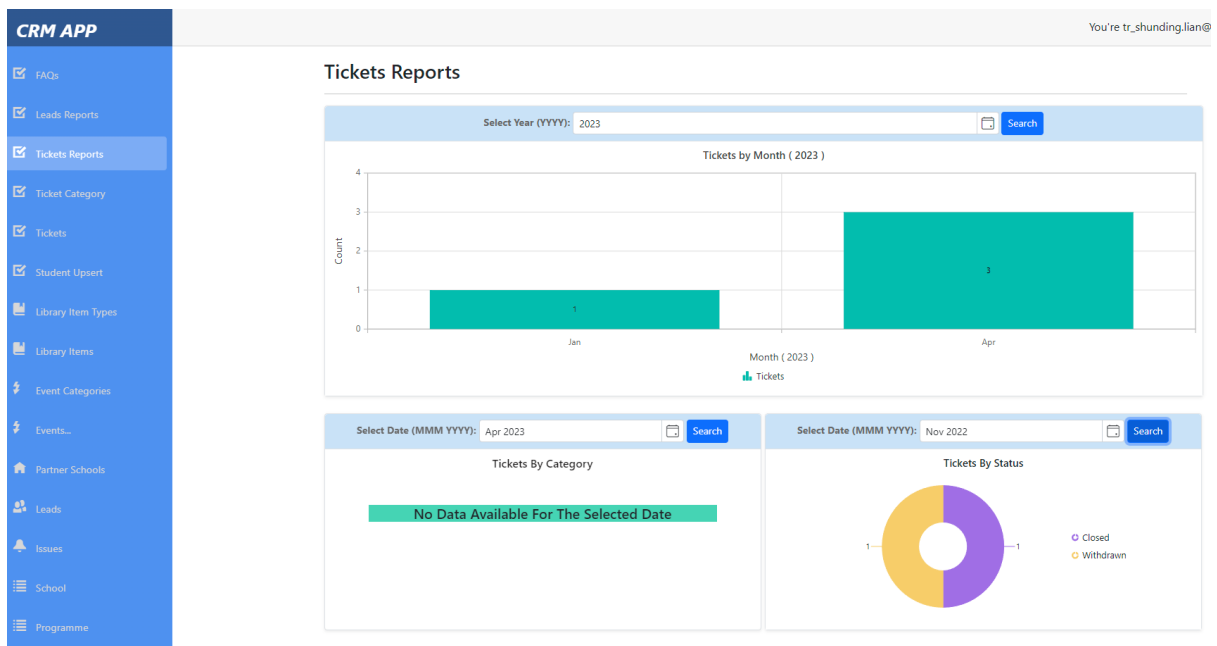


Figure 5-4-13 Reports Dashboard for Analytical Data.

This functionality is only applicable for the manager. The manager can filter the data by datetime, and the reports will show data according to By Month, By Category and By Status. If there is no data, the chart will show “No Data Available”.

5.4.5 Use Chatbot Service

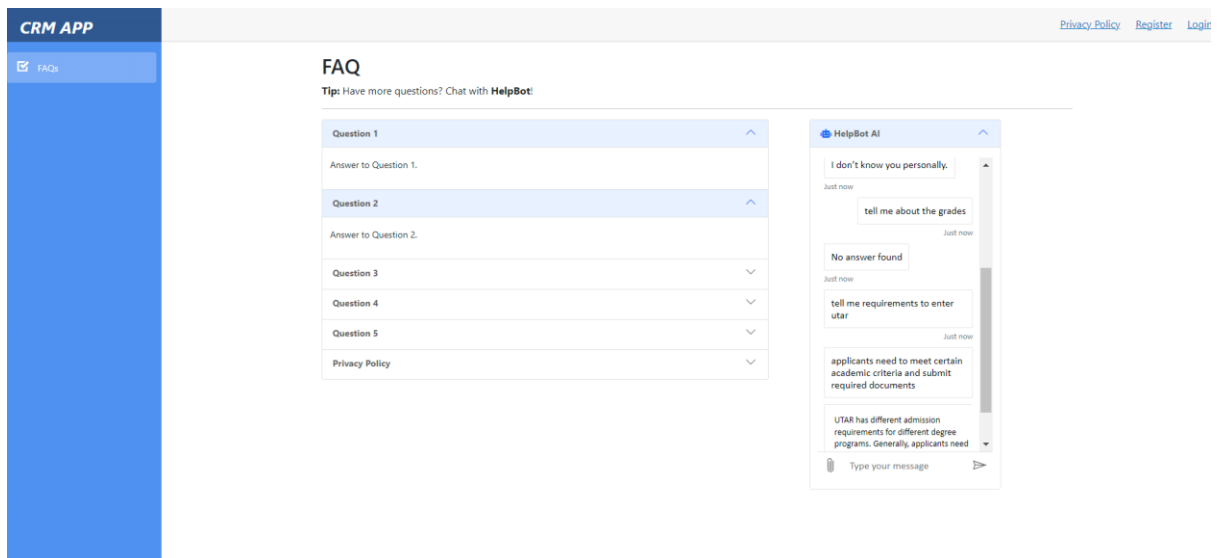


Figure 5-4-14 FAQs and Chatbot service.

The chatbot is located in the FAQs page, given their similar purpose, which is to provide more information to the customers. In the screenshot, the bot is trained using QnAs related to University Tunku Abdul Rahman. The Chatbot utilizes Azure Cognitive Services, to output Natural Language Processed (NLP) answers. If there is no answer, the Chatbot replies no answer found.

5.5 Implementation Issues and Challenges

Issues and challenges are a part of the development process. The issues and challenges related to this implementation phase of the project are as follows:

- **Defining the user requirements.** Since the CRM system is a huge system that covers many aspects of a sales process, it is hard to define and lower the scope for the CRM system intended to be developed for this project. Hence, many preparations and studies must be conducted beforehand to identify the desirable yet essential user requirements.
- **Defining the logic behind a CRM system model.** Similar to defining the user requirements, the logic behind a CRM system requires patience and effort to define. A CRM system works with data that encompasses many aspects of a company. Hence, the flow of the modules, entity definition, use cases and many more require a huge amount of time for planning.
- **Finding resources to learn.** Since the project utilizes various modern technologies such as Blazor, ASP .Net, Syncfusion components and many more, it is hard to find proper resources related to the said technologies. Hence, patience is the key to locating the essential resources, and advice is needed from people with experience.
- **New tools and programming languages.** The language used in this project, C# is a popular language for web app development. However, it is a high-level programming language that requires a huge amount of practice and understanding to fully grasp it. Besides, frameworks such as the Entity Framework Core, Blazor, and Syncfusion Components are modern technologies that are new and unconventional, documentation regarding said frameworks must be studied to utilize them.
- **Unfamiliar system development architecture.** Learning a new architecture such as Model-View-Controller (MVC) can pose a challenge for developers when implementing a CRM system. MVC is a widely used architectural pattern that separates

an application into three interconnected components - the model, the view, and the controller. Understanding how these components interact with each other is critical for implementing a successful CRM system using MVC architecture. One of the key benefits of MVC is its support for data binding, which allows data to be displayed in the view without the need for manual updating. In MVC, the model represents the application's data and business logic, the view represents the user interface, and the controller handles user input and updates the model and view accordingly. When data changes in the model, the view is automatically updated to reflect those changes. This simplifies the process of data management and ensures that the UI is always up to date with the latest data. However, learning the intricacies of MVC and how data bindings work can be challenging for developers who are not familiar with the pattern. To overcome this challenge, developers must have a solid understanding of the components of MVC and how they interact with each other. Additionally, they must have experience working with data binding and be able to troubleshoot issues that may arise during the implementation process.

- Limitations as a student. Meta for developers requires verification as a developer to be able to incorporate their plugins. Despite the configurations for the plugins are completed, however, the plugins are not allowed to be incorporated solely due to the lack of the ability for a student to identify as a verified developer.

5.6 Concluding Remarks

In brief, Chapter 5 provides a comprehensive overview of the implementation phase of the system, encompassing its development, usage, and challenges encountered. Throughout the chapter, the various components and modules that constitute the system are thoroughly discussed, emphasizing their integration, design, and functionality.

Moreover, the challenges and issues faced during the implementation phase are meticulously analyzed, providing valuable insights into the intricacies and nuances of the project. These experiences have influenced the system's approach and aided in its refinement, ensuring that it meets the project's objectives and requirements.

The next chapter will discuss testing and evaluating the implemented system.

CHAPTER 6 System Evaluation

6.1 System Testing and Performance Metrics

A crucial step in the software development process is testing, which is assessing the functionality and behavior of a software system to make sure it complies with the requirements and operates at its best. It entails assessing and confirming that the software system works as planned and satisfies end users' demands.

Use case testing is a type of black box testing that focuses on evaluating a software system's functionality in relation to how it interacts with users or other actors. It is a testing strategy that involves locating and testing the use cases or scenarios of the system to make sure they produce the desired outcomes. An example of a real-world scenario that a user might experience when engaging with the software system is described in a use case. The steps a user takes to complete a particular job or objective within the software system are represented by use cases.

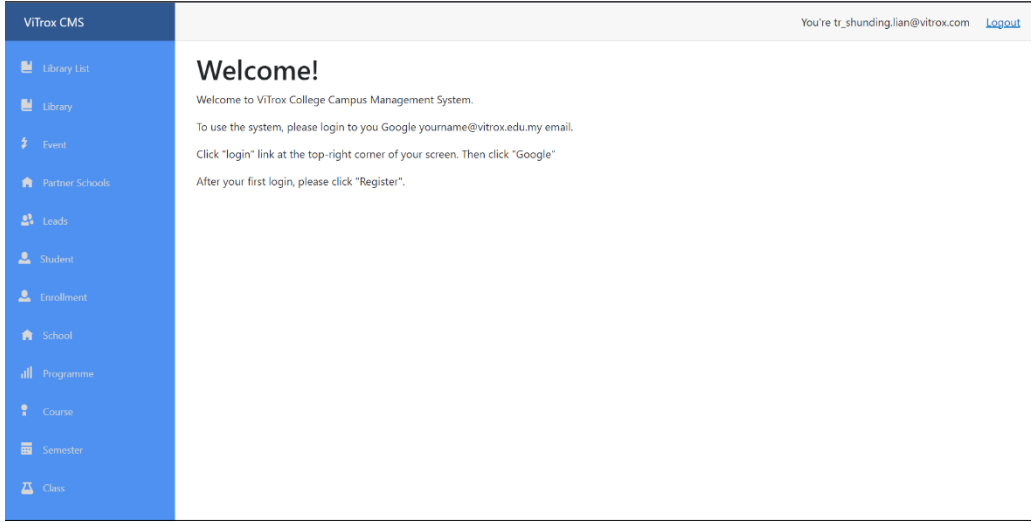
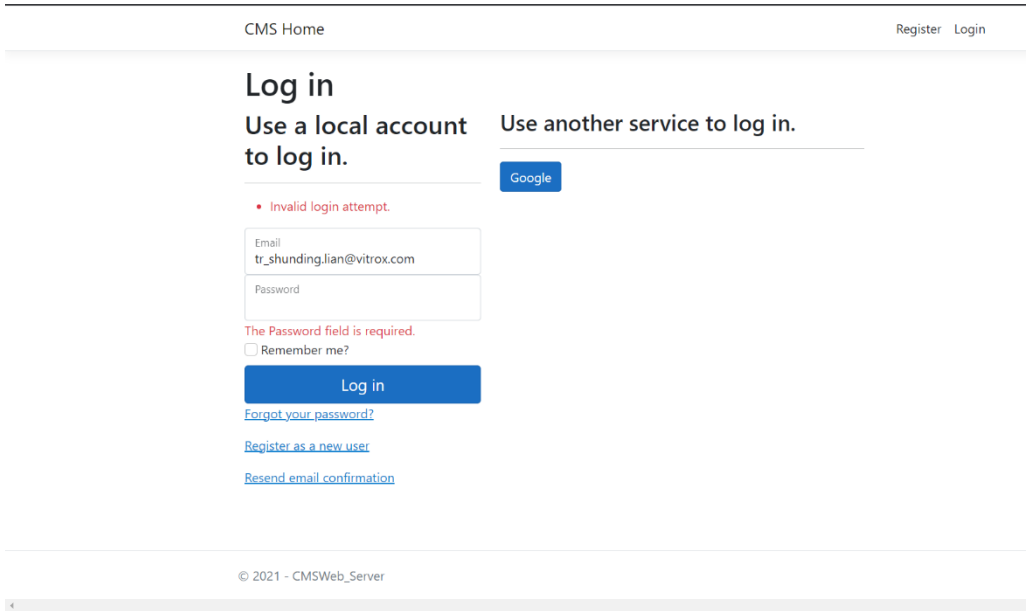
Identifying the various software system use cases and testing them to see if they produce the desired results is known as use case testing. By examining the system requirements, user stories, or other pertinent documentation, testers first identify the use cases. They then create test cases based on the identified use cases and execute them to verify that the system behaves as expected. Tests for the Use Case Testing must include both positive and negative test cases and should cover every conceivable scenario. Negative test cases verify that the system correctly handles problems and exceptions whereas positive test cases verify that the system performs as expected when the use case is successful.

Use case testing has the benefit of offering a practical method for testing the software system. Testing use cases guarantees that the software system satisfies the needs of the end users because they are based on actual circumstances. Use case testing aids in the early detection of flaws in software development, which lowers the cost of addressing flaws later in the development cycle. Case Study Various software systems, such as desktop apps, mobile

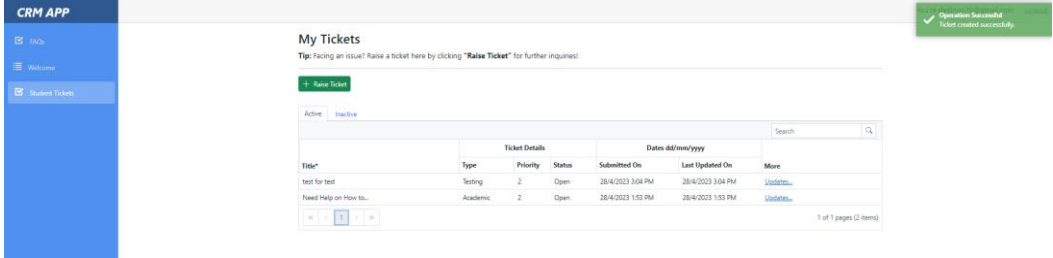
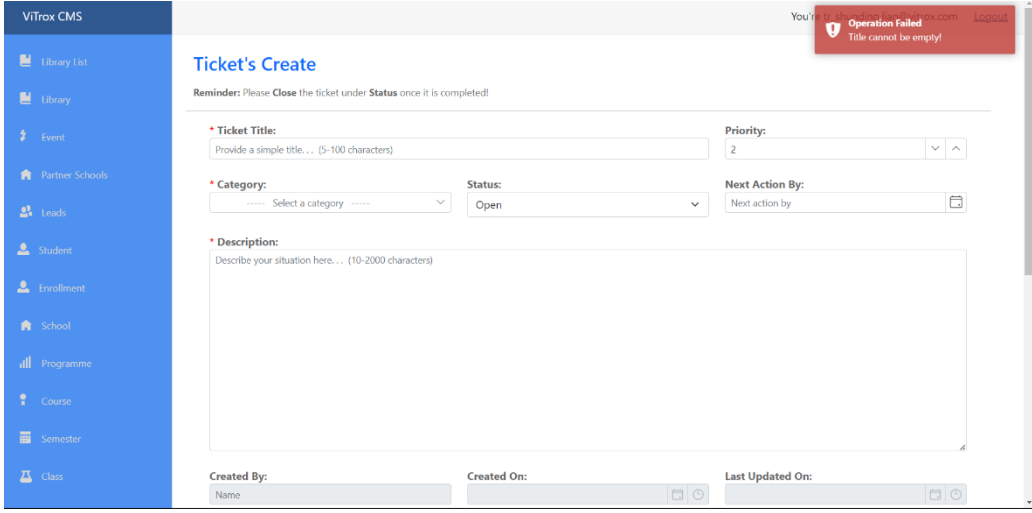
applications, and online applications, can all be put through use case testing. It is particularly helpful for testing software programs that interact with consumers often, such as banking, social media, and e-commerce apps.

6.2 Testing Setup and Result

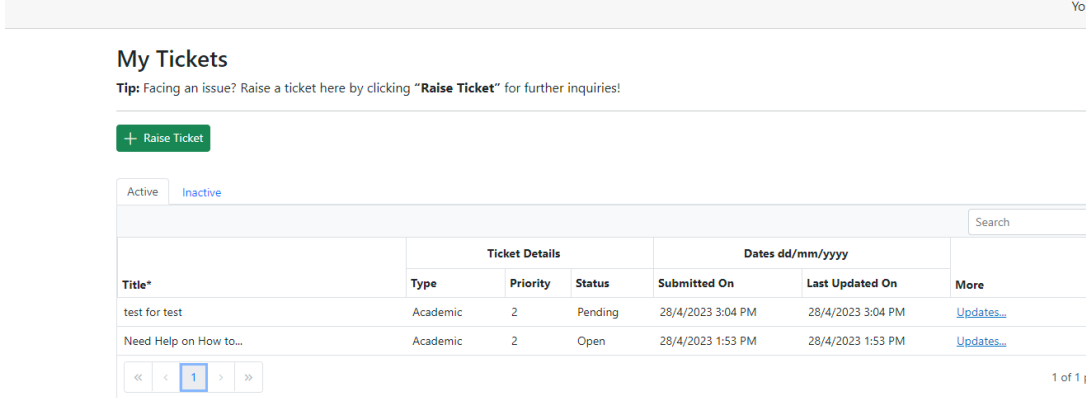
Use Case Testing 1 [F001] Login

Test Case	Status
<p>User successfully login into the system.</p> 	Pass
<p>Error Message displayed when user key in wrong email or password or both.</p> 	Pass

Use Case Testing 2 [F002] Raise Ticket

Test Case	Status																										
<p>Customer can raise ticket successfully.</p>  <p>The screenshot shows the 'CRM APP' interface. On the left is a blue sidebar with navigation items: Home, Welcome, and Student Tickets. The main content area is titled 'My Tickets' and includes a tip: 'Tip: Facing an issue? Raise a ticket here by clicking "Raise Ticket" for further inquiry!'. Below the tip is a green 'Raise Ticket' button. A table displays two tickets:</p> <table border="1"> <thead> <tr> <th rowspan="2">Title</th> <th colspan="3">Ticket Details</th> <th colspan="2">Dates dd/mm/yyyy</th> <th rowspan="2">More</th> </tr> <tr> <th>Type</th> <th>Priority</th> <th>Status</th> <th>Submitted On</th> <th>Last Updated On</th> </tr> </thead> <tbody> <tr> <td>test for test</td> <td>Testing</td> <td>2</td> <td>Open</td> <td>28/4/2023 3:04 PM</td> <td>28/4/2023 3:04 PM</td> <td>Update</td> </tr> <tr> <td>Need Help on How to...</td> <td>Academic</td> <td>2</td> <td>Open</td> <td>28/4/2023 1:53 PM</td> <td>28/4/2023 1:53 PM</td> <td>Update</td> </tr> </tbody> </table> <p>A green toast notification in the top right corner reads: 'Operation Successful! Ticket created successfully.'</p>	Title	Ticket Details			Dates dd/mm/yyyy		More	Type	Priority	Status	Submitted On	Last Updated On	test for test	Testing	2	Open	28/4/2023 3:04 PM	28/4/2023 3:04 PM	Update	Need Help on How to...	Academic	2	Open	28/4/2023 1:53 PM	28/4/2023 1:53 PM	Update	Pass
Title		Ticket Details			Dates dd/mm/yyyy			More																			
	Type	Priority	Status	Submitted On	Last Updated On																						
test for test	Testing	2	Open	28/4/2023 3:04 PM	28/4/2023 3:04 PM	Update																					
Need Help on How to...	Academic	2	Open	28/4/2023 1:53 PM	28/4/2023 1:53 PM	Update																					
<p>If the customer does not fill in one of the required information, or the required minimum length is not met, the system will not allow customer to raise ticket successfully and will display error message using toast notification.</p>  <p>The screenshot shows the 'Ticket's Create' form in the 'VITrox CMS' interface. The form includes fields for 'Ticket Title', 'Priority', 'Category', 'Status', 'Next Action By', and 'Description'. A red toast notification in the top right corner reads: 'Operation Failed! Title cannot be empty!'. The 'Created By' field is currently empty.</p>	Pass																										

Use Case Testing 3 [F003] Manage Ticket (Customer-Side)

Test Case	Status
<p>Customer can navigate to the ticket list to view and manage tickets.</p> 	Pass

Customer can withdraw the ticket.

Pass

Ticket's Updates

* Ticket Title: test for test Priority: 2

* Category: Academic Status: Pending Next Action By: Next action by

* Description: yes just testing

Created By: Name Created On: 28/4/2023 3:04 PM Last Updated On: 28/4/2023 3:08 PM

Upload File (Optional, Max File Size = 5MB): Choose File No file chosen

File Name	View
No records to display	

[Return](#) [Withdraw](#)

Updates:

+ Add Update Cancel Excel Export PDF Export Search

No.	Updated by	Description	Updated on
1	tr_shunding.lian@vitrox.com	Requested from testing team. Will update you in 3 working days.	28/4/2023 3:08 PM

Operational Successful
Ticket Withdrawn successfully

My Tickets

Tip: Facing an issue? Raise a ticket here by clicking "Raise Ticket" for further inquiries!

[+ Raise Ticket](#)

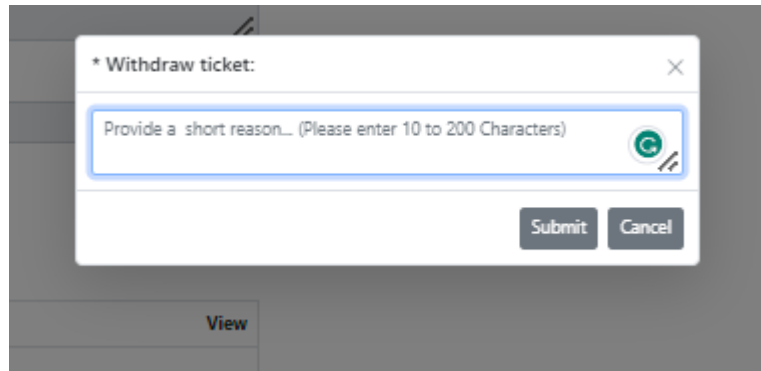
Active Inactive Search

Title*	Ticket Details			Dates dd/mm/yyyy		More
	Type	Priority	Status	Submitted On	Last Updated On	
Need Help on How to...	Academic	2	Open	28/4/2023 1:53 PM	28/4/2023 1:53 PM	View Details

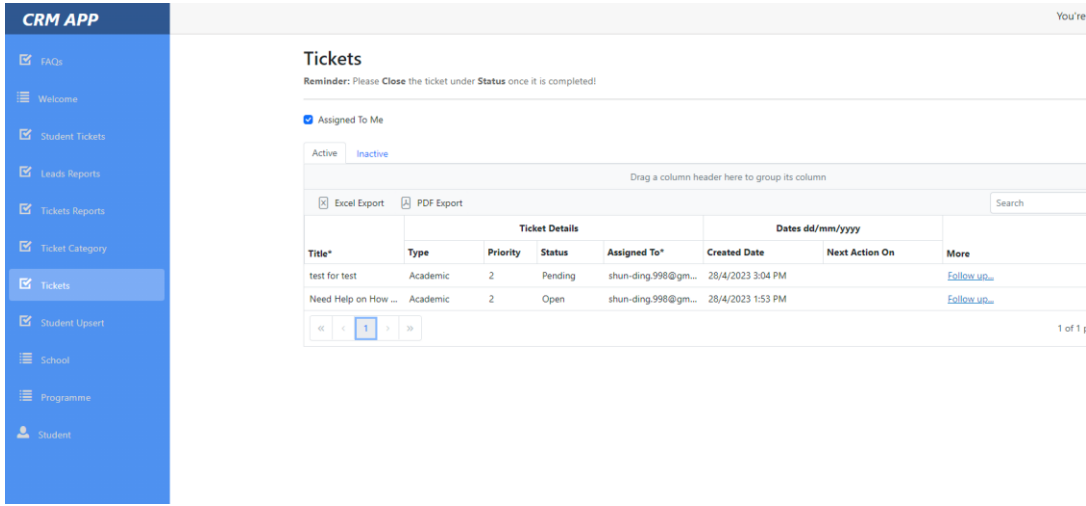
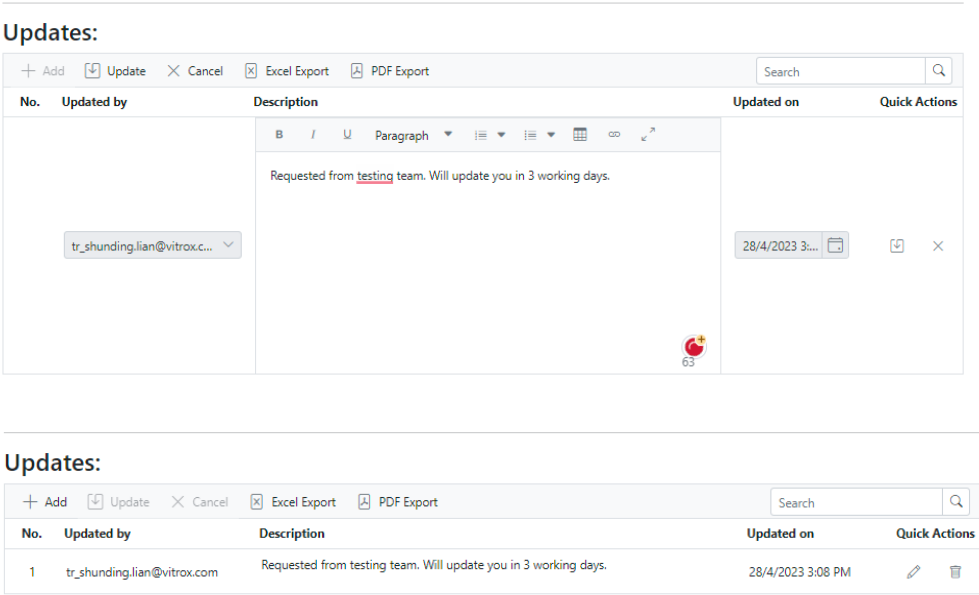
1 of 1 pages (1 items)

Customer able to cancel the withdrawal request.

Pass



Use Case Testing 4 [F004] Manage Ticket (Admin-Side)

Test Case	Status
<p>CSR or CSM can navigate to the ticket list to view and manage tickets.</p> 	Pass
<p>CSR or CSM can add follow-up comments.</p> 	Pass

CSM can reassign the person in charge (category) of the ticket.

Pass

Ticket's Follow Up

Reminder: Please Close the ticket under Status once it is completed!

* Ticket Title: test for test Priority: 2

* Category: Testing (dropdown menu open with options: Academic, Admission, Facility, Finance, General, Testing) Status: Pending Next Action By: Next action by

Created By: Name Created On: 28/4/2023 3:04 PM Last Updated On: 28/4/2023 3:08 PM

Upload File (Optional, Max File Size = 5MB): Choose File No file chosen

File Name	View	Quick Actions
No records to display		

[Return](#) [Update](#)

You might also like: [Operation Successful](#) Ticket updated successfully.

* Category: Academic Status: Pending Next Action By: Next action by

* Description: yes just testing

Created By: Name Created On: 28/4/2023 3:04 PM Last Updated On: 28/4/2023 3:08 PM

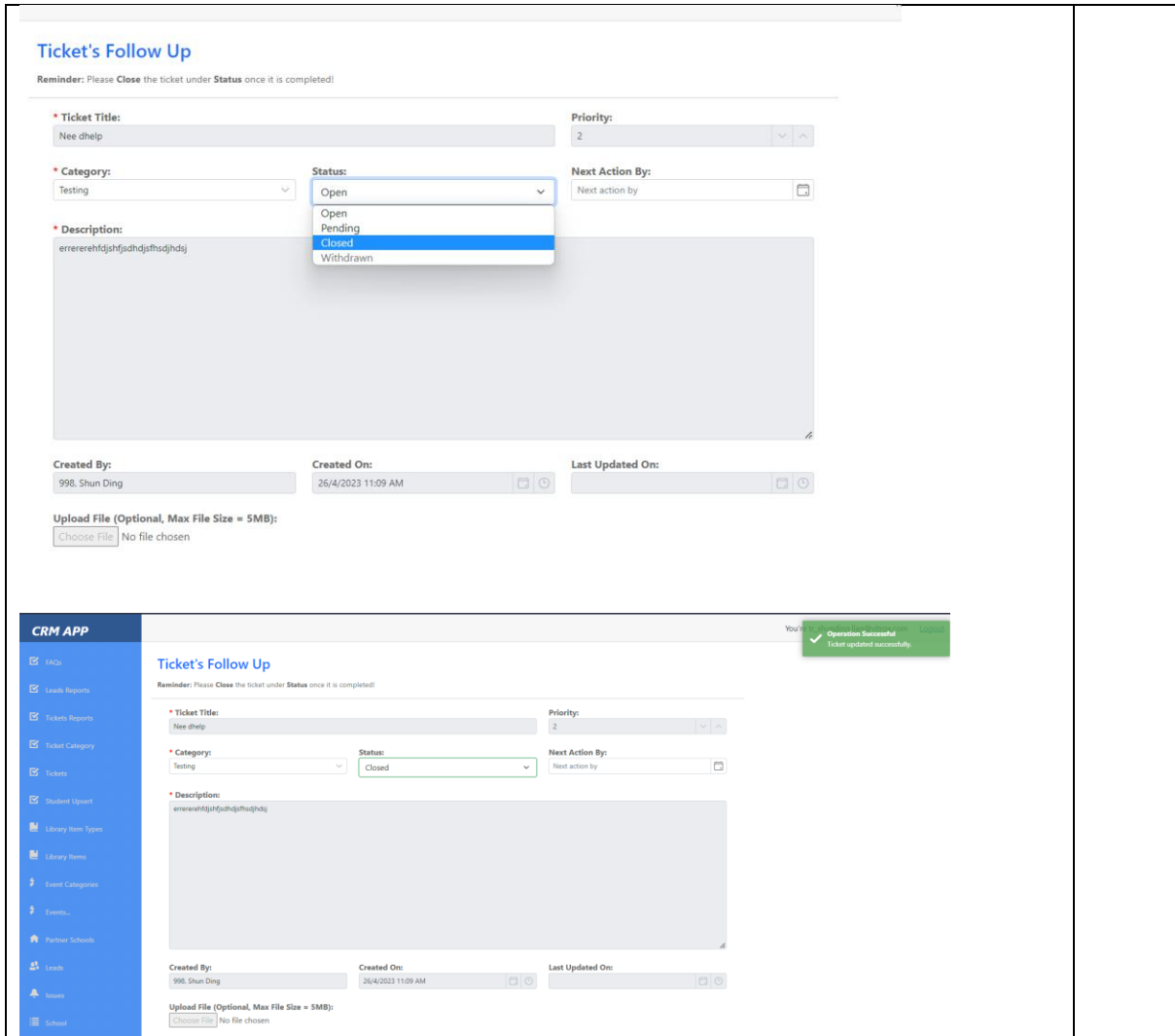
Upload File (Optional, Max File Size = 5MB): Choose File No file chosen

File Name	View	Quick Actions
No records to display		

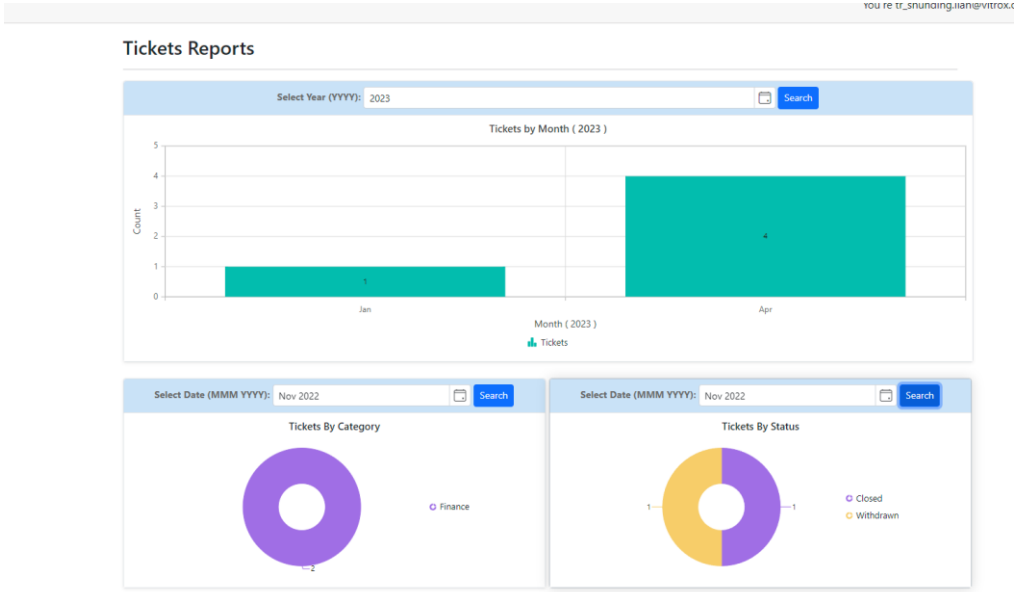
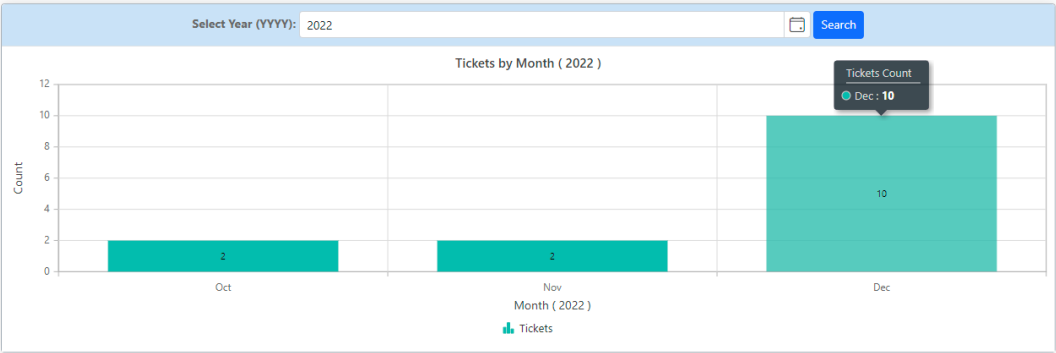
[Return](#) [Update](#)

CSR or CSM can change the status from Open or Pending to "Closed".

Pass

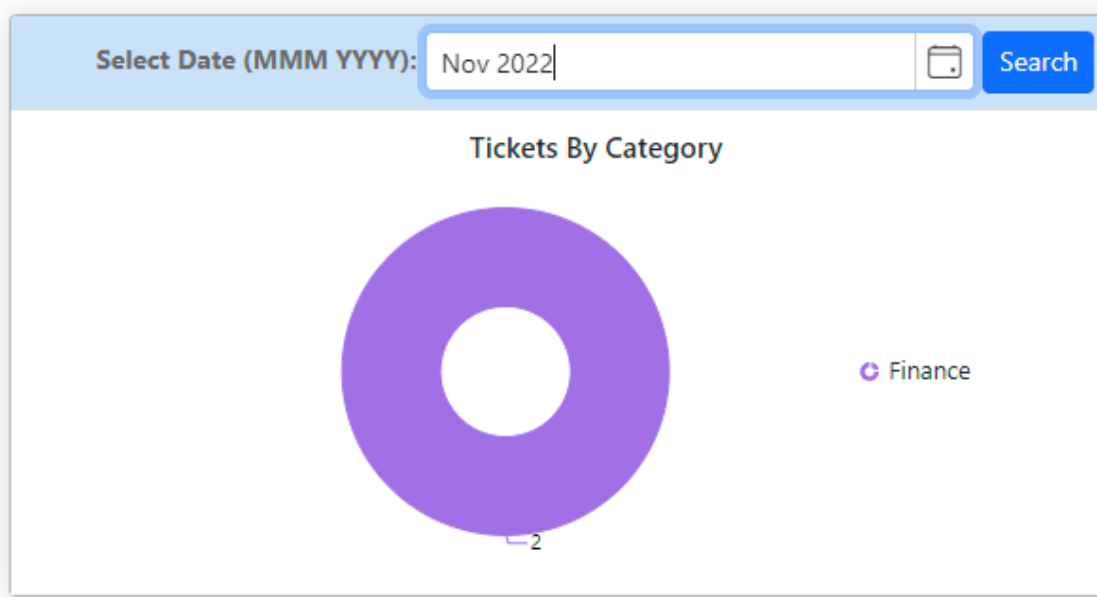


Use Case Testing 5 [F005] View Analytical Reports

Test Case	Status
<p>CSM can view the analytical reports.</p> 	Pass
<p>User can filter the data by year and system will show it in a chart.</p> 	Pass

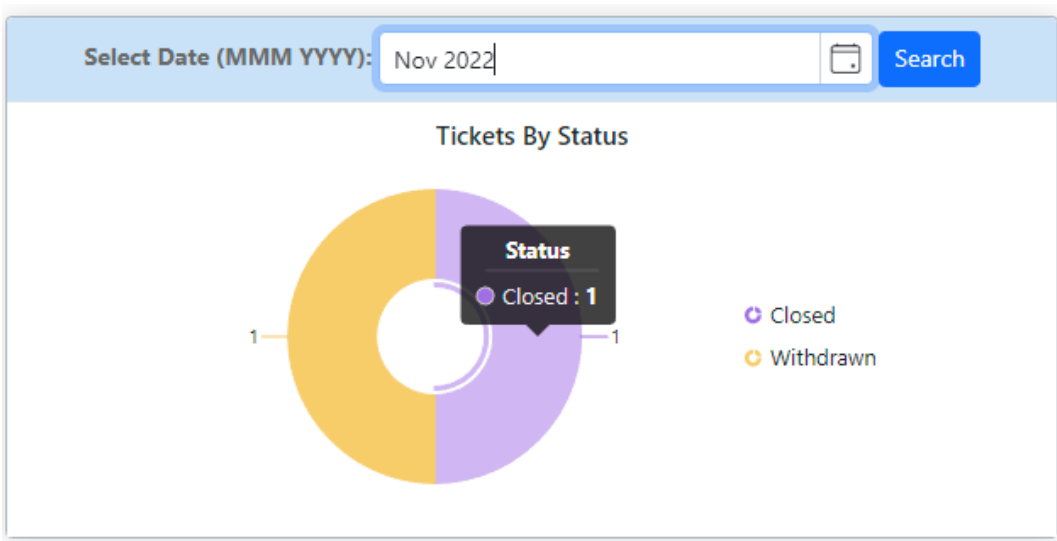
User can filter the data by category and system will show it in a chart.

Pas
s



User can filter the data by status and system will show it in a chart.

Pas
s



System will display “NO DATA AVAILABLE” if data is not found.

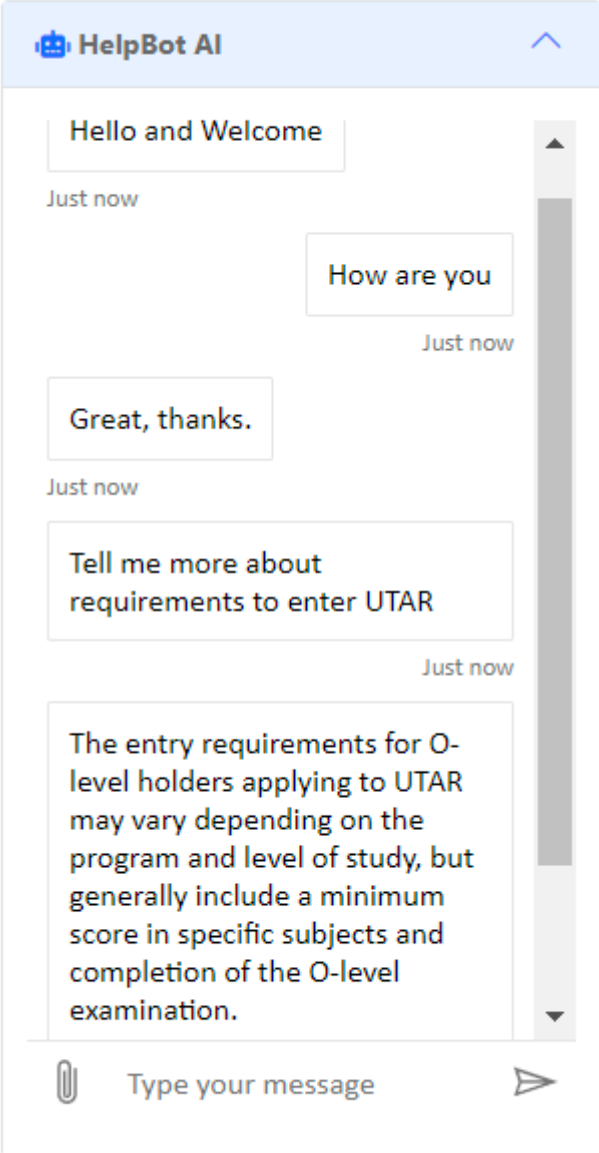
Pass

Tickets Reports

The screenshot displays the 'Tickets Reports' interface with three panels, each showing a search bar and a message indicating no data is available for the selected date.

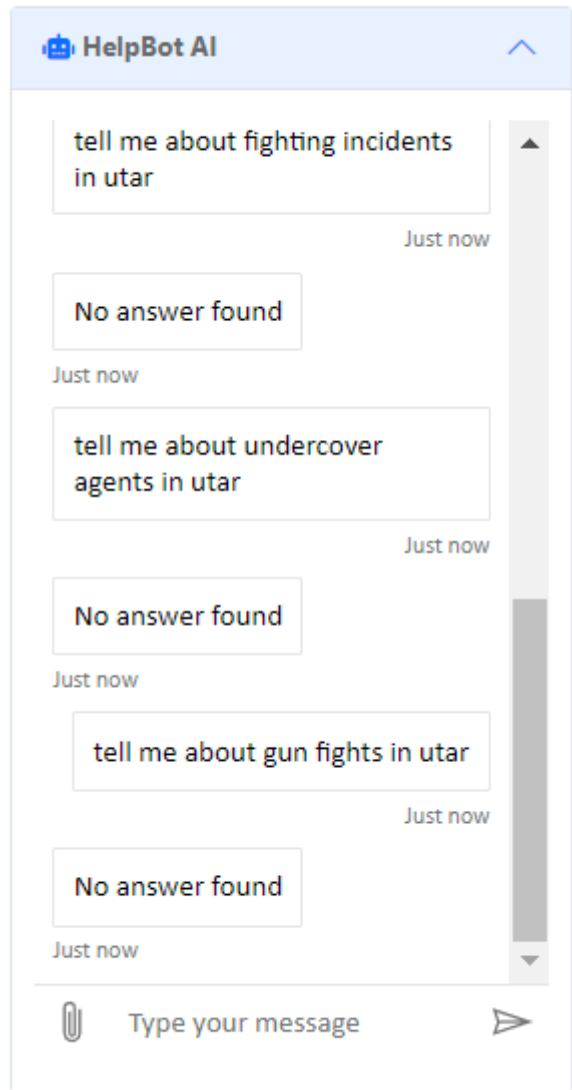
- Tickets By Year:** Search bar: "Select Year (YYYY): 2025". Message: "No Data Available For The Selected Date".
- Tickets By Category:** Search bar: "Select Date (MMM YYYY): Jun 2025". Message: "No Data Available For The Selected Date".
- Tickets By Status:** Search bar: "Select Date (MMM YYYY): Jun 2024". Message: "No Data Available For The Selected Date".

Use Case Testing 6 [F006] Use Chatbot Service

Test Case	Status
<p data-bbox="204 297 954 331">Users can interact with the chatbot to solve their question.</p>  <p data-bbox="220 347 821 1496">The screenshot shows a chatbot interface titled 'HelpBot AI'. The chat history includes: a system message 'Hello and Welcome' (Just now), a user message 'How are you' (Just now), a system message 'Great, thanks.' (Just now), a user message 'Tell me more about requirements to enter UTAR' (Just now), and a system message providing detailed information: 'The entry requirements for O-level holders applying to UTAR may vary depending on the program and level of study, but generally include a minimum score in specific subjects and completion of the O-level examination.' At the bottom, there is a text input field with a paperclip icon on the left, the placeholder text 'Type your message', and a send button on the right.</p>	<p data-bbox="1273 297 1337 331">Pass</p>

System will show “No Answer” if it cannot answer the question asked by user

Pass



6.3 Project Challenges

1. Knowledge Gap: A key challenge that may arise in developing a CRM system for a final year project is a knowledge gap between the project requirements and the skills and knowledge of the student. This can be addressed by ensuring that the student has sufficient training and education about the project requirements, as well as providing resources for learning and development as needed.

2. Time Constraint: Another challenge that the student team may face is time constraints. Developing a CRM system can be a time-consuming process, and it is important to ensure that the student has sufficient time and resources to complete the project within the designated timeframe. This can be addressed by carefully planning the project timeline and ensuring that resources are allocated effectively.

3. Rapid Changes and Delivery: The need for rapid changes and delivery can also be a significant challenge for a school final year project on a CRM system. This may be due to changing requirements, academic deadlines, or other factors. To address this challenge, the student has to adopt an agile development approach, with frequent iterations and constant communication with stakeholders. Also, the student will require constant mentoring from industrial experts, since a CRM system is a professional tool. This can help to ensure that the system is developed quickly and effectively, and can be adapted to meet changing requirements as needed.

6.4 Objectives Evaluation

1. CRM system for managing customer support request tickets: Achieved

The CRM system has successfully streamlined the process of managing customer support request tickets. By providing features such as raising tickets, managing tickets on both the customer and admin sides, and allowing customer service representatives (CSR) and customer service managers (CSM) to follow up, close, or reassign tickets, the system has enhanced the customer service experience.

2. CRM system providing a chatbot for system admin and customers: Achieved

The implementation of a chatbot within the CRM system has enabled users, including customers, CSRs, and CSMs, to interact and receive assistance with common issues or questions. This feature has contributed to a more efficient and user-friendly experience, improving customer satisfaction and support.

3. CRM system offering a user dashboard for analytical reports on ticketing management: Achieved

The CRM system now provides a user dashboard for CSMs to access and analyze reports related to ticketing management. With the ability to filter by time, category, and status, the dashboard allows managers to gain valuable insights into customer service operations and make informed decisions to further enhance the customer experience. This feature has successfully met the objective of providing a comprehensive overview of ticketing management analytics.

6.5 Concluding Remark

In conclusion, Chapter 6 extensively delves into the system evaluation and discussion aspects of the Final Year Project. Throughout this chapter, various methods and techniques have been examined to assess the system's performance, functionality, and usability. In this context, testing is conducted to identify any potential system flaws. This testing procedure ensures that the system's primary features or functions are operational and ready for public deployment. Moreover, several project challenges have been encountered during different phases, such as design, implementation, and evaluation. By analyzing these challenges and the strategies employed to overcome them, a deeper comprehension of the intricacies and complexities involved in the project has been achieved. These experiences have contributed significantly to the project's overall success. Moving forward, the insights gleaned from the system evaluation and discussion will shape the project's final conclusions and recommendations, which will be presented in the final chapter, Chapter 7.

CHAPTER 7

Conclusion And Recommendations

7.1 Conclusion

In conclusion, the development project has been a resounding success. Through meticulous planning, execution, and dedication, the CRM system for customer service relationship management has been created, which not only meets the initial vision but also delivers valuable features to enhance customer service experiences.

The project's scope has been accomplished, as all the planned modules and functionalities have been implemented effectively. The system handles customer support requests through a central ticketing system, provides a platform for communication between customers and the customer service team, and offers a user dashboard with analytical reports for better tracking of the customer service process.

The objectives of the project have been achieved by the CRM system for customer service relationship management. It aids the customer support team in managing support request tickets, facilitates online chat between system admins and customers through a chatbot, and provides the organization's manager with a dashboard to visualize analytical results related to ticketing management. As a result, the CRM system fosters an improved customer service experience, contributing to increased customer retention rates.

In terms of contributions, the project has successfully developed a CRM system that focuses on customer service management. The system allows organizations to manage customer inquiries more efficiently, improves communication between customers and the customer service team, and provides valuable analytical insights for better decision-making. By implementing these features, the project has made a significant contribution to enhancing the customer service experience and reducing customer churn rates.

For limitations, the system will face maintenance and updates challenges. The system may require regular maintenance and updates, which could result in downtime and additional costs. This is especially true given Blazor is a new framework from Microsoft. Also, the components such as Syncfusion updates from time to time, which will require change of code.

7.2 Recommendations and Future Enhancements

This chapter offers suggestions for further research and improvements to the current system based on the conclusions and learnings from the earlier chapters. The goals of these suggestions are system performance and functionality enhancement for development and expansion. Below is the recommendations that suggest: -

1. Chat System Implementation using signal R.

Implementing a chat system using SignalR is a crucial recommendation for a CRM app. With the help of the real-time communication library SignalR, clients and servers can communicate in both directions, giving users access to instant messaging. In order to quickly reply to consumer enquiries, address problems, and offer support, this capability can be especially helpful for customer service agents and supervisors. Additionally, real-time messaging can also improve customer satisfaction and build better customer relationships. SignalR's technology uses web sockets, ensuring a fast, secure, and reliable communication channel between the client and the server. This helps to reduce latency and delays, providing a more efficient and effective communication experience for customers and customer service representatives. Furthermore, SignalR is a scalable and reliable solution for any app due to its server-side components' ability to handle large volumes of messages and user connections. A CRM app's functionality and usability can be enhanced by implementing a chat system utilizing SignalR. This will lead to better customer service, which will promote business growth.

2. Mobile App Integration using .net MAUI.

An open-source framework called MAUI (Multi-platform App UI) is used to create cross-platform programs that run on Android, iOS, and Windows. Integrating a mobile app using .NET MAUI can provide users with a seamless experience across multiple devices, leading to better customer engagement. The codebase of the program may be shared between several platforms' thanks to .NET MAUI, which cuts down on both the

cost and time of development. Additionally, it allows for the simultaneous implementation of updates and improvements across all platforms, resulting in a uniform user interface. The visibility and accessibility of a mobile app can be increased through integration using .NET MAUI, which will enhance adoption rates. As they can access the app from their mobile device and offer support no matter where or when they are, it can be very helpful for customer care workers who are constantly on the go. Overall, .NET MAUI integration may improve user experience, save down on expenses and development time, and boost adoption rates for mobile apps, making it a crucial suggestion for CRM apps.

3. Transactional Chatbot Implementation

A transactional chatbot can lessen the strain of customer care professionals by automating routine CRUD tasks like updating a customer's profile or checking the status of an order, as well as responding to frequently asked questions. Customers who use transactional chatbots might also benefit from a more individualized experience because they can get updates and real-time responses to their questions. With the help of Natural Language Processing (NLP) and Machine Learning (ML) algorithms, the chatbot can understand the customer's intent and provide accurate and relevant responses, making the customer service experience more efficient and effective. By retrieving and updating data directly from the database, a transactional chatbot can increase data consistency and accuracy while lowering the possibility of human error. Having access to real-time data and insights can help managers and customer service representatives make better decisions.

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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	Study week no.: 2
Student Name & ID: Lian Shunding(19ACB05002)	
Supervisor: Ts Tan Teik Boon	
Project Title: Customer Relationship Management (CRM) System for Customer Service Management	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Revise the work done in FYP1, then look for relevant sources on the Internet.

2. WORK TO BE DONE

- Revise Project Objectives.

3. PROBLEMS ENCOUNTERED

- Uncertainty of Project Objectives.

4. SELF EVALUATION OF THE PROGRESS

- Need to plan the project properly.



Supervisor's Signature



Student's Signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	Study week no.: 4
Student Name & ID: Lian Shunding(19ACB05002)	
Supervisor: Ts Tan Teik Boon	
Project Title: Customer Relationship Management (CRM) System for Customer Service Management	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Completed Functions For Ticket Lists

2. WORK TO BE DONE

- Work On Ticket Upsert

3. PROBLEMS ENCOUNTERED

- Logic hard to understand.

4. SELF EVALUATION OF THE PROGRESS

- Have to spend more time researching.



Supervisor's Signature



Student's Signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	Study week no.: 6
Student Name & ID: Lian Shunding(19ACB05002)	
Supervisor: Ts Tan Teik Boon	
Project Title: Customer Relationship Management (CRM) System for Customer Service Management	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Completed Student Upsert

2. WORK TO BE DONE

- Work on followup ticket and email sendgrid

3. PROBLEMS ENCOUNTERED

- A large program requires a lot of time.

4. SELF EVALUATION OF THE PROGRESS

- Need to work harder.



Supervisor's Signature



Student's Signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	Study week no.: 8
Student Name & ID: Lian Shunding(19ACB05002)	
Supervisor: Ts Tan Teik Boon	
Project Title: Customer Relationship Management (CRM) System for Customer Service Management	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Ticket follow up

2. WORK TO BE DONE

- Charts for analytical reports

3. PROBLEMS ENCOUNTERED

- Unfamiliar with concept and data binding

4. SELF EVALUATION OF THE PROGRESS

- Need To Spend More Time To Learn.



Supervisor's Signature



Student's Signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	Study week no.: 10
Student Name & ID: Lian Shunding(19ACB05002)	
Supervisor: Ts Tan Teik Boon	
Project Title: Customer Relationship Management (CRM) System for Customer Service Management	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Charts for dashboard

2. WORK TO BE DONE

- Chatbot function

3. PROBLEMS ENCOUNTERED

- Hard to implement because Facebook does not allow unverified developers to use their plugin.

4. SELF EVALUATION OF THE PROGRESS

- Find other methods.



Supervisor's Signature



Student's Signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	Study week no.: 12
Student Name & ID: Lian Shunding(19ACB05002)	
Supervisor: Ts Tan Teik Boon	
Project Title: Customer Relationship Management (CRM) System for Customer Service Management	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Chatbot Done

2. WORK TO BE DONE

- Report to be finalized.

3. PROBLEMS ENCOUNTERED

- Need to revise system to understand the logic.

4. SELF EVALUATION OF THE PROGRESS

- Work Harder



Supervisor's Signature



Student's Signature

POSTER



FACULTY OF INFORMATION COMMUNICATION AND TECHNOLOGY

CUSTOMER RELATIONSHIP MANAGEMENT (CRM) SYSTEM FOR CUSTOMER SERVICE MANAGEMENT



1. INTRODUCTION

- The CRM system is mainly focused to be utilised to reduce customer churn rate.
- It is a system that provides functionality such as streamlining and automating sales process.

2. PROBLEM STATEMENT

- The existing CRM systems focus on pre-sales closing.
- Bad after-sales service induce high customer churn rate.



3. OBJECTIVES



TICKET MANAGEMENT
SYSTEM

DASHBOARD FOR DATA
CENTRALIZING

CHATBOT SERVICE

4. CONTRIBUTIONS



FOCUSES AFTER-
SALES PROCESS

INCREASE CUSTOMER
RETENTION

PROJECT DEVELOPER: LIAN SHUNDING
PROJECT SUPERVISOR: TS TAN TEIK BOON

PLAGIARISM CHECK RESULT

FYP2-CRM SYSTEM FOR CUSTOMER RELATIONSHIP MANAGEMENT

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TECHNOLOGY**

Full Name(s) of Candidate(s)	Lian Shunding
ID Number(s)	19ACB05002
Programme / Course	CS
Title of Final Year Project	Customer Relationship Management (CRM) System for Customer Service Management

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Name: Mr Tan Teik BoonDate: 28 April 2023

Signature of Co-Supervisor

Name:

Date:



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FACULTY OF INFORMATION & COMMUNICATION TECHNOLOGY (KAMPAR CAMPUS)

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