

Analytical Human Resource Management System

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Declaration

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A handwritten signature in black ink, appearing to read "Yew".

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Abstract

Human Resource Management (HRM) has been known for being slow and arduous due to the lack of agility, contributed by the large amount of data exchange needed to perform HR related tasks. A HRM software helps in making it more fluid and efficient, however, most HRM software is rigid and tailored for a specific target group of users. It is also no longer enough for HRM software to be a passive tool waiting to be used. HRM software must actively monitor workforce status and report any anomaly or possible complications. To confront these challenges, a cloud-based Human Resource Management Service System will be developed. It is determined that this system will help companies that employ shift-based work to be productive with its workforce and solve problems which may lead to low productivity such as attendance. Its key features would include workforce management, shift management, leave self-service, dashboard analytics, training module, payroll module, admin management, company management, benefits & compensation, reporting module and role management. The methodology used in this project will be the Agile Model. The system will be coded entirely in Microsoft Visual Studio Community 2022 with supporting tools such as Microsoft Azure and Github. The system adopts a monolithic architecture and uses the ASP.NET Core MVC framework version 7.0. A SQL database is to be hosted on Microsoft Azure, and APIs will be provided to allow CRUD functionality for mobile applications that complement the system. To ensure the system meets all functional requirements listed and to assure the system's quality, black-box testing would be performed on the system to thoroughly test the functionality offered by the system. The result of the project is a HRMS that allows great freedom of customization to be used in any type of industry. The HRMS has successfully lowered hardware costs, provided ease of access, accurate productivity tracking and high adaptability. Several limitations remain, such as unable to locate data quickly and missing potential in dashboard analytic, which would likely be implemented in future improvement.

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Chapter 1

Introduction

1 Introduction

This chapter discusses the problem currently faced by human resource management which the project aims to solve, a brief introduction to the proposed solution which is an Analytical Human Resource Management System, and the proposed components of aforementioned system as well as how the components helps in the problem stated. By the end of this chapter, the reader will gain an understanding of the problem the project is solving, and the scope of the project.

1.1 Problem

Michael Beer, creator of The Harvard Model of Human Resource Management, defined Human Resource Management (HRM) as a strategic approach to the employment, development and well being of the people working in an organisation. HRM is an all encompassing effort that involves all management decisions and actions that can change the relationship between an organisation and its human resource. It aims to take full advantage of human resources that are at the disposal of the organisation and improve the performance of employees to achieve the organisation's objective (HRD Connect, 2019).

With that said, HRM remains one of the most challenging efforts in an organisation. HRM faces different problems everyday due to the general complexity from managing actual living people with different personality, job position and needs. However, traditional HRM and HR related tasks have long been known for being long and arduous due to the lack of agility (VantageCircle, 2021). This can be mostly attributed to the huge amount of data HR departments need to collect and maintain (SutiSoft, 2017). Since HR are responsible for every employee in the organisation, their responsibility includes a large amount of administration tasks (Zoho, 2020). From approving time off and running payroll, all HR processes require a large amount of data exchange. In contrast, employees and employers may require HR information at any given time, from anywhere and usually in a short time (SutiSoft, 2017). With time-consuming HR processes, employees might find themselves unengaged and unsatisfied in their work, leading to high turnover rate.

This could be somewhat alleviated using automated systems which speed up the process and decrease the workload of HR employees. It is very common for companies to invest large amounts of funds into multiple HRM systems, making HRM systems always in demand. However, traditional HRM systems often lack adaptability to react to world state, making them unable to keep up with the evolution of various industries' business practices. Several common complaints received about HRM systems are listed below.

1.1.1 HRM Software is Rigid and Tailored for a Specific Industry

HRM software is commonly customised to suit a specific organisation's business practices. This means most HRM software do not perform well in industry outside their specialty, which forces cross-industry companies having to employ several HRM systems at once. In addition, when an organisation evolves, the HRM lacks the ability to follow that evolution, making them frequently obsolete. A survey highlights many instances of disappointment due to system limitation, like attendance taking and reporting (TrustRadius, 2021).

1.1.2 HRM Software have High Learning Curve

HRM software commonly targets companies with mostly white-collar employees who are experienced with computing systems and are well-educated. Those unfamiliar with computing systems are unable to utilise HRM effectively (TrustRadius, 2021), leaving industries that employ low-skilled workers without a good HRM choice. Even when a HRM targets the labour industry, the HRM does not include the worker as a user of the system, rather only allowing administrative staff to access the HRM.

1.1.3 HRM Software is a Passive System

Recent developments in the world such as the Covid-19 pandemic proves that the landscape of HRM is ever-changing. It is no longer enough for HRM to only be a passive system assisting in tasks. Hidden trends such as high turnover rate could easily be missed without thoroughly checking through every report, and could lead to a human resource crisis for a company. Although all the information needed for checking whether the workforce is in healthy status is available, without transforming them into reports, it is hard to interpret the data directly. Thus, constant analytics should be performed on critical metrics to ensure any anomaly that happens gets reported immediately. HRM should be actively monitoring the workforce and monitoring for any anomalies with advanced analytics.

1.2 Proposed Solution : Cloud-Based Analytical HRM System

The solution to the problem is to develop a smart cloud-based Human Resource Management Service which aims to provide a centralised platform to store all the HR related information with automated information transfer. The system will be shift oriented, whereby every staff member is assigned a specific period of work time such as 9AM to 6PM with rest time in between that could be repeatable or one time deal. It will track attendance, performance and payroll according to shifts worked by employees. The shift will be highly customizable, making it viable for all types of industry. It will be hosted on the service provider's server and accessible by any company with an Internet connection.

Information privacy and security would be controlled by an access level control module. This system would also emphasise on employee self-service, which aims to remove some administrative tasks from the HR employees to normal employees. The administrative tasks the system is aiming for are leave requesting and work scheduling. To increase employee engagement, employees may now access HR information they need immediately through their devices. Information such as payroll calculation would be transparent and visible by workers. On top of that, the system would be highly customizable, allowing companies to inject their own policies and culture into the system. In addition, the system would be equipped with several advanced analytics algorithms to process raw data into useful information, making workforce monitoring easier.

To fulfil its goal of improving the agility and fluidity of HRM, the following modules will be targeted:

1.2.1 Workforce Management

Responsible for managing staff profile, performance rating and related documents. Home to the access level control, which will dictate what every employee gets access to. Also allows staff to self-edit their profile, and submit changes to their documents.

1.2.2 Dashboard Analytics

This module tracks several important metrics constantly such as headcount and absent rate, with the intention of analysing them and displaying the result on several dashboards for easier understanding.

1.2.3 Leave Self-Service

This module automates paid time off accrual and sick times accrual. This module also handles leave request submission by employee and leave request approval by employer.

1.2.4 Company Management

Since the system is a service-offering system, many companies will have their own database within the system. A module that allows the service provider's technician to manage and maintain company databases and information is provided.

1.3 Objectives

Based on the problem stated prior, the described system set out to fulfil several objectives in order to solve the underlying problem plaguing traditional HRM.

1.3.1 Lower Hardware Cost

Since the system is cloud-based, the company does not need to invest in IT infrastructure in order to utilise the HRM system. This means that the company can reduce cost spend in HRM.

1.3.2 Ease of Access

There is a mobile version of this system that caters to people not acquainted with computer systems. This lowers the access barrier for using the system and allows more employees to utilise the self-service functions of the proposed system.

1.3.3 Accurate Productivity Tracking

The real-time attendance system can be used to accurately track employee attendance and detect unproductive employees. This makes sure no employees can cheat the system. In addition, the tracking provides information that can be used to monitor overall organisation productivity.

1.3.4 Adaptability

The shift-based attendance system and the leave management system allows any industry to utilise the HRM. Whether the company tracks attendance by days, weeks, or period of hours, the company can utilise the proposed system. In addition, the system provides customizability which grants it adaptability to suit most company's needs.

1.4 Advantages

1.4.1 Competition Analysis

Table 1.1: Competitor HRM's Attributes

Software	Sapling HR People Ops Platform	Eddy HR Suite
Website	https://www.saplinghr.com/plans	https://eddy.com/
Price	\$6.99 per user monthly with optional add ons	Customised pricing
Real Time Attendance Tracking	None	Simple stopwatch-like time tracking with start and end buttons.
Payroll	No	Yes
Work Scheduling	No	No
Leave Self-Service	Yes, with \$175 per month add on.	Yes

Dashboard Analytics	Common dashboard and employee experience tracking.	Simple information dashboard with no analytics.
Other Features	<p>Onboarding</p> <ul style="list-style-type: none"> - Give new hires access to update their personal profile and complete all required paperwork. <p>Surveys</p> <ul style="list-style-type: none"> - Analyse employee experience feedback and track progress overtime. 	<p>Hiring</p> <ul style="list-style-type: none"> - Applicant tracking system helps find and hire reliable workers in less time. - Post openings to multiple job boards in a single click. - Create your own customizable company careers page. - Automate communication with applicants.

By comparing the proposed system with the competitor's attribute, it can be said the proposed system's contributions are as follows:

1.4.2 Cloud Based

The system will be hosted in the service provider's central server. This means that the company who wishes to use the system does not need to install any hardware or IT infrastructure to be able to use this system. They would only require Internet connection. The company that uses the system would not need to bother with maintenance of the system and the databases involved since it is the service provider's responsibility.

1.4.3 Automated Workflow

Several automated processes are used to assist in workflows such as scheduling and paid time off accrual, greatly enhancing the efficiency of said processes. This ensures a large portion of the workflow can be automated, greatly reducing the need for human effort, meaning the company can reduce costs in managing human resources.

1.4.4 Dashboard Analytics

Dashboard analytics are used to provide crucial information by calculating important metrics for the company such as predicting costs of labour. Said analytics is very useful in understanding the current workforce state at a glance.

1.4.5 Real-Time Attendance Tracking

The proposed system will contain attendance tracking using advanced techniques such as face recognition and geofencing to increase accuracy. The features will be built with customizability in mind, allowing attendance tracking based on shifts scheduling and work assigned. In addition, the tracking system will interface with the payroll module in the system to simplify calculation of payroll.

1.4.6 Self-Service and Transparency

Employees are allowed to perform minor administrative tasks on their own such as submitting leave requests and modifying personal details. Employees can view how their shifts are assigned and how their payroll is calculated, increasing transparency and trust. This further delegates the responsibility away from HR staff, allowing more work to be done and processed quicker, enhancing employee satisfaction.

1.5 Contributions

Although most organisations that have a HRM department, due to the fact that the system is built with shift-based work in mind, several industries could benefit greatly from our proposed system.

The industries that the system could contributes to are:

1.5.1 Manufacturing Company

The system is designed with factory workers in mind, and thus manufacturing companies that own factories is our main target. The attendance system will be useful in tracking whether a worker completes a shift, and leave request management would decrease unexpected absence.

1.5.2 Construction Company

Since construction companies pay workers by shift work, the system will also be suitable for them.

1.5.3 Retail Company

Most retailers such as convenience stores and supermarkets have cashiers and staff work around day shift and night shifts. This system can be used by retailers to keep track of shifts and payroll.

1.5.4 Emergency Services

Emergency Services also employs shift work, with the one working their shifts on standby for emergency response. They might not necessarily pay their staff according to shifts worked, but the system would still be useful to track overtime worked.

1.6 Project Plan

The project will be separated into several phases which are project conception, literature review, methodology and requirement analysis, design and implementation, testing and submission.

Each phase contains several milestones that must be completed. Once all milestones in a phase are successfully completed, the project will move to the next phase. An estimated deadline is provided to ensure the project is completed within the time limit.

Table 1.2: Estimated Date for Project Milestone Completion

Milestone	Estimated Finish Date
<u>Project Conception</u>	
Proposal Preparation	21/2/2022
Project Goals and Objectives	26/2/2022
Project Plan	8/3/2022
Project Scope	18/3/2022
<u>Literature Review</u>	
Company Background	23/3/2022
Project Background	26/3/2022
Literature Review	2/4/2022
Feasibility of Study	9/4/2022
<u>Methodology and Requirement Analysis</u>	
Research Approaches	23/4/2022
SDLC Methodology	7/5/2022
Requirement Analysis	14/5/2022
<u>Design & Implementation</u>	
Diagrams Creation	21/5/2022
UI Design & Development	11/6/2022
System Module Design & Development	2/10/2022
Database Design & Development	23/10/2022
<u>Testing</u>	
Initial Unit Testing	30/10/2022
System Testing	6/11/2022
Problem Identification	13/11/2022

Problem Correction and Debugging	27/11/2022
Final Testing	3/12/2022
<u>Submission</u>	
User Guides Preparation	10/12/2022
Fine Tuning Documentation	24/12/2022
Project Handover	31/12/2022

1.7 Project Team & Organization

As the proposed system's are complex and contain a lot of components, to ensure it is feasible, three teams of two are assigned for this project.

1.7.1 Website and Backend Team: Yaw Foong Zeng and Teo Jian Xiang

This team will be responsible for creating the backend to support the both website and mobile version of the system, which includes business logic, databases and API required by the mobile version of the system. In addition, the team will be responsible for creating the website where companies use to access the HRM.

1.7.2 Mobile Team: Lim Zhi Shuang and Liew Yan Lin

This team will be responsible for developing the mobile version of the system. Some functions differ from the website version, as such, the mobile version can be seen as a lite version of the system. This team's main focus will be developing the real-time attendance tracking system using face recognition and geo-fencing.

1.7.3 User Interface Team: Looi Jia Toong and Angelina

This team will be responsible for creating the UI design for both versions of the system. In addition, the team will assist in the previous two teams by developing UI heavy modules.

1.8 Chapter Summary and Evaluation

This chapter provided a description of the problems faced by modern HRM used by companies as well as proposing a cloud-based analytical HRM as the solution.

This chapter detailed the components that make up the proposed system, as well as the features it offered which gave it an advantage over its competitor's HRM.

This chapter also provided a detailed timeline and team organisation for the development of the project.

Chapter 2

Literature Review

2 Literature Review

In this chapter, previous research and literature written on the subject of elements related to Analytical HRM will be revealed and reviewed. First, this chapter will explain what is a HRMS via review of several literature and discuss their importance. Continuing, factors impeding HRMS adoption is discussed among several literature reviews. Next, HR analytics will be discussed and defined via studying related articles and the result of applying HR analytics will be discussed. After that, the chapter reviews the reason for unsuccessful HR analytic adoption. Finally, a feasibility study is conducted to determine the technical feasibility and operational feasibility of the system.

2.1 Human Resource Management System

2.1.1 Definition of HRMS

There are several interchangeable terms that can be used to refer to HRMs, such as e-HRM, HR intranet, web-based HR and HRIS. The earliest definitions of HRMS defined HRMS as a “specialised information system within the traditional functional areas of the organisation, designed to support the planning, administration, decision-making and control activities of HRM” by DeSanctis in 1986. However, several experts disagreed with the prior definition as it narrows the scope to the HR position and disregards the adoption and deployment of information systems in the corporate organisation. Kavanagh et al. (2012) mentioned that although HRMS is mainly software and hardware, the people, forms, policies and procedures, and data are also part of the system. Lately, the focus of HRMS has shifted to more strategic applications in an organisation such as recruitment, performance analysing, compensation management and self-service features (Chakraborty, 2013).

With recent developments, several experts agreed that a line cannot be drawn between IT-based information systems for HR and internet based HR applications as these two are basically doing the same thing. Thus, Ruel et al. (2011) defined HRMS as “all IT-based information systems and applications either stand alone or networked, for human resource management purpose, be it for facilitating HR practices, policies or strategies”.

2.1.2 Importance of HRMS

HRMS can perform most of the HR processes within an organisation on a daily basis, which could benefit the organisation in several ways. For example, HRMS implies automation of tasks and processes, which helps reduce the use of resources, be it financial, material and human. Reduction of HR costs, less usage of paper as well as to assist managers in the HR process are but some of the instances of resource usage reduction (Chakraborty, 2013).

According to Hendrickson (2003), HRMS increase the efficiency and effectiveness of HR processes in an organisation as well as provide self-services features such as computer based training and online recruitment. In addition, HRMS produces data as a byproduct which can be transferred via front-end web applications to employees and line-managers (Ruel et al., 2011). This in turn creates more accurate data and saves time as employees can enter and update data by themselves. HRMS reduces information inaccuracy by tracking and controlling human resources related transactions (Lengnick-Hall & Moritz, 2003).

In short, HRMS has become increasingly important for performing HR-related functions in an organisation. It allows large corporations to effectively support a large workforce while still having low time and financial costs. It allows managers to make better managerial decisions by utilising the data captured from the HRMS.

2.1.3 Factors preventing HRMS adoption

Numerous studies have been done on factors preventing HRMS adoption despite the clear benefits it provides. These studies have mainly followed Diffusion of Innovation theory which was provided by Rogers (2003) since HRMS is regarded as a HRM innovation. In his theory, Rogers linked initial adoption decision to five specific attributes: relative advantage, complexity, compatibility, trialability and voluntariness (Rogers, 2003). In another research five contextual factors were identified which influence innovation adoption: innovation characteristics, organisational characteristics, environmental characteristics, task characteristics and individual characteristics (Kwon & Zmud, 1987). Based on previous studies and the research model of Teo et al. (2007) and Troshani et al. (2011), there are three prominent factors affecting HRMS adoption: organisational, technological and environmental.

Organisational factors represent organisation characteristics which prevents the adoption of HRMS. Level of centralization in an organisation can affect HRMS adoption, as stated by Yang et al. (2007) since resistance from lower level managers or employees can make HRMS adoption difficult. In addition, organisation sizes could define the needs of HR functions (Hendrickson. 2003). For instance, a small company with less than 10 employees may not be able to justify implementing a costly HRMS. Furthermore, HRMS expertise level in an organisation is also a significant factor. The lack of IT knowledge and competence in utilising HRMS has slowed the urgency of HRMS adoption (Teo et al, 2007).

Technological factors represent the technology characteristic of an organisation which can influence HRMS adoption. This mainly alludes to technology readiness of an organisation which depends on said organisation's technology infrastructure and IT human resources' expertise level (Oliveira & Martins, 2010). The infrastructure available greatly affects the type and scale of HRMS an organisation can adopt, and expertise of IT human resources

greatly influences whether the maintenance of the HRMS can be done under low cost, making it operate continuously without fail. Without both components, adoption of HRMS becomes costly and unfeasible (Oliveira & Martins, 2010).

Environmental factors describe physical characteristics the organisation operates under, such as the area they operate in, industry-specific characteristics, government regulations and supporting infrastructure (Oliveira & Martins, 2010; Troshani et al., 2011). Competition can be a great motivator for adoption of HRMS. As competitive pressure grows to reduce cost and serve a more strategic role as well as to better manage the employees in the organisations, firms have realised that they cannot be competitive if they do not manage their human resources effectively (Teo et al., 2007), leading to adoption of HRMS. Conversely, if none of their competitors are utilising HRMS, the organisation is more reluctant to adopt HRMS. Besides competition, governments also can play a vital role for encouraging technology adoption by raising awareness, training, and support, and funding (Troshani et al., 2011).

2.2 HR Analytics

2.2.1 Definition of HR Analytics

Human Resource Analytics (HRA) first appeared in the HR published literature in 2003-2004. Lawler et al (2004) distinguish HRA as separate from HR metrics. HR metrics are a measure of key HRM outcomes, commonly classified as efficiency, effectiveness or impact. Lawler et al. (2004) state that HRA are measures but rather represent statistical techniques and experimental approaches that could be utilised to show the impact of HR activities. Despite this distinction, there is still a definitional ambiguity in the literature.

Bassi (2011) debates that HRA should be considered both as “systematically reporting on an array of HR metrics” or more sophisticated solutions, based on “predictive models”. Furthermore, Bassi’s definition includes the notion of using an “evidence-based approach” to making decisions on the “people's side of business”. The conclusion she gives for HRA is that it is “an approach for making better decisions on the people's side of the business; it consists of an array of tools and technologies, ranging from simple reporting of HR metrics all the way up to predictive modelling” (Bassi, 2011).

HRA also has its fair share of controversy. Rasmussen and Ulrich (2015), argued that HRA is merely a fad. Fad means ‘largely insignificant, non-rational swings that come and go with little or no lasting impact on the language of management techniques or organisation themselves’ (Abrahamson & Eisenman, 2008). They arise from a chance conjunction of forces that trigger diffusion largely based on bandwagon effects and eventually disappear

when the inflated expectations for the innovation are not realised (Abrahamson & Eisenman, 2008).

From the definitions and labels given by previous researchers, several characteristics about the HRA can be determined:

- HRA is not the same as HR metrics. It involves a more sophisticated analysis of HR-related data.
- HRA does not only focus on HR functional data, it involves integrating data from different sources, internal and external to the firm.
- HRA uses information technology to collect, manipulate and report data.
- HRA supports people-related decisions.
- HRA is the practice of linking HR decisions to business outcomes and organisational performance.

Based on all the various definitions, Marler et al. (2017) define HRA as a HR practice enabled by information technology that uses descriptive, visual, and statistical analyses of data related to HR processes, human capital, organisational performance, and external economic benchmarks to establish business impact and enable data-driven decision-making.

2.2.2 How does HR Analytics work?

Most articles prescribe some version of the LAMP model, first introduced in the book Beyond HR: The New Science of Human Capital (Boudreau & Ramstad, 2007) which stood for Logic, Analytics, Measures and Processes. It is stated by Boudreau & Ramstad (2007) these are four critical components in a measurement system necessary to uncover evidence-based relationships and also motivate enhanced decision making based on those analyses. The two also suggested that LAMP is crucial to understanding the cause-effect relationship between HRM processes and strategic HRM business outcomes.

It seems there is great potential to invoke theories of innovation, social influence and cognition to help guide and explain the cause-effect relationships between HR Analytics antecedents, outcomes and moderators. Industrial psychology has some history addressing this question with regard to the adoption of ‘utility analysis’ in the 1970s and 1980s (Cascio & Boudreau, 2010). Boudreau (2012) has also suggested that decisions of leaders outside the HR discipline may be influenced by considering their dominant ‘mental models’, and by ‘retooling’ HR analysis and reporting using analogies to frameworks from other management disciplines such as operations, finance and marketing (Boudreau, 2010; Rousseau & Boudreau, 2011).

2.2.3 What are the outcomes of HR Analytics?

Previous studies have suggested strong evidence for a positive cause-effect relationship between HRA and financial performance (Aral et al., 2012). Coco et al. (2011) performed a detailed case study of how the home improvement retail chain, Lowes, used HRA and was able to establish that highly engaged employees lead to 4% higher average customer ticket sales per store. Harris et al. provided several high-level study examples to illustrate the impact of HRA on business. For instance, they describe how Google uses HRA to predict employee performance using their applicant database. Sysco utilises HRA to detect causal relationships between work environment surveys, delivery driver satisfaction, customer loyalty and higher revenue.

2.2.4 What moderating factors affect HRA outcomes?

The most common reason that HRA is not widely adopted is the lack of skilled analytical HR professionals. Bassi (2011) predicts that without the necessary knowledge to use analytical software and how to use measures of business results, the HR department will inevitably cede responsibility of analytics to the IT and finance departments. Angrave et al. (2016) echo this concern and suggest that not only does the lack of analytical skill impede the uptake of HRA, there is a concern that should HRA be adopted it will not be used by HR professionals but by others that is likely to misinterpret the analyses.

In order for HRA to be successful, the organisation must be politically accepting of HRA. In order for HR professionals to gain access to the cross department data needed to perform analyses, managers from other departments must be willing to provide access as well as be involved in the process. In addition, Rasmussen and Ulrich (2015) observe that there is a tendency to reject data that threatens existing beliefs. People have a tendency to reject new data that contradicts their previous belief. Thus, it is important for HR professionals to establish their credibility among managers that may not believe data-driven results and involve key stakeholders in the process of analysis.

Finally, the importance of HRM information technology such as HCM software cannot be ignored in HRA. Aral et al. (2012) proved empirically that companies with HRA but without HCM software experienced no performance increase. Other studies suggest that information technology can be an enormous enabler and a significant impediment to HRA. Information technology captures and stores data from across company departments and produces reports which helps in HRA. However, the current reality is that HRM IT does not have capabilities that match that promise. Data collected may not be collected or inaccurate (Bassi, 2011), data across departments are not accessible (Douthitt & Mondore, 2014). Furthermore, reports and analysis are basic and reflect outdated metrics (Angrave et al., 2016).

2.2.5 Implementation of HRA

There are several common implementation techniques for HRA. The goal of HR analytics is to seek answers to critical questions such as improvement of productivity, suitability of an employee for a job, staffing requirements of organisations, performance of individuals, teams and departments, and identification of skill gaps. The insights required to answer these questions can be obtained through several analytical techniques (Shrivastava, S et al., 2018):

- Data Mining and Machine Learning:

Data mining refers to revealing trends in large amounts of raw data, which are converted into relevant information. Commonly, this is coupled with machine learning, which is the use of computers in analysing data and identifying patterns. Most would identify this as a type of artificial intelligence.

- Contextual Analysis:

An analysis of text in an attempt to understand its meaning, characteristics, the context of historical and structural setting. This would also obtain an understanding of the intentions of the author and the goal the author wishes to achieve through his or her choice of words. A great example of this is organisations analysing candidate's job applications to assess fitment for a job, stability in career, attitude and behaviour.

- Predictive Analytics:

As the name suggests, data analysis techniques such as predictive algorithms and data mining are used to forecast what would likely happen in the future, what-if scenarios and estimation of risk. As an instance, using predictive analytics to forecast change staffing changes during organisational restructuring.

- Prescriptive Analytics:

Provide solutions to organisational problems while keeping in consideration various possibilities based on a specific scenario.

2.2.6 Notable Real Life Implementation of HR Analytics

A notable example would be Google, which has extensively used analytics to take strategic people-related decisions to great success. As a front-runner in the domain of people analytics, Google has achieved superior business results through its extensive usage of analytics in the domain of HR. Data and analytics have replaced opinions, feelings and intuitions of its managers and are now the foundation of all its people-centric decisions (Talent Management and HR, 2014). Below are several of their successful project:

Project Oxygen

A research-backed, multi-year project that aimed to identify and rank leadership traits of managers which involves a detailed analysis of qualitative comments from employees' surveys, expectations from manager which are sourced from complaints and praises in performance reviews. Contextual analysis were performed to identify behaviours of a good manager such as good coach, do not micromanage, express interest in member's well-being, good communicator and so on (re: Work, 2016).

Algorithm-based People Management

The algorithm developed by Google helps the recruitment team to re-assess candidate profiles that are discarded from consideration in order to not miss out any potential applicants. This has led to hiring of potential candidates who had initially been rejected (Gardener et al., 2011). The algorithm maps employees' attitudes, behaviours, personality details and other by asking applicants to fill up elaborate online surveys. Scores are assigned to applicants using mathematical formulas to predict whether the candidate fits the organisation which helps eliminate the subjectivity in the recruitment process .

Similarly, the retention algorithm makes use of past data such as performance review and promotion to screen employees who may exit the organisation. This allows management to retain their talents before it is too late.

2.3 Feasibility Study

2.3.1 Technical Feasibility

The project can be separated into two parts, the mobile application and the web backend.

For the web backend, the ASP.NET Core framework will be used. ASP.NET Core is easily accessible and associated IDEs such as Microsoft Visual Studio are readily available without cost. It is assumed that using ASP.NET Core framework for the system will involve HTML, CSS and Javascript, which are reasonable considering the technical skills of the web backend team. As for the databases, SQL Server will be used. The team is trained in low-level SQL, databases would not possess any technical risks. As these are the technologies common for web applications development, a wide array of online resources and help are readily available, making most obstacles and challenges faced during the development trivial.

As for the mobile application, the mobile team will develop the application using Flutter and communicate with the backend through API. The mobile application team is experienced in mobile development, thus technical risk would be minimal at the mobile side as well.

For hardware, both teams possess several laptops with high performance to use in coding the system. Both teams also possess multiple mobile devices using different operating systems, making testing on multiple platforms feasible.

In conclusion, the technologies involved in this project are easily accessible, the technical skills of the team members are reasonable and there are no obstacles posed by hardware limitation, thus the project is feasible.

2.3.2 Operation Feasibility

With the HRMS in operation, collecting and maintaining huge amounts of data required by HR functions becomes feasible. Transfer of data is also streamlined, promoting efficiency of HR processes.

All functions are isolated into their own specific modules. Failure on one module will not affect the other modules, making corrective maintenance low cost.

The system is highly customizable and catered to individuals with low technological literacy. This ensures HRMS is no longer a rigid system that can only work within a certain scope. It is unlikely that users require frequent customer support, making support of the system's operation manageable.

The self-service function also reduces the workload on HR employees, reducing overtime costs. Employees can directly go through certain HR processes such as requesting leave without going through a HR employee, hastening the process.

Managers would also no longer need to monitor a huge amount of information since they can directly look at the dashboard analytics and quickly notice any anomalies happening. Action can then be taken immediately, reducing the severity of that anomaly.

To conclude, the operation of this system will greatly enhance the productivity as well as efficiency of the company and there are no major risks for continued operation of the system, thus, the system is operation feasible.

2.4 Chapter Summary and Evaluation

Through this chapter, we have defined HRMS as all IT-based information systems and applications either stand alone or networked, for human resource management purposes, be it for facilitating HR practices, policies or strategies. In addition, we have also discussed the importance of HRMS, how it helps in improving managerial decision making and lowering costs for effective HRM. The chapter also discussed the reason for HRM not widely adopted in the form of organisational factor, technological factor and environmental factor.

The second part of this chapter provided the definition for HRA which is a HR practice enabled by information technology that uses descriptive, visual, and statistical analyses of data to establish business impact and enable data-driven decision-making. This chapter also describes the LAMP model used frequently in HRA and the factors impeding successful HRA implementation, which are lack of expertise, lack of trust and lack of information technology.

Finally, a feasibility study is conducted to ensure the system would not have any technical risk faced in development and any operational risk. It is concluded that the system is both technically feasible and operationally feasible.

Chapter 3

Methodology and Requirements Analysis

3 Methodology and Requirements Analysis

This chapter will give a brief introduction into the development methodology the project will follow during its Software Development Life Cycle (SDLC), which is the agile method. In addition, this chapter will describe the requirements gathering techniques used to gather the expected requirements for the system. Requirement analysis will then be performed to identify key stakeholders and their concern in order to extract useful requirements. Finally, all identified functional and non-functional requirements from said gathering technique will be listed.

3.1 Methodology: The Agile SDLC Model

3.1.1 Introduction to Agile SDLC Model

The SDLC of this project will utilise the agile model.

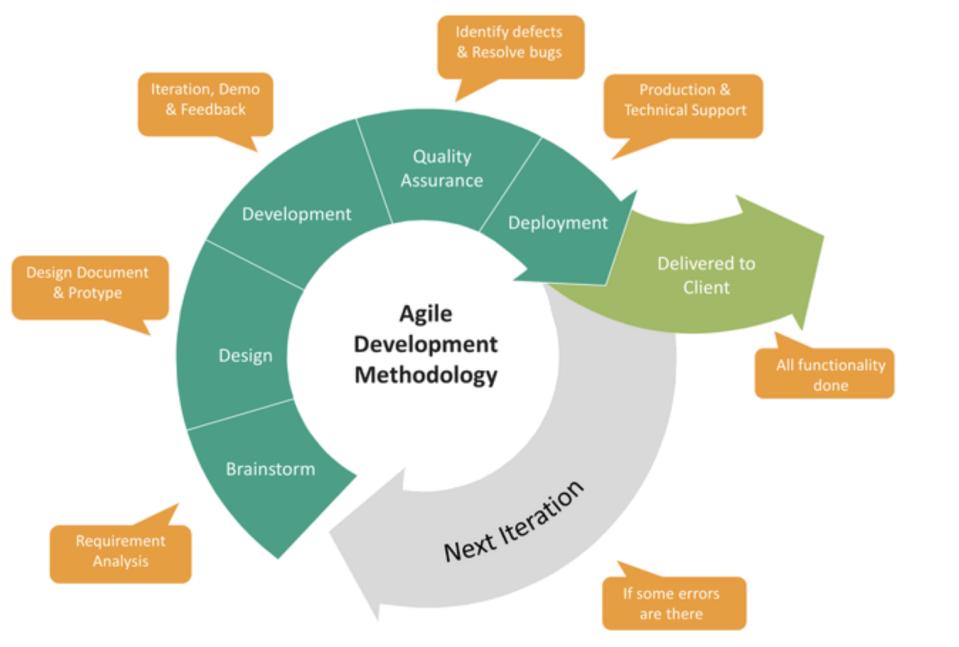


Figure 3.1: Agile Model

The Agile Model is a software development approach that combines iterative and incremental process models with the aim of guaranteeing process adaptability and customer satisfaction via quick successive delivery of functioning software products . In the Agile Model, products are broken down into small incremental builds which are provided in iterations. Each build typically only lasts from about one to three weeks (Tutorialspoint).

On every iteration, the project goes through various phases before the iteration is considered complete. The phases are as follows, in the order they are supposed to be completed (Javatpoint, 2011):

1. Requirement Gathering:

Requirements are gathered from key stakeholders via requirement gathering technique. Concerns about the initial system or the previous iteration are gathered and recorded to develop the requirements that should be implemented in the current iteration.

2. Designing:

After the requirements are correctly identified, the team begins designing the system, figuring out how the system should implement the requirements gathered. Here, high-level UML diagrams will be produced to assist in construction of the system.

3. Development:

Also commonly known as the iteration phase, this is where the actual coding begins. Developers work on the project implementation according to what was discussed during the designing phases. Keeping in mind the product will be improved on future iteration, the product will include minimal changes or functionality to ensure the iteration meets the deadline.

4. Testing:

After a product is produced, it undergoes rigorous testing to scrutinise any possible bugs and ensure the product quality via software quality assurance.

5. Deployment:

The finished product is then deployed to the client's work environment. Technical support is given, and feedback is gathered for improvements needed in the next iteration.

The iteration continues until the product is deemed finished or completed, in which they go into permanent maintenance phase.

3.1.2 Benefits of Agile Methodology

The Agile Model is a very realistic approach to software development. Changes happen in industry frequently, and for fields where requirements change almost everyday, Agile Model

can ensure the project is not resistant to requirements changes. Its flexibility lets developers experiment on various methods to handle a specific problem to find the optimal solution.

In addition, functionality can be developed rapidly and demonstrated. The Agile Model does not require a lot of human resources to succeed, enabling concurrent development and delivery within an overall planned context. This gives the client confidence in the project and encourages user involvement, ensuring client satisfaction (Tutorialspoint).

Lack of knowledge within the HR fields and the possibility of changing requirements during development is the reason Agile Model is selected for this project.

3.2 Requirements Gathering Technique

The selected requirements gathering technique is an interview with key stakeholders of this project. The interview will determine the expected requirements and functionality the stakeholders wish to see in the project.

An interview with stakeholders are chosen because of their experience in the HR field and their knowledge in HRMS. Clear requirements can be extracted from the key stakeholders. Although shift workers are the main focus of this system, it is impossible to perform a survey on a large number of shift workers. In addition, most of them are technologically illiterate, making it difficult to extract useful information.

As for why one-on-one interview is not considered, the team wishes to save time as the stakeholders have a busy schedule, and having a group interview would encourage discussion and allow conflicting requirements to be resolved prematurely.

3.2.1 Conducting the Interview

The interview was conducted on 9th of March 2022, Wednesday. The duration of the interview was one hour, starting from 9 p.m. to 10 p.m. The interviewee of this session are Mr. Anderson Chua, the founder of the company Beyond Alpha and its co-founder, Mr. Chua Kok Jiun and Ts. Ong Jia Hui. The interviewer are members from every team working on this project, namely Yaw Foong Zeng and Teo Jian Xiang from the Web Backend Team, Lim Zhi Shuang and Liew Yan Lin from the Mobile App Team, as well as Angelina Oon Ruo Qi and Looi Jia Toong from the UI Design Team. In addition, Mr. Ooi, a TARUC lecturer is present to guide the interview and provide his professional opinions on the project scope.

The goal of this interview is to draft rough parameters for the system and identify the functional requirements that the system should fulfil as well as enquiring about the work processes of the industry.

3.2.2 Interview Questions and Answers

The interview questions are unstructured and are posed on the fly.

1. Is the developed system solely used by BeyondAlpha?

No, the developed system will be provided as a complimentary system to the companies that are already using BeyondAlpha's services. Thus, there will be different companies using the system.

2. Since the system will be used by different companies, how should we standardise the requirements? For example, some companies would like to set the break time at 1pm, some prefer to be 2pm.

In that case, the HRMS that is going to be developed should have a flexible setting to let the companies customise their own preference.

3. What is the programming language that should be used in developing the HRMS?

For the Mobile Apps, Flutter Dart programming language will be used. As for web applications, .NET Core will be used.

4. How should overtime be counted? How can we verify if a worker deserves overtime pay?

The supervisor for the worker should register for an overtime period beforehand. If the worker requires overtime pay for periods that are not discussed prior, it should be sent as a request and approved by the supervisor.

5. When a leave is requested, it should be approved or denied by their immediate supervisor, correct? If the supervisor does not process the leave request for a set period of time, what should happen?

Yes, the leave request should be approved by the supervisor. If the supervisor does not respond, it is escalated to the next superior officer. If it is still unapproved, a fallback option should be implemented, in which the request is sent to their HR department.

6. Since multiple companies will be using this system, will the system be cloud-based?

Yes, the system will be cloud-based and allow multiple companies to access it via unique company ID.

7. How should the workers of a company register their information in the system?

The worker will register an account using the company's unique ID, then the staff of the company will approve the registration.

8. How should the attendance of the workers be taken?

The workers will need to choose the shift they are checking in or out first before scanning the QR code or going through facial recognition.

9. Do we need to track the attendance of the workers when they are attending the training programme?

No, tracking the attendance of the employees when they are attending the training is not compulsory. But the training module should include the function of letting the employees upload their certificate of attendance and the certificate they received after they attended it.

10. Is the Benefit and Compensation Module the same for the mobile application side and web application side?

No, the mobile application side would be more for the employees and workers side. As for the web application side, it is more for the administrator. For example, if the employees would like to apply for compensation, they can apply through the phone. But upon approval, the administrator has to approve via the web.

11. For the Leave Application Module, how should the Emergency Leave be treated? Can the leave application be approved immediately or should the leave still need to be on pending and wait for the employers to approve?

Emergency leave would usually be approved immediately as it is an emergency. But it also depends on the company as some companies have their own policies as they should apply the leave within 5 working days. Thus, it would be better if there is a flexible setting on the web version provided to the administrator.

12. How should we manage if employees forgot to check out after their shift?

When the shift is over for 15 minutes and the employee has not checked out, the system shall prompt a message to notify them to check out.

3.3 Requirements Analysis

The following section will detail the requirements analysis process performed for this project.

3.3.1 Identification of Key Stakeholders and End-Users

To initiate the requirements analysis process, key stakeholders are identified. The technique used is Viewpoint Analysis (VPA).

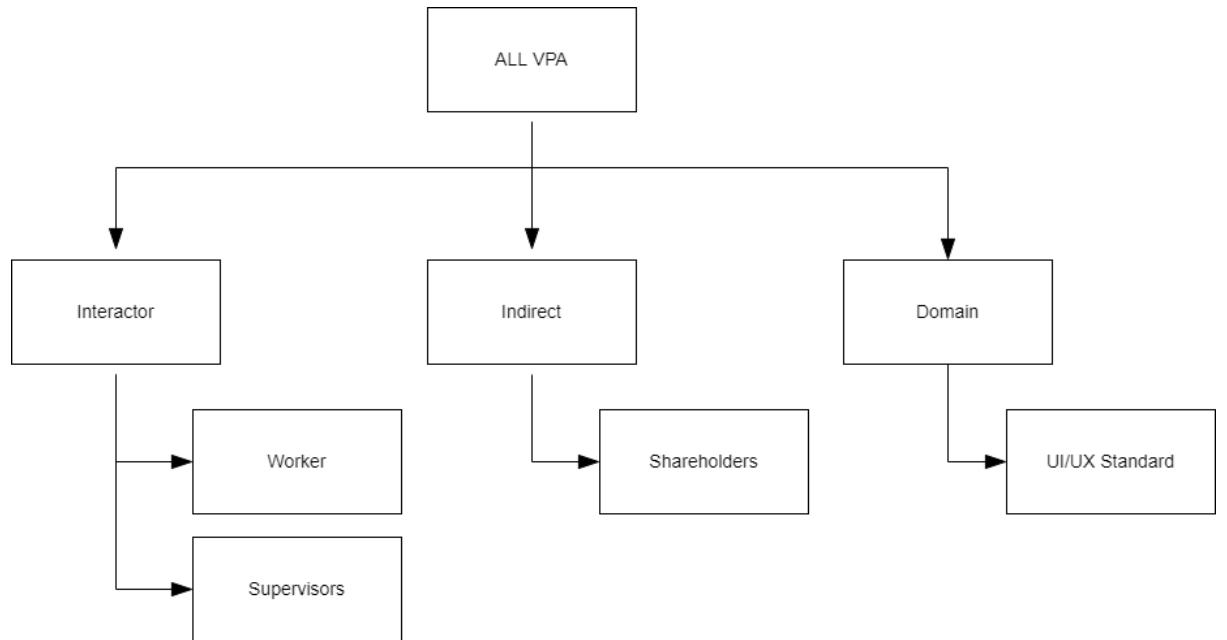


Figure 3.2: Viewpoint Analysis

Using VPA, the identified stakeholders are workers, their supervisors, shareholders and UI standards.

Workers and their supervisors represent the interactors of the system. They make up the bulk of the system users as they require the system to perform daily HR processes. Their needs and technological literacy should be taken into account when designing the system so that the system fulfils its goal as a functional HRMS.

For indirect stakeholders, shareholders control and make long-term business decisions for the company. They have the company's best interests in mind and design a business plan to guide the company into success. As such, it is important the system fits the vision of the shareholders. The system should be able to provide various reports for the shareholders for their decision making. The shareholders viewpoint will be explored through a scheduled interview with one of the company major shareholders.

As for the domain section, UI/UX Standards affect the user experience. A standardised UI/UX design provides an easy to use and learn interface for the users, enhancing user experience. Poor UI/UX standards could lead to decreased efficiency.

3.3.2 Requirement Capturing

The identified stakeholders' requirements will be gathered via the selected requirements gathering techniques.

As mentioned above, a group interview will be conducted with the company's founder and shareholders to gather requirements that the system is expected to be fulfilled by the system.

3.3.3 Categorize Requirements

The requirements are then categorised into functional requirements and non-functional requirements, which themselves are composed of several categories.

Functional requirements are categorised into business requirements, administrative requirements, user requirements and system requirements.

Non functional requirements are split into usability requirements, reliability requirements, availability requirements and security requirements.

3.3.4 Interpret and Record Requirements

After the requirements are categorised, feasibility of every requirement is examined and documented. The requirements are defined precisely and prioritisation of the requirements are worked out via an impact analysis.

Conflicts found within requirements, such as overlapping requirements are to be resolved before final documentation. Requirement conflicts are resolved through further discussion with stakeholders after their identification.

3.4 Functional Requirements

3.4.1 Business Requirement

Leave Self-Service

- The system should allow users to submit leave requests.
- The system should allow supervisors to approve or deny leave requests.
- The system should allow supervisors to manage how time off accrual works.

Payroll Calculation

- The system should calculate payroll for each employee based on their attendance.
- The system should allow staff to view the summary of their own monthly payroll.

Shift Management

- The system should allow users to schedule shifts.
- The system should allow staff to create and edit work shifts.

- The system should allow supervisors to adjust the pay rate for different shifts.
- The system should allow tracking of staff's attendance.

Workforce Management

- The system should allow staff to register an account.
- The system should allow staff to edit their profile.
- The system should allow staff to edit profiles of staff under their lead. The system should enforce access level control to restrict which staff can access which functionality of the system.
- The system should allow staff to update their relevant work documents such as resumes and work permits.

Training Module

- The system should allow staff to track their licence and certification.
- The system should allow staff to create and edit training courses.

3.4.2 Administrative Requirement

Role Management

- The system should allow company admins to add a new role.
- The system should allow company admins to edit an existing role.
- The system should allow company admins to add permissions to a role
- The system should allow company admins to edit permissions of a role.

Company Management

- The system should allow system admins to create a company.
- The system should allow system admins to edit a company.
- The system should allow system admins to manage the company's database.

Admin Management

- The system should allow super admin to create admin accounts.
- The system should allow super admin to remove admin accounts.

3.4.3 User Requirement

Workforce Management

- The system should allow staff to rate their co-worker.
- The system should allow staff to view shifts assigned to them.

Shift Management

- The system should allow staff to generate QR code for attendance tracking purposes.

Dashboard Analytics

- The system should allow staff to view employees' performance.
- The system should allow staff to view employees' development.
- The system should allow staff to view the workforce demographic.
- The system should allow staff to view the workforce overview
- The system should allow staff to view the absent rate.
- The system should allow staff to view the overtime rate.

Training Module

- The system should allow staff to monitor their training.

Benefit and Compensation

- The system should allow staff to view offered benefits.
- The system should allow staff to apply for compensation.
- The system should allow staff to approve compensation.

3.4.4 System Requirement

General

- The system should be coded in ASP.NET Core.
- The system should use SQL Server for its database.
- The system should run on Google Chrome, Mozilla Firefox and Microsoft Edge.

3.5 Non-Functional Requirements

Usability

- The system should be able to provide response to user interaction with a maximum waiting time of 1 second.

Reliability

- The system shall perform needed calculations correctly and accurately display the results of dashboard analytics.
- The system shall calculate the payroll of staff correctly.

Availability

- The system should not have downtime more than 10 days per year.

Security

- The system should not allow unauthorised users to access the company database.

- The system should not allow information of a company to be leaked to users of other companies.
- The system should utilise OAuth 2.0 to avoid cross site scripting attacks.
- The system should encrypt the information stored within the database.

3.6 Chapter Summary and Evaluation

In this chapter, an introduction to the Agile SDLC Model, and its various phases are given. Several benefits of Agile Model are provided to justify the selection of Agile Model as the methodology of this project, such as adaptability to changes.

Then, the requirements gathering technique used by this project is detailed, which is an unstructured interview. The details of the interview conducted with the founder and co-founders of BeyondAlpha is provided, as well as the questions asked and answer given.

Continuing, a detailed description of the requirements analysis performed in this project is discussed. A viewpoint analysis is performed to identify key stakeholders, which are the worker and shareholders. The requirements are captured through interviews, followed by interpretation and documentation of the requirements.

Finally, a comprehensive list of functional and non-functional requirements are listed.

Chapter 4

System Design

4 System Design

This chapter will solidify the various designs of the proposed system. It will begin with an overall design explanation of the proposed system, followed by the user interface design and data design. Next, several reports planned to be included in the system will be presented. This is followed by several security designs planned for implementation in order to ensure the system's secureness. Continuing, how activities will be performed within the system are presented in the process design. A detailed walkthrough of the software architecture will also be provided. Finally, algorithms that are planned to be implemented will be described and explained.

4.1 System Design

The system design can be described as a composition of modules that interact with each other.

The proposed system has 11 modules.

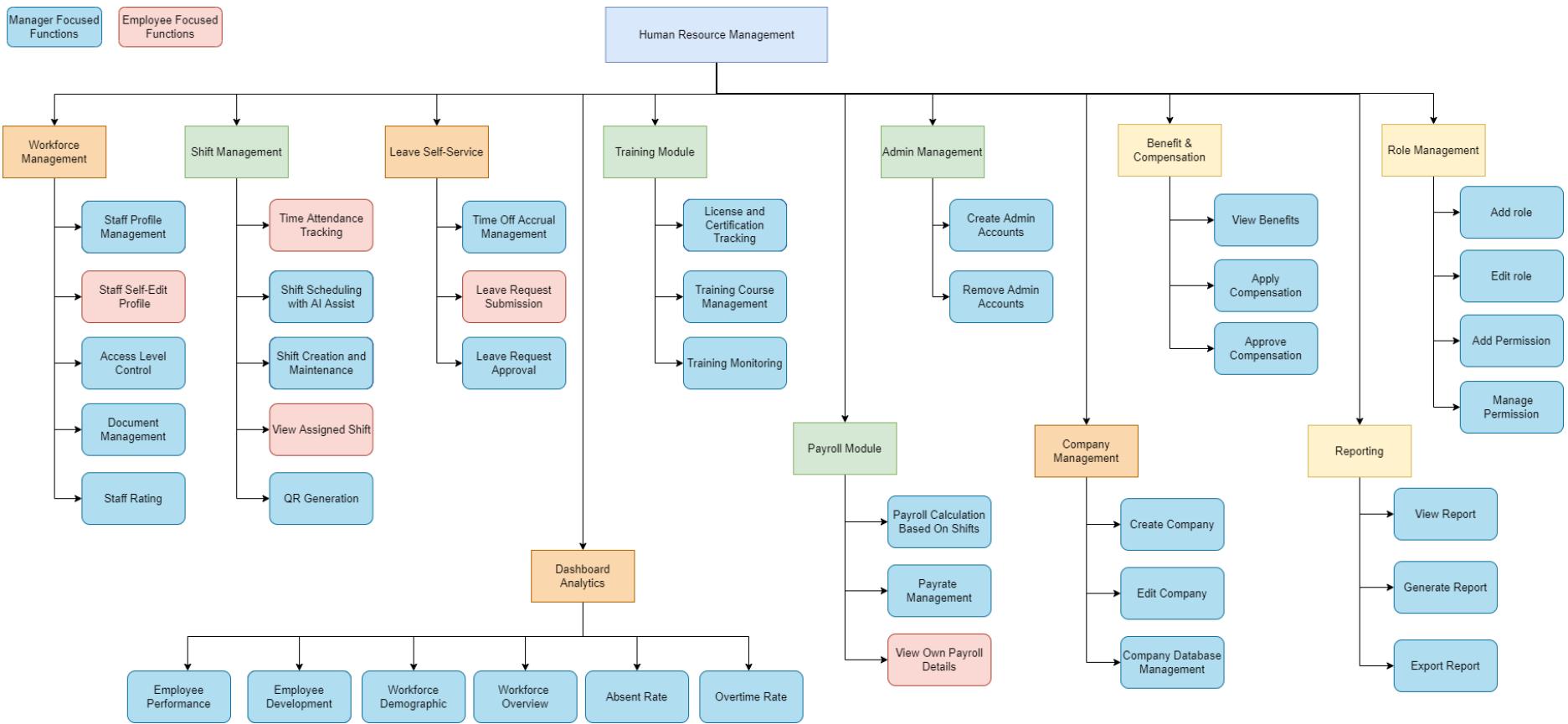


Figure 4.1: An Overall Structure Chart of the Proposed System

4.1.1 Workforce Management

This module keeps track of all employees across every organisation. The existence module allows users to login and logout of their account since it holds all employee profiles. It also provides employees the ability to edit their personal profile as well as team member's profile that are led by them. Since it is responsible for managing user accounts, it will also be responsible for access level control. This will restrict certain critical functions to only those with proper authorization.

Aside from that, this module also provides some non-essential functions to ease employee management. The document management function will allow employees to peruse their personal documents such as licence and medical reports. Authorised managers may even request to look at other employee documents without the need of physically contacting said employee. In addition, a simple rating system allows employees to rate people they had worked with no matter their position. Ratings will be displayed on the employee's profile to assist in HR assessment.

4.1.2 Shift Management

This module focuses on utilising the workforce effectively. This module allows the creation of shifts, which are the duration of time an employee should be working. Once created, they can be assigned to employees, which makes them able to see it on their timetable. This module can also automatically choose appropriate employees to work on created shifts, hastening the process.

In addition to shift management, this module also performs attendance tracking. Once a shift has been assigned, the employee will show up to the shift and take their attendance using a generated QR code, which is also handled by this module. The attendance will be marked and the employee will be considered present.

4.1.3 Leave Self-Service

This module maintains the duration of paid time off and sick times of every employee. Depending on the company policy, managers can adjust how the time off are accrued and carried over to the next year.

A normal employee can also request a leave of absence via this module by submitting a simple form. The request will be processed by their immediate supervisor, which may accept or reject the request via this module as well.

4.1.4 Dashboard Analytics

To put it simply, this module extracts data from the current company's database, processes it, and finally displays it in a visual dashboard. Several dashboards had been planned for the proposed system, such as employee demographics and employee performance, however, more dashboards can be added in easily whenever needed.

4.1.5 Training Module

This module will manage and keep tracks of all training currently undergoing or completed by every employee. Training courses or learning paths can be created and assigned to employees that need it. It will then monitor the duration of training undergone by the employee until it is completed.

Other than that, this module also keeps track of any licence and certifications owned by an employee. If the licence and certification needs to be renewed periodically, the module will remind the employee and their immediate superior.

4.1.6 Payroll Module

This module retrieves information about all the shifts an employee has worked and calculates the proper payment that should be given to that employee. The pay rate that is assigned to every shift whether it be normal pay rate or overtime rate can also be modified here. Once payroll has been calculated, employees may look at a report that details how their payroll is calculated.

4.1.7 Admin Management

This module is responsible for maintaining admin accounts which possess special privileges within the system. Admin's responsibility includes creating and maintaining company profile that will be using the proposed system. Different admins may have different privileges. For example, a company admin can only manage their own company, but a super admin will be able to make modifications to all companies.

4.1.8 Company Management

This module stores and maintains all company profile and personalization settings for every company registered within the system. It is also within this module that the registration of company and modification of company profile happens. Employees are registered under their own company and cannot access the database of the other companies.

4.1.9 Benefits & Compensation

This module allows employees to view benefits that the company provides for them. It is also here that employees can apply compensation for expenditures spent during company

businesses. Similarly to leave requests, the compensation has to be approved by an authorised personnel before it is counted into their payroll.

4.1.10 Reporting

This module provides a detailed summary of information deemed crucial for managing the HR of an organisation. Employees with proper authorization may generate customised reports to monitor the status of the workforce here. In addition, they may also view previously generated reports for comparison and export generated reports into other formats.

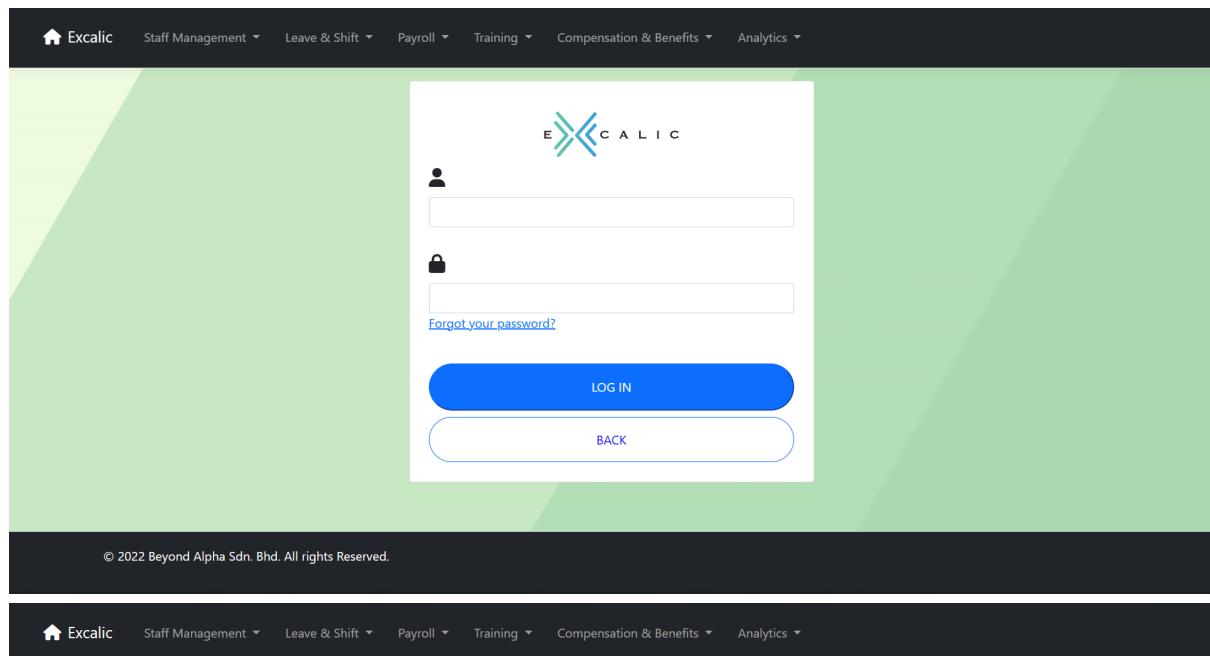
4.1.11 Role Management

This module represents the user authorization control of the system. This module, together with the workforce management module limits the action an unauthorised user can perform on the system for security reasons.

This is done via the creation and maintenance of roles, which is basically a checklist of operations that an employee or an admin is allowed to perform. This role can then be assigned to users or admins to allow or disallow them from performing certain tasks. Roles can be edited and their permissions changed in this module as well.

4.2 UI Design

4.2.1 Login Screens



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Home Staff Management Leave & Shift Payroll Training Compensation & Benefits Analytics

Forgot your password?

Enter your email.

Email

Reset Password

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4.2.2 Homepage

Excalic

Staff Management ▾ Leave & Shift ▾ Payroll ▾ Training ▾ Compensation & Benefits ▾ Analytics ▾

Superadmin

Hello, Superadmin !

Welcome back, let's continue where you left off.

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4.2.3 Company Management

Excalic

Staff Management ▾ Leave & Shift ▾ Payroll ▾ Training ▾ Compensation & Benefits ▾ Analytics ▾

Superadmin

Company List

Search + Create New

Company Name	Creation Date	Admin	
Ascendas	13/12/2022 5:08:27 AM	AscendaAdmin	
ACG	22/12/2022 2:51:31 PM	Superadmin	
Acilit	14/12/2022 1:44:50 PM	AcilitAdmin	
DashDemo	20/12/2021 12:00:00 AM	SuperAdmin	
GoodSmile Sdn Bhd	22/12/2022 9:14:53 AM	AscendaAdmin	
selfdesign sdn bhd	22/12/2022 3:17:22 PM	jianxiang	

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The screenshot shows the top navigation bar of the Excalic application. It includes the logo 'Excalic' with a house icon, followed by several dropdown menu items: 'Staff Management', 'Leave & Shift', 'Payroll', 'Training', 'Compensation & Benefits', and 'Analytics'. On the far right, there is a user profile icon labeled 'Superadmin'.

Create Company

This is a form titled 'Create Company'. It contains the following fields:

- Company ID: An input field.
- Company Name: An input field.
- Admin: An input field containing 'AciliitAdmin'.
- Address: An input field.
- Longitude: An input field.
- Latitude: An input field.
- Leave Hours Per Day: An input field.

4.2.4 Admin Management

The screenshot shows the 'Admin List' page. At the top, there is a search bar with a magnifying glass icon and a 'Search' button. To the right of the search bar is a blue button labeled '+ Create New'. Below the search area is a table with the following columns: 'Admin ID', 'Username', and 'Superadmin Permission'. The table lists six users:

Admin ID	Username	Superadmin Permission
AciliitAdmin	aciliit	<input type="checkbox"/>
AscendaAdmin	ascenda	<input type="checkbox"/>
ben	12345	<input type="checkbox"/>
jianxiang	jianxiang123@	<input type="checkbox"/>
sds	1234567	<input type="checkbox"/>
Superadmin	test123	<input checked="" type="checkbox"/>

The screenshot shows the 'Create Admin' form. It has fields for 'Admin ID' and 'Username', both with placeholder text. A checkbox for 'Superadmin Permission' is unchecked. At the bottom are 'Create' and 'Back to List' buttons.

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4.2.5 Leave Management

The screenshot shows the 'Leave Application' page. It includes a summary of leave balances and a table of leave requests.

Leave Application

+ Create New

8 hours of paid leave left.
145 hours of paid leave is pending approval.
76 hours of sick leave left.
20 hours of sick leave is pending approval.

Status	Decided By	Date Created	Leave Start Time	Leave End Time	Reason for Leave	Response
Approved	Superadmin	1/1/0001 12:00:00 AM	2022/12/24 09:32 AM	2022/12/24 09:32 AM	Because I lazy to go	
		1/1/0001 12:00:00 AM	2023/01/26 05:27 PM	2023/01/26 05:27 PM	Because I lazy to go	
Approved	Superadmin	1/1/0001 12:00:00 AM	2023/01/01 01:28 AM	2023/01/01 01:28 AM	asd	okay

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Create

Leave

Leave ID

E00001-L00004

Leave Start Time

31/12/2022 02:21 AM 

Leave Type

Paid

Leave End Time

01/01/2023 02:21 AM 

Reason for Leave

Leave Document

Choose File No file chosen

[Back to List](#)

Leave Approve

Name	Status	Decided By	Date Created	Leave Start Time	Leave End Time	Reason for Leave	Response
Looi Jia Toong	Approved	Looi Jia Toong	1/1/0001 12:00:00 AM	2022/12/22 03:30 PM	2022/12/22 03:30 PM	test	Approved
Looi Jia Toong	Rejected	JianXiang	1/1/0001 12:00:00 AM	2022/12/31 06:45 PM	2022/12/31 06:45 PM	birthday leave	dsad

Leave Approve

Search: Search

Name	Status	Decided By	Date Created	Leave Start Time	Leave End Time	Reason for Leave	Response
JianXiang	Approved	Superadmin	1/1/0001 12:00:00 AM	2022/12/24 09:32 AM	2022/12/24 09:32 AM	Because I lazy to go	
JianXiang			1/1/0001 12:00:00 AM	2023/01/26 05:27 PM	2023/01/26 05:27 PM	Because I lazy to go	
JianXiang	Approved	Superadmin	1/1/0001 12:00:00 AM	2023/01/01 01:28 AM	2023/01/01 01:28 AM	asd	okay
Lim Zhi Shuang	Approved	JianXiang	1/1/0001 12:00:00 AM	2022/12/16 07:00 PM	2022/12/16 07:00 PM	Test	Approved
Lim Zhi Shuang	Approved	JianXiang	1/1/0001 12:00:00 AM	2022/12/23 08:00 PM	2022/12/23 08:00 PM	Sick	Approved
Lim Zhi Shuang			1/1/0001 12:00:00 AM	2022/12/23 04:00 PM	2022/12/23 04:00 PM	Testing	
Lim Zhi Shuang	Approved	Looi Jia Toong	1/1/0001 12:00:00 AM	2022/12/26 04:00 PM	2022/12/26 04:00 PM	Testing	approve leave
Lim Zhi Shuang			1/1/0001 12:00:00 AM	2022/12/30 02:00 PM	2022/12/30 02:00 PM	Testing1	
Lim Zhi Shuang	Rejected	JianXiang	1/1/0001 12:00:00 AM	2023/01/04 06:00 PM	2023/01/04 06:00 PM	System preview	test reject response
Lim Zhi Shuang			28/12/2022 6:12:36 PM	2022/12/30 04:00 PM	2022/12/30 04:00 PM		

4.2.6 Payroll Module

Payroll List

Sort By: + Create New

Payroll ID	Staff ID	Salary This Month	Overtime Pay	KWSP Total	Zakat Total
PROLL00001	E00003	265.75	0	33	0
PROLL00002	E00002	3500	47.5	150	0
PROLL00003	E00004	817.3375	47.5	104.225	23.6875
PROLL00004	E00001	557.8375	47.5	71.225	16.1875
PROLL00005	E00020	0	0	0	0
PROLL00006	E90005	798.75	0	99	0
PROLL00007	E00001	0	0	0	0
PROLL00009	E90011	0	0	0	0
PROLL00010	E00025	0	0	0	0

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Excalic Staff Management ▾ Leave & Shift ▾ Payroll ▾ Training ▾ Compensation & Benefits ▾ Analytics ▾

Superadmin

Payrate List

Sort By: + Create New

Payrate ID	Payrate Name	Rate Per Hour	
PR50	Normal	50	
PRATE00003	dsada	123	
PRATE00004	dsdsa	123	
PRATE00006	nihao	12345	
PRATE00007	DSAD	213	
PRATE00008	dsa	12	
PRATE00009	123DSA	123	
PRATE00011	ewq1	1234567	
PRATE00012	rsa	13	

Excalic Staff Management ▾ Leave & Shift ▾ Payroll ▾ Training ▾ Compensation & Benefits ▾ Analytics ▾

jxteo

Your Payroll

Staff ID	Salary This Month	Overtime Pay	KWSP Total	Zakat Total
E00001	557.8375	47.5	71.225	16.1875
E00001	0	0	0	0

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4.2.7 Shift Management

Excalic Staff Management ▾ Leave & Shift ▾ Payroll ▾ Training ▾ Compensation & Benefits ▾ Analytics ▾ [jxteo](#)

Shift List

Search

+ Create New

Shift ID	Shift Start Time	Shift End Time	Overtime Shift	Main Shift	Payrate	Action
OT00002	23/12/2022 3:38:00 PM	23/12/2022 8:01:00 PM	<input type="checkbox"/>	S00023		   
S00021	22/12/2022 10:47:00 AM	22/12/2022 6:47:00 PM	<input type="checkbox"/>			   
S00022	23/12/2022 10:47:00 AM	23/12/2022 6:47:00 PM	<input type="checkbox"/>			   
S00023	23/12/2022 1:38:00 PM	23/12/2022 3:38:00 PM	<input type="checkbox"/>			   
S00025	22/12/2022 3:48:00 PM	22/12/2022 7:48:00 PM	<input type="checkbox"/>			   
S00026	23/12/2022 3:48:00 PM	23/12/2022 7:48:00 PM	<input type="checkbox"/>			   
S00046	28/12/2022 9:09:00 AM	28/12/2022 11:15:00 PM	<input type="checkbox"/>			   
S00047	29/12/2022 9:09:00 AM	29/12/2022 11:15:00 PM	<input type="checkbox"/>			   
S00048	30/12/2022 9:09:00 AM	30/12/2022 11:15:00 PM	<input type="checkbox"/>			   

Excalic Staff Management ▾ Leave & Shift ▾ Payroll ▾ Training ▾ Compensation & Benefits ▾ Analytics ▾ [jxteo](#)

Create Shift

Overtime Shift

Shift Start Time

Shift End Time

Payrate Used

Company

[Create](#) [Back to List](#)

Excalic Staff Management Leave & Shift Payroll Training Compensation & Benefits Analytics jxteo

Create QR Code



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4.2.8 Training Management

Excalic Staff Management Leave & Shift Payroll Training Compensation & Benefits Analytics jxteo

Training List

Search + Create New

Training ID	Training Name	Start Date	Duration	Action
T00009	dssdad	31/12/2022 9:25:00 AM	5	
T00010	dssdad	23/12/2022 1:09:00 PM	5	
T00012	FDSFSDF	4/1/2023 7:11:00 PM	4	
T00013	DSADA	5/1/2023 5:48:00 PM	2	
T00014	dsdsaa	5/1/2023 5:49:00 PM	5	
T00015	DSA	4/1/2023 5:49:00 PM	12	
T00016	fadsa	31/12/2022 5:54:00 PM	10	

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Excalic Staff Management ▾ Leave & Shift ▾ Payroll ▾ Training ▾ Compensation & Benefits ▾ Analytics ▾ 

View Training Progress

Sort By: [+ Assign Employee](#)

Staff ID	Training ID	Completed	Duration Left
E00001	T00009	<input type="checkbox"/>	5
E00001	T00010	<input checked="" type="checkbox"/>	0
E00002	T00009	<input type="checkbox"/>	5
E00004	T00010	<input checked="" type="checkbox"/>	0
E00019	T00009	<input type="checkbox"/>	5
E90011	T00016	<input type="checkbox"/>	10

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4.2.9 Workforce Management

Excalic Staff Management ▾ Leave & Shift ▾ Payroll ▾ Training ▾ Compensation & Benefits ▾ Analytics ▾ 

Employee

[Search](#) [+ Create New](#)

Employee ID	Name	Employer	 		Documents
E00001	JianXiang		 		Documents
E00016	Goh Jia Ming	E00001 JianXiang	  		Documents
E00017	Goh Jia Mings	E00001 JianXiang	  		Documents
E00019	Looi Jia Toong	E00001 JianXiang	  		Documents
E00020	andrea test	E00001 JianXiang	  		Documents
E00028	Manager test	E00001 JianXiang	  		Documents
E00031	Gong Xi Fa Chai	E00001 JianXiang	  		Documents
E00027	Angelina Oon	E00019 Looi Jia Toong	  		Documents

The screenshot shows the top navigation bar of the Excalic application. It includes the logo, a search bar, and links for Staff Management, Leave & Shift, Payroll, Training, Compensation & Benefits, and Analytics. A user icon with the name 'jxteo' is also present.

Create Employee

Employee ID
E00032

Company
Ascendas

Employee Company ID
100020

Name

Profile Picture
 Choose File No file chosen

Username

Description

The screenshot shows the top navigation bar of the Excalic application, identical to the one in the first screenshot.

Document

Document ID	Document Name	Date Created	Expiry Date	Notify Date	Actions
D00001	asdff	1/1/0001 12:00:00 AM	1/1/2023 12:00:00 AM	31/12/2022 12:00:00 AM	Download
D00002	dsadsa	1/1/0001 12:00:00 AM	1/12/2022 12:00:00 AM	1/11/2022 12:00:00 AM	Download
D00003	dsadsa	1/1/0001 12:00:00 AM	1/12/2022 12:00:00 AM	1/11/2022 12:00:00 AM	Download
D00004	FDSFSD	1/1/0001 12:00:00 AM	1/1/2023 12:00:00 AM	31/12/2022 12:00:00 AM	Download
D00005	DSDADASDF	1/1/0001 12:00:00 AM	2/1/2222 12:00:00 AM	1/1/2222 12:00:00 AM	Download
D00006	dsda	1/1/0001 12:00:00 AM	31/12/2022 12:00:00 AM	30/12/2022 12:00:00 AM	Download
D00008	dsadsa	1/1/0001 12:00:00 AM	2/1/2023 12:00:00 AM	1/1/2023 12:00:00 AM	Download
D00009	DSDADASDF	1/1/0001 12:00:00 AM	2/1/2023 12:00:00 AM	1/1/2023 12:00:00 AM	Download
D00011	rckrck	1/1/0001 12:00:00 AM	1/1/0001 12:00:00 AM	1/1/0001 12:00:00 AM	Download

Create

Document

Document ID

E00001-D0017

Document Name

Expiry Date

30/12/2022 06:27:10.255 PM



Notify Date

30/12/2022 06:27:10.255 PM



Document File

Choose File No file chosen

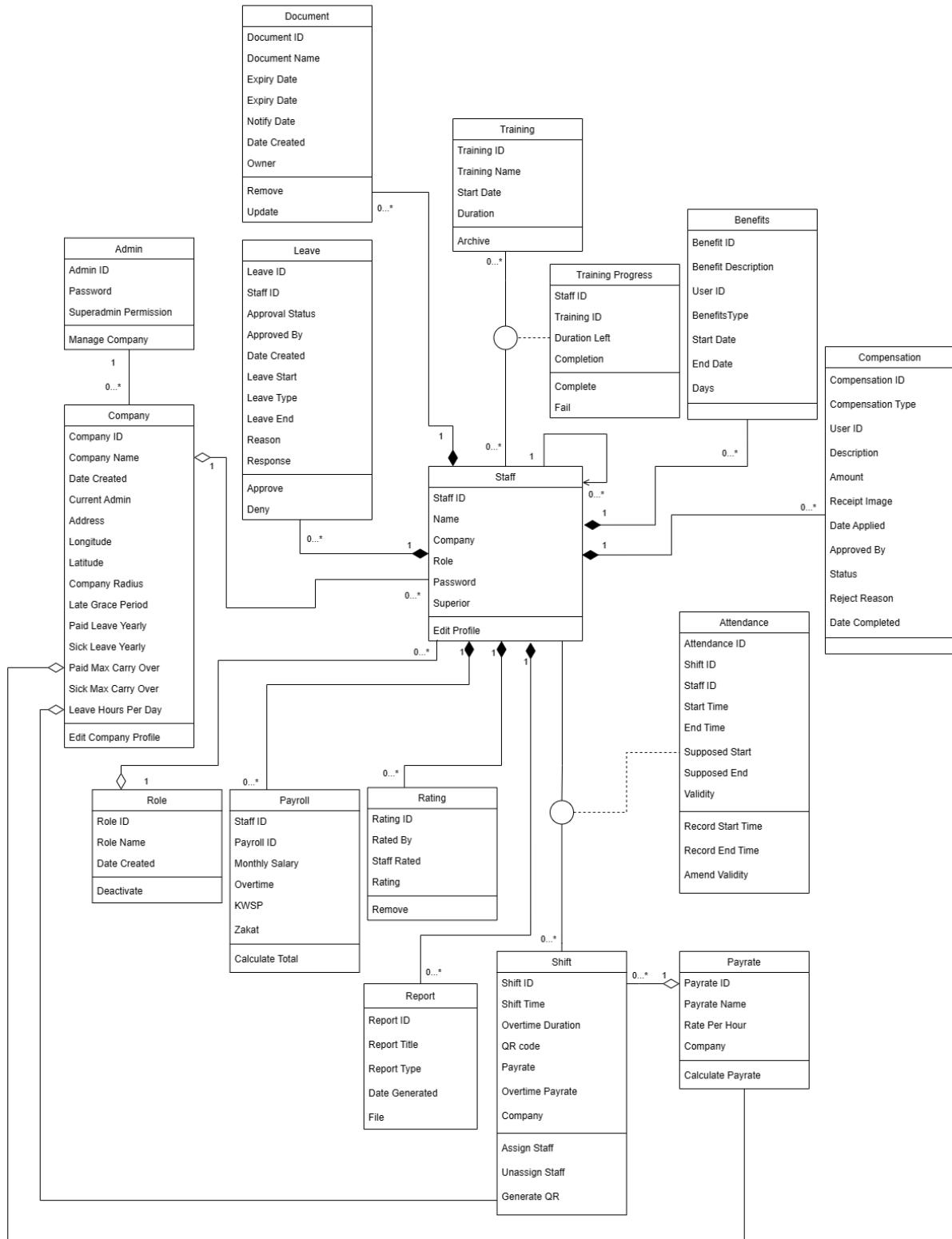
[Create](#)

[Back to List](#)

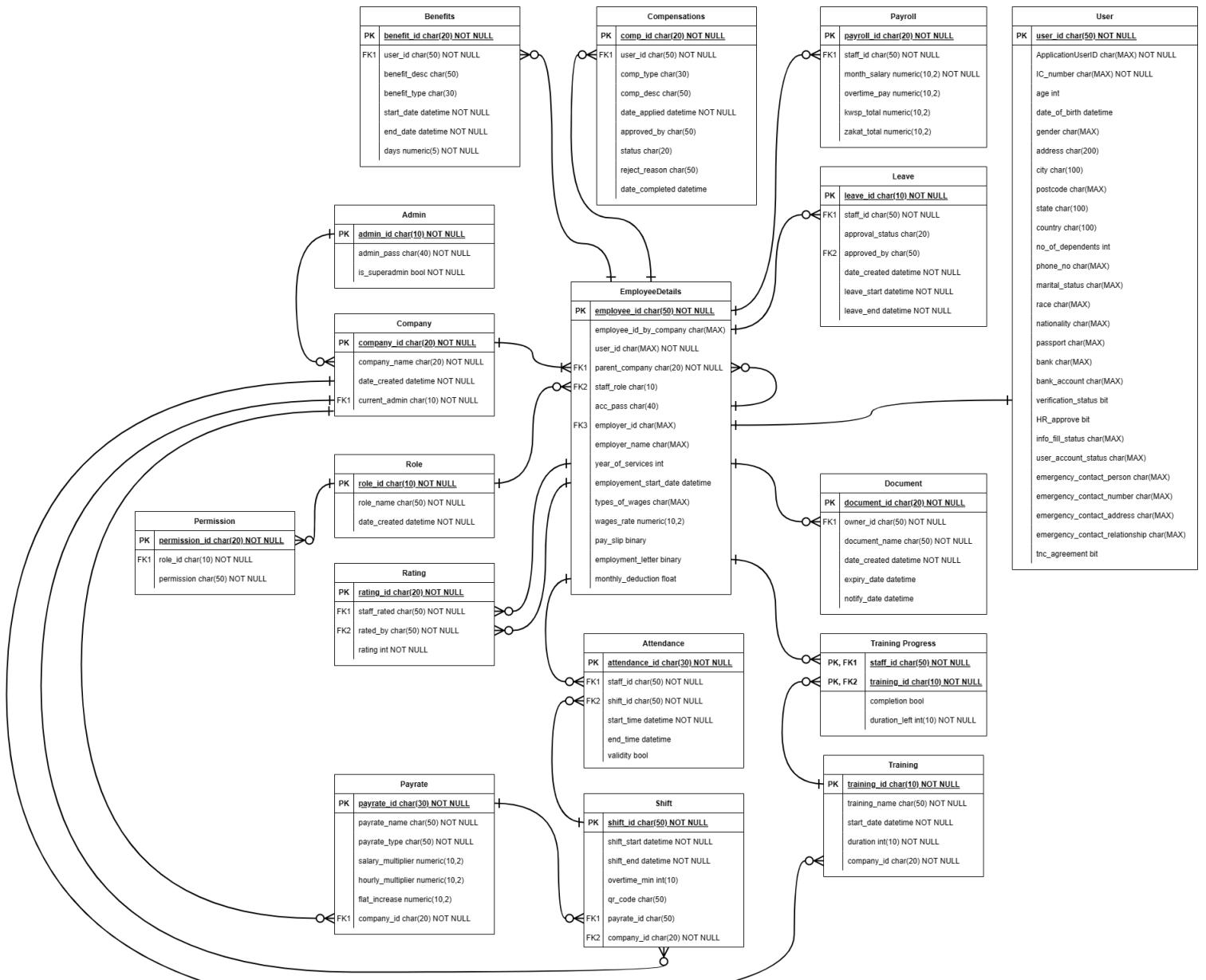
4.3 Data Design

The data design proposed for this system is detailed in the following diagrams.

4.3.1 Class Diagram



4.3.2 Entity Relation Diagram



4.4 Report Design

4.4.1 Salary Slip

Salary Slip			
[Company Name]			
[Address]			
Employee Name: _____			
Designation: _____			
Month & Year: _____			
Earnings		Deductions	
Basic & DA	\$0,000,00	Provident Fund	\$0,000,00
HRA	\$0,000,00	E.S.I	\$0,000,00
Conveyance	\$0,000,00	Loan	\$0,000,00
		Profession Tax	\$0,000,00
		TSD/IT	\$0,000,00
Total Addition	\$0,000,00	Total Deduction	\$0,000,00
		NET Salary	\$0,000,00
Cheque No: _____	Name of Bank: _____		
Date: _____	Branch No: _____		
Signature of the Employee: _____	Director: _____		

4.4.2 Payroll Report

Month: 02, 2016 MICRO MART

Page 1

No.	Emp No.	Employee Name	Basic Pay	Overtime	Bonus/ Allowance	Deduction	Gross Pay	Employee EPF	Socso	PCB	Net Pay	Employer EPF	Socso	Leave Ann. Med.	Oth.	Month End Pay
1	001	DAVID LIM	7,500.00	0.00	10,000.00	0.00	0.00	1,100.00	0.00	2,447.80	0.00	1,200.00	0.00	0	0	0.00
2	002	RAJ KUMAR A/L SUBRAMANIAI	7,500.00	0.00	8,100.00	0.00	15,600.00	1,716.00	14.75	2,255.20	11,614.05	1,872.00	51.65	3	1	11,614.05
3	003	ALI MUHAMMAD	3,380.00	0.00	0.00	0.00	3,380.00	372.00	14.75	0.00	2,993.25	440.00	51.65	0	0	2,993.25
4	004	SIVARAMAN	2,000.00	0.00	0.00	0.00	2,000.00	220.00	9.75	0.00	1,770.25	260.00	34.15	0	0	1,770.25
5	004X	SIVA KUMAR	6,000.00	0.00	0.00	0.00	6,000.00	660.00	14.75	245.90	5,079.35	720.00	51.65	0	0	5,079.35
6	005	VIMALA	7,000.00	0.00	0.00	0.00	7,000.00	770.00	14.75	582.45	5,632.80	840.00	51.65	0	0	5,632.80
7	006	JASON LEE	4,453.00	0.00	0.00	0.00	4,453.00	491.00	14.75	144.10	3,803.15	580.00	51.65	0	0	3,803.15
8	007	AHMAD FAIZ	5,000.00	0.00	5,000.00	0.00	10,000.00	1,100.00	14.75	658.35	8,226.90	1,300.00	51.65	0	0	4,276.95
Grand Total			42,833.00	0.00	23,100.00	0.00	48,433.00	6,429.00	98.25	6,333.80	39,119.75	7,212.00	344.05	3	1	35,169.80

4.4.3 Individual Attendance Report

Time Sheet

Employee Details: Name Email Phone

Manager Details: Name

Period Start Date Period End Date

Total Work Week Hours	Total Hours Worked	Regular Hours	Overtime Hours
40.00	8.00	8.00	0.00

Date(s)	Time In	Lunch Start	Lunch End	Time Out	Hours Worked
10/25/17	8am	11:30am	12:30pm	5pm	8.00
Date	Time In	Lunch Start	Lunch End	Time Out	0.00
Date	Time In	Lunch Start	Lunch End	Time Out	0.00
Date	Time In	Lunch Start	Lunch End	Time Out	0.00
Date	Time In	Lunch Start	Lunch End	Time Out	0.00

4.4.4 Weekly Attendance Report

Company Name

Manager Name:

Department:

Week Starting: 1/4/2021

	Employee Name	Monday	Tuesday	Wednesday	Thursday	Friday	Total Hours	Signature
1							0:00	
2							0:00	
3							0:00	
4							0:00	
5							0:00	
6							0:00	
7							0:00	
8							0:00	
9							0:00	
10							0:00	

Manager Signature: _____

Attendance
Total

0

4.5 Security Design

Several security practices will be implemented to guarantee the system is secure.

4.5.1 OAuth 2.0

Open Authorization (OAuth) is an open standard used for delegating access. It is commonly implemented as a way for users to grant websites or applications access to their information that is on other websites without giving their passwords (www.varonis.com, n.d.).

Workflow of OAuth 2.0

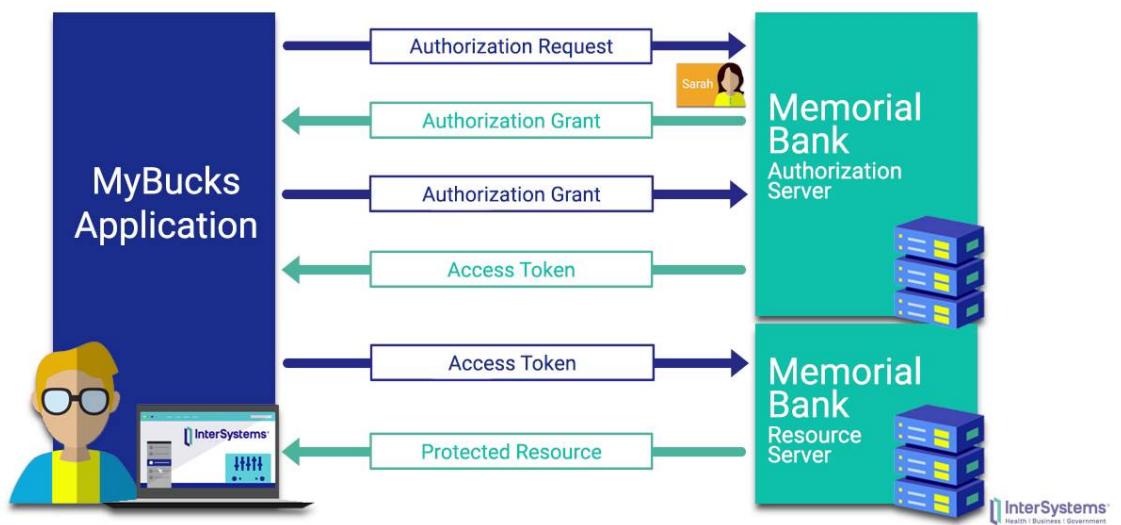


Figure 4.2: OAuth 2.0 Workflow

OAuth works by inserting an authorization layer that separates the role of the client from that of the resource owner. Using OAuth, the client can request access to resources controlled by the resource owner and hosted by the resource server. The client is issued a different set of credentials than those of the resource owner in the form of an access token, which is a string denoting a specific scope, lifetime and other access attributes. These tokens are then issued to third-party clients by an authorization server with the approval of the resource owner, which is then used to access the protected resource hosted by the resource server (Auth0, n.d.).

4.5.2 ASP.NET Identity

ASP.NET Identity (ANI) is a membership system which is created for the purpose of authenticating and authorizing the users in an ASP.NET application. ANI allows developers to easily add custom login and logout functionality such as being able to sign in with social identities (www.c-sharpcorner.com, n.d.).

ASP.Net Identity 2.0

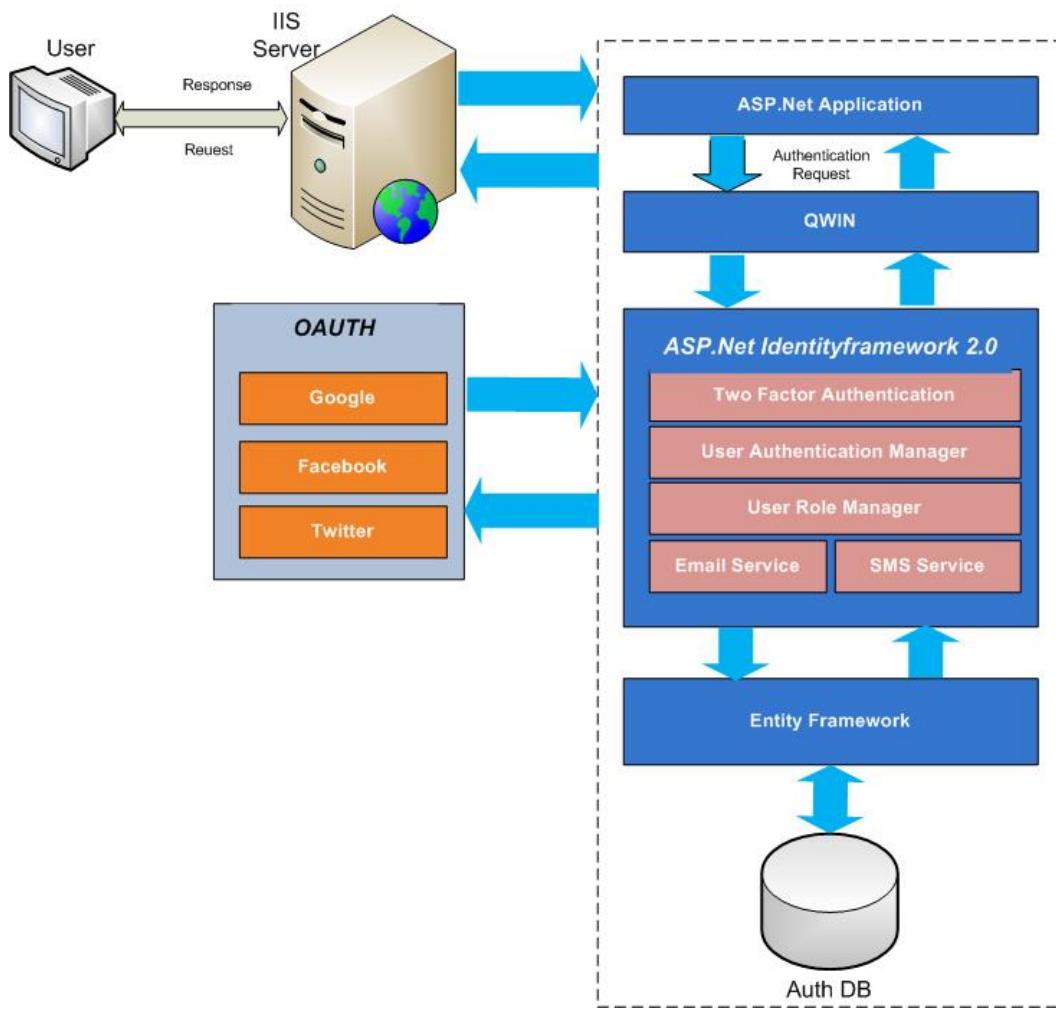


Figure 4.3: ASP.NET Identity 2.0

There are several reasons why ANI is preferred over other forms of membership system. First of all, ANI can be used with all of the ASP.NET frameworks, which means you can use ANI to build web, phone, store or hybrid applications. Secondly, developers have control over the schema of user and profile information, making plugging in profile data of users easy. Third of all, ANI comes with a role provider that lets you restrict access to parts of your application by roles. Roles such as “Admin” can be easily created and assigned to users. In addition, ANI supports claims-based authentication, where a user’s identity is represented as a set of claims. Claims give developers more freedom in describing a user’s identity than roles allow. Last but not least, developers can easily add social logins such as Facebook and Google to their applications and store user-specific data within your application (jongalloway, n.d.).

4.5.3 Database Encryption

In an effort to prevent data leakage to unintended users, the database will be encrypted and can only be decrypted using a company's decryption key.

Database encryption works by transforming data stored in a database from a readable state into a cipher text of unreadable characters via the utilization of an encryption algorithm. Unlike other security methods such as antivirus software, this form of defense is positioned at the data level itself (MyDiamo, 2016). Without the proper decryption key, even if the data is stolen, it is meaningless to the attacker.

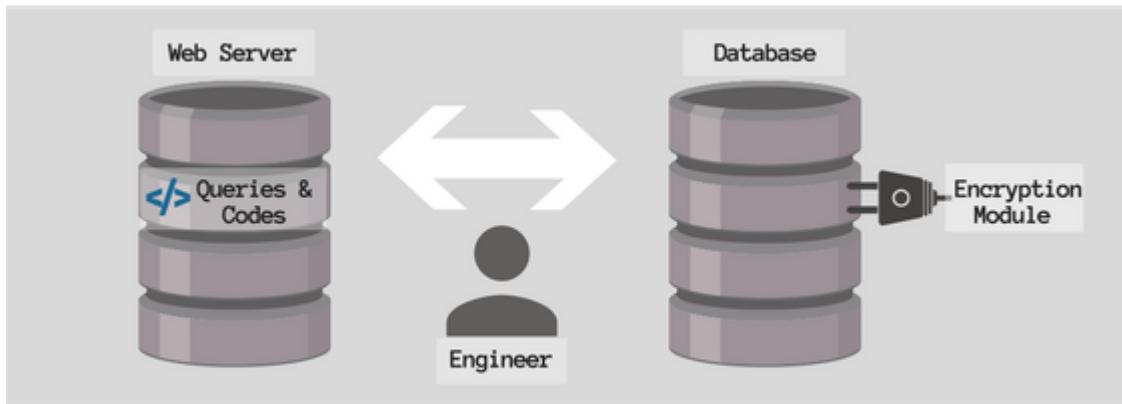


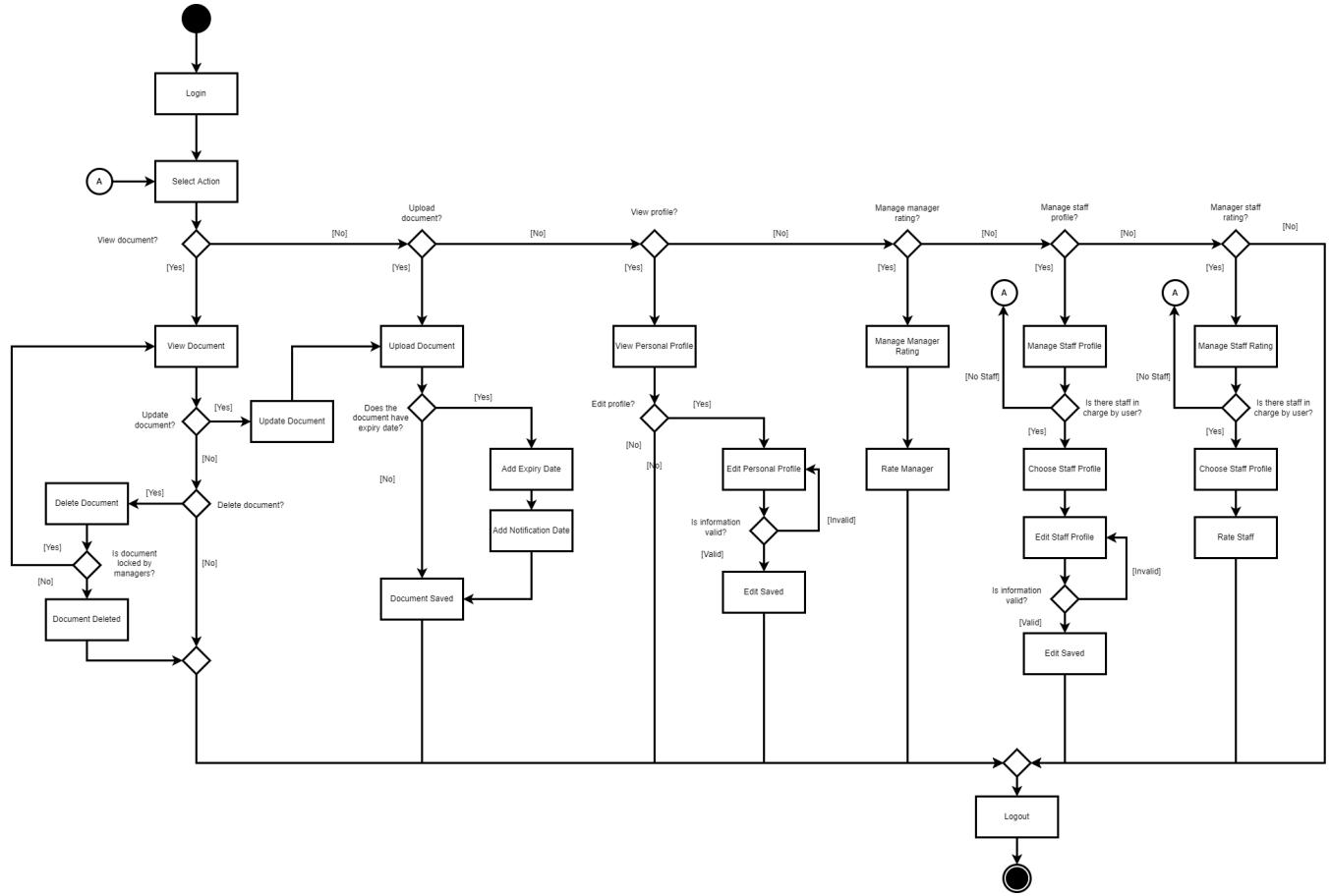
Figure 4.4: Database Encryption

The project will utilize the plug-in database encryption method. The concept of this method is that an encryption package will be attached onto the database itself. Unlike other methods, this encryption works independently of the application and requires less modification to query and code. This is very useful for column-level encryption, access control and auditing (N-able, 2019).

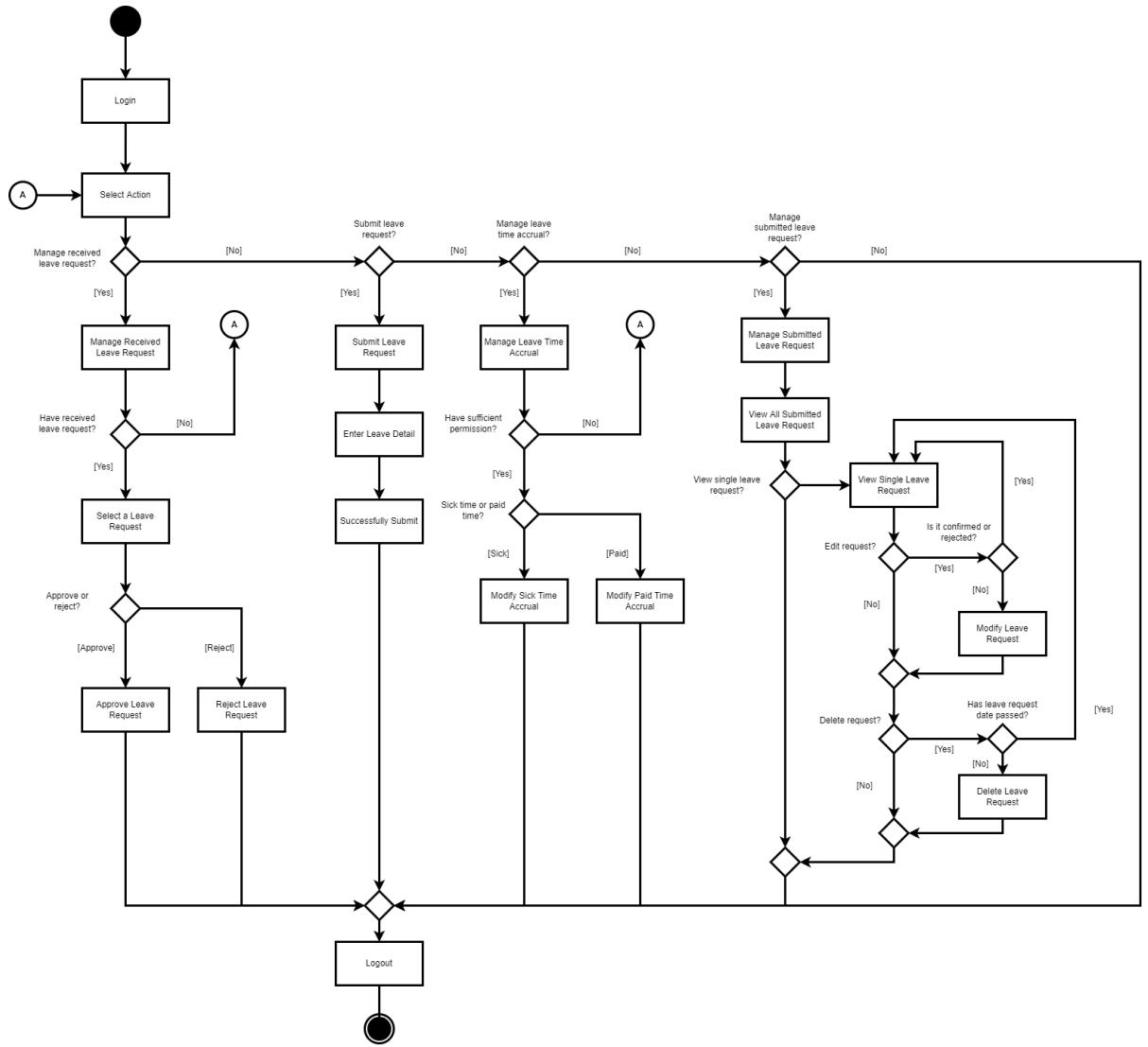
4.6 Process Design

4.6.1 Activity Diagram

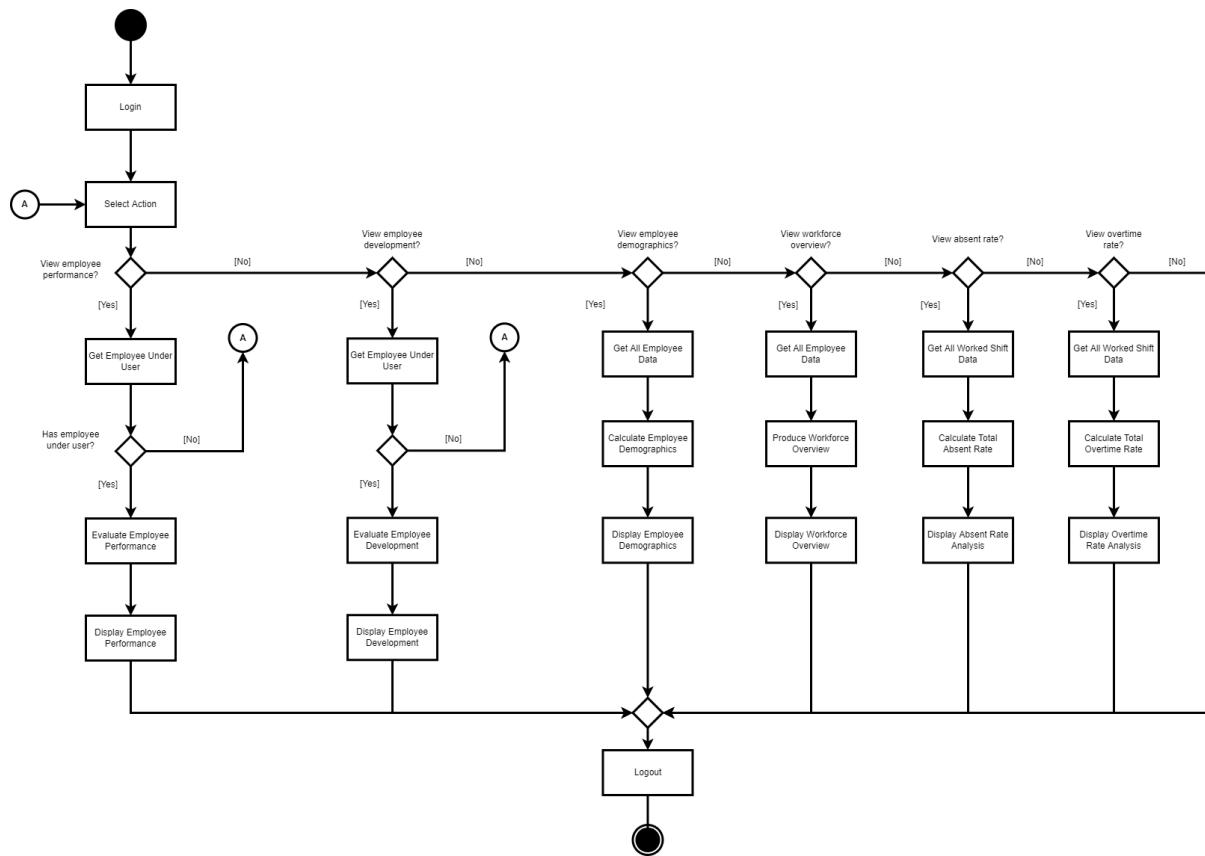
Workforce Management



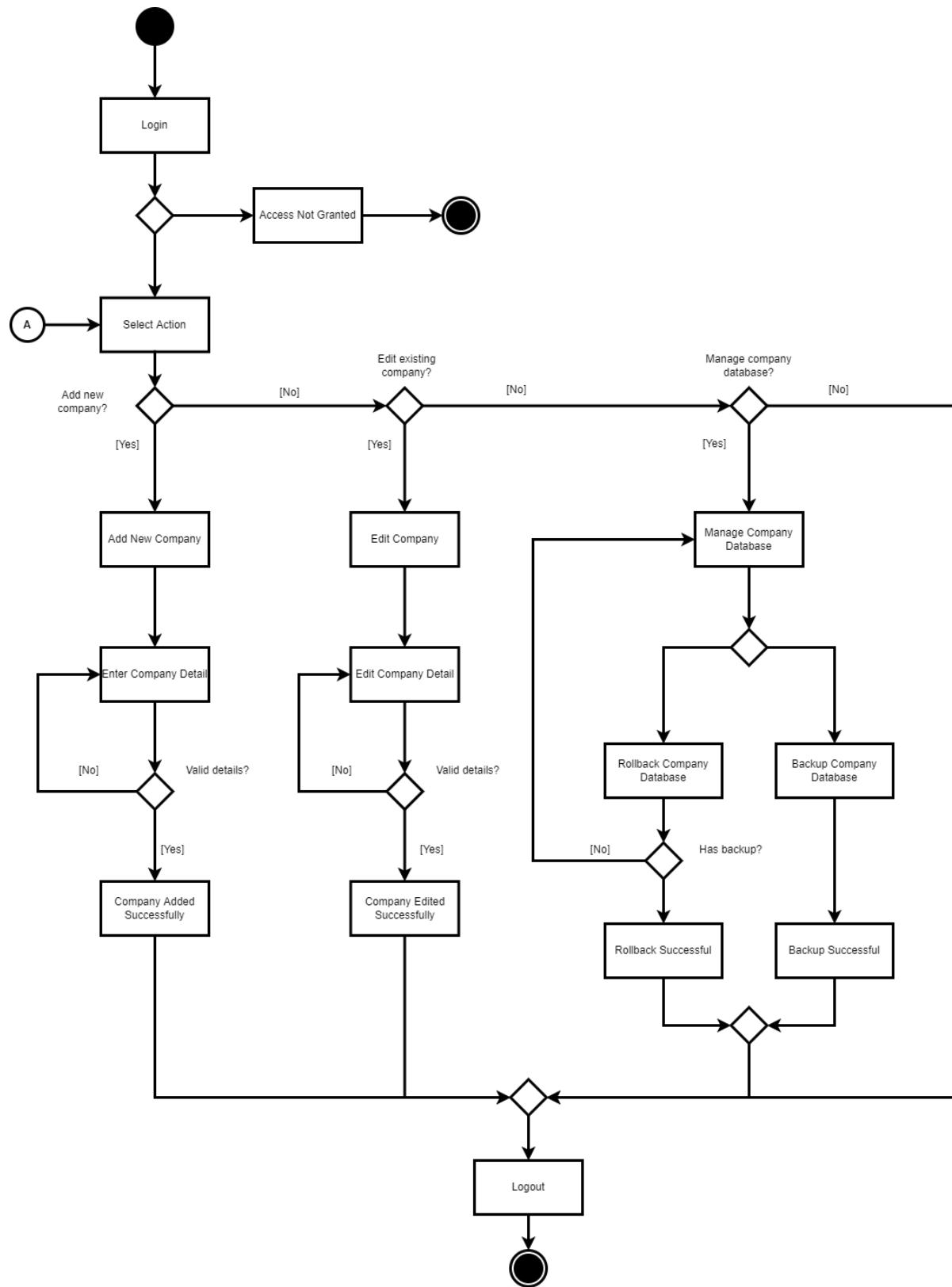
Leave Self-Service



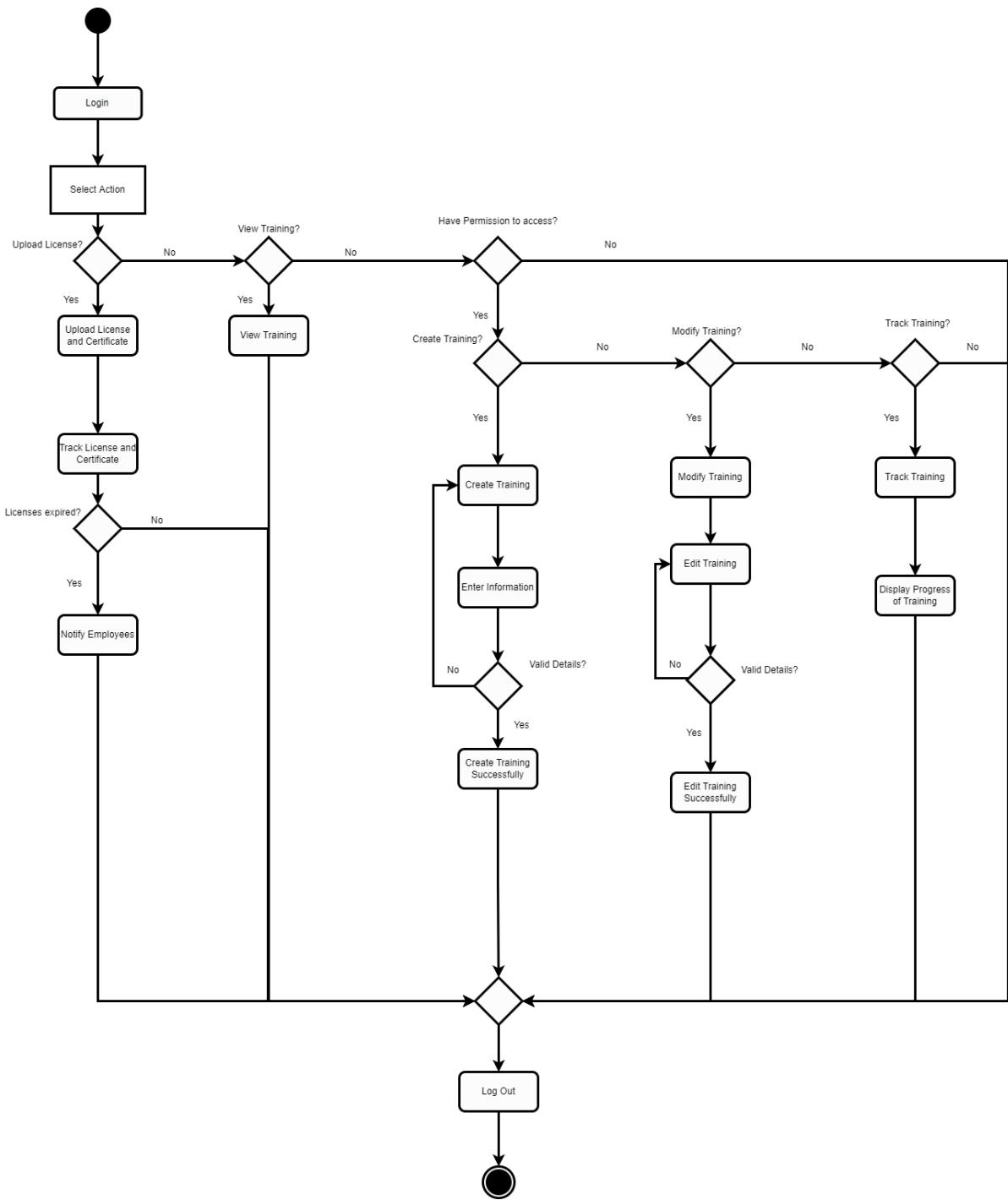
Dashboard Analytics



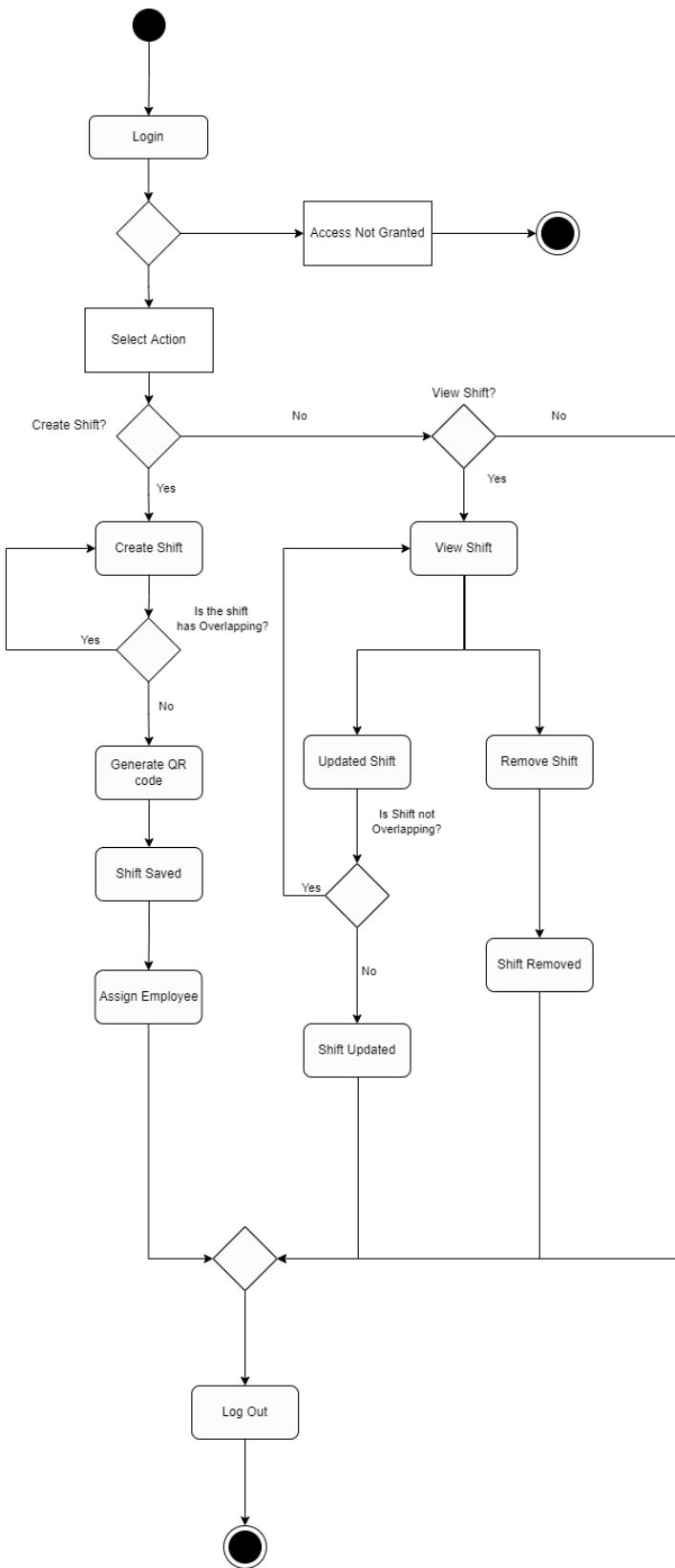
Company Management



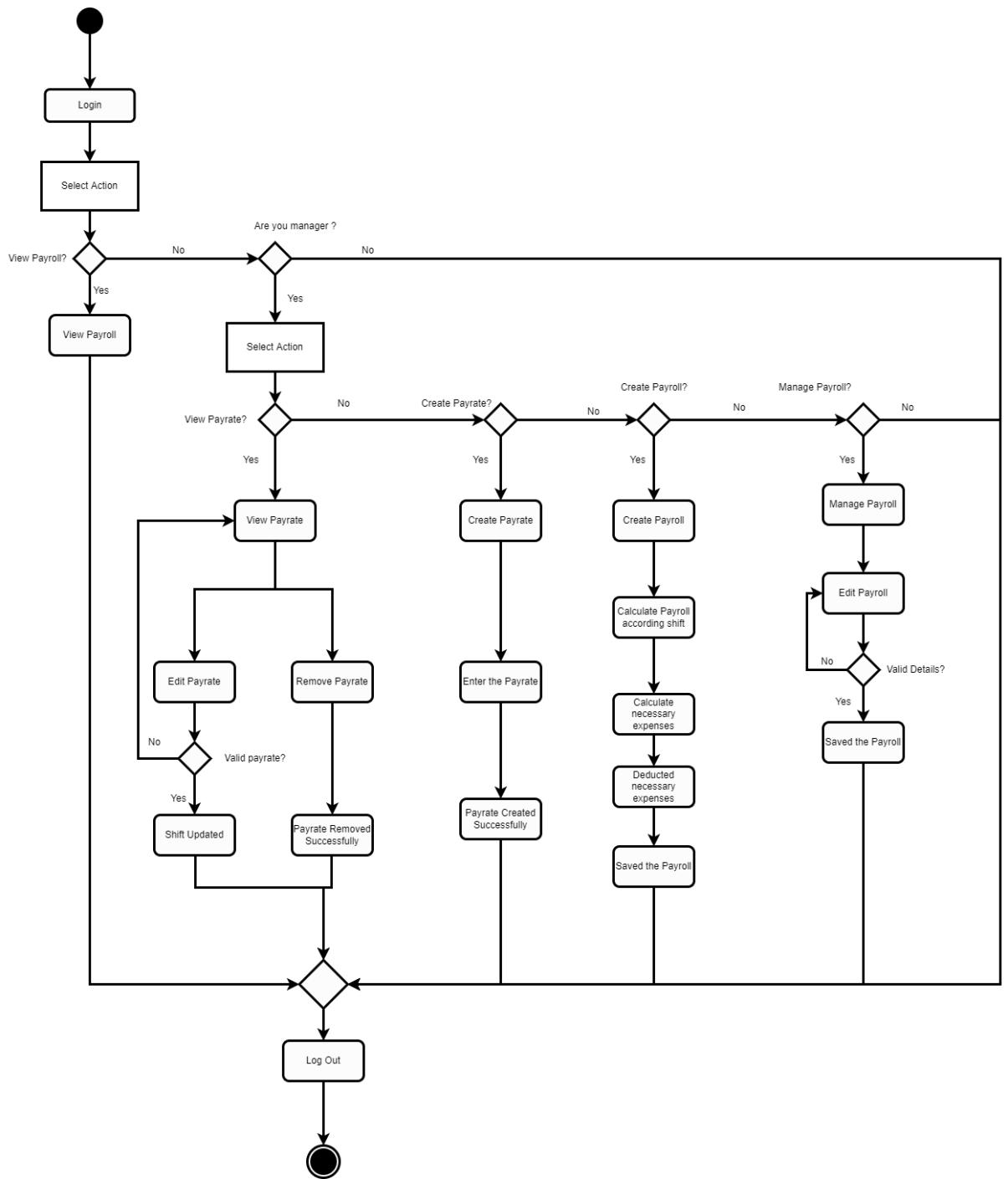
Training Module



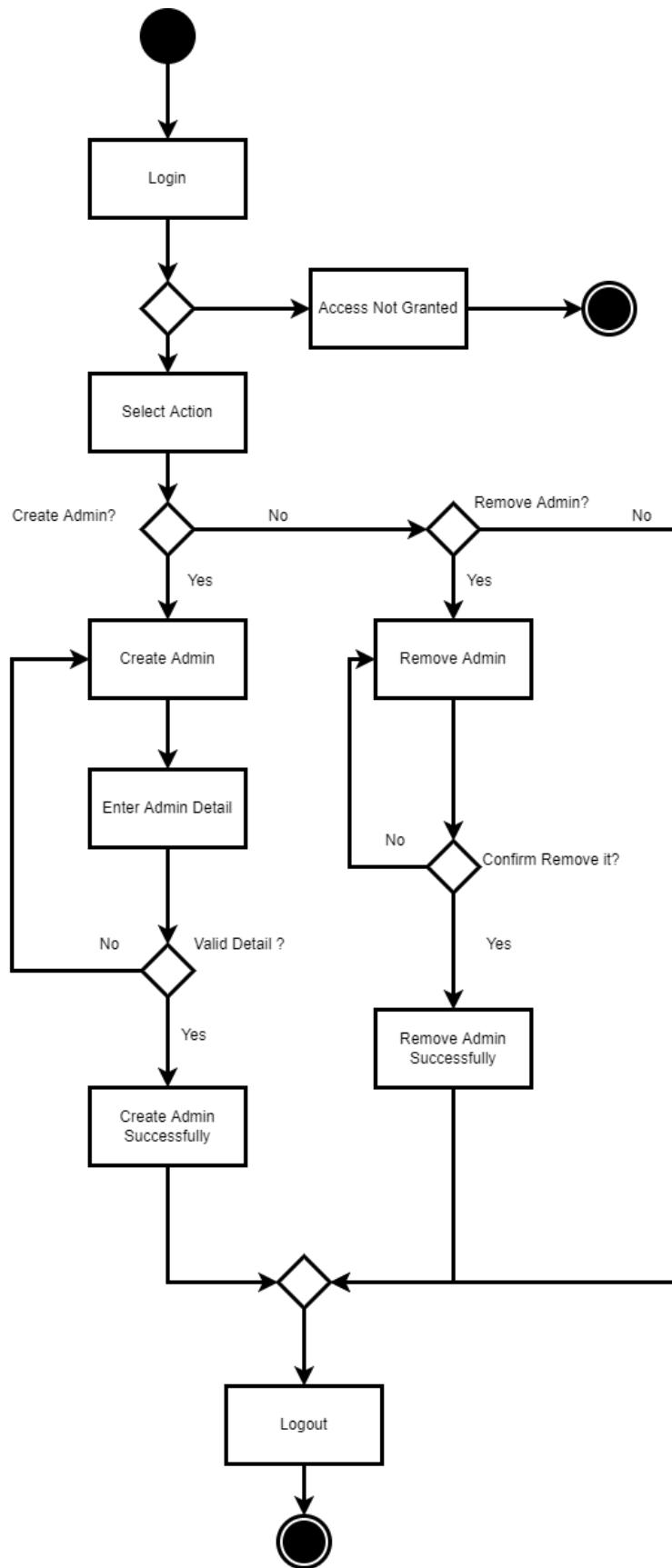
Shift Management



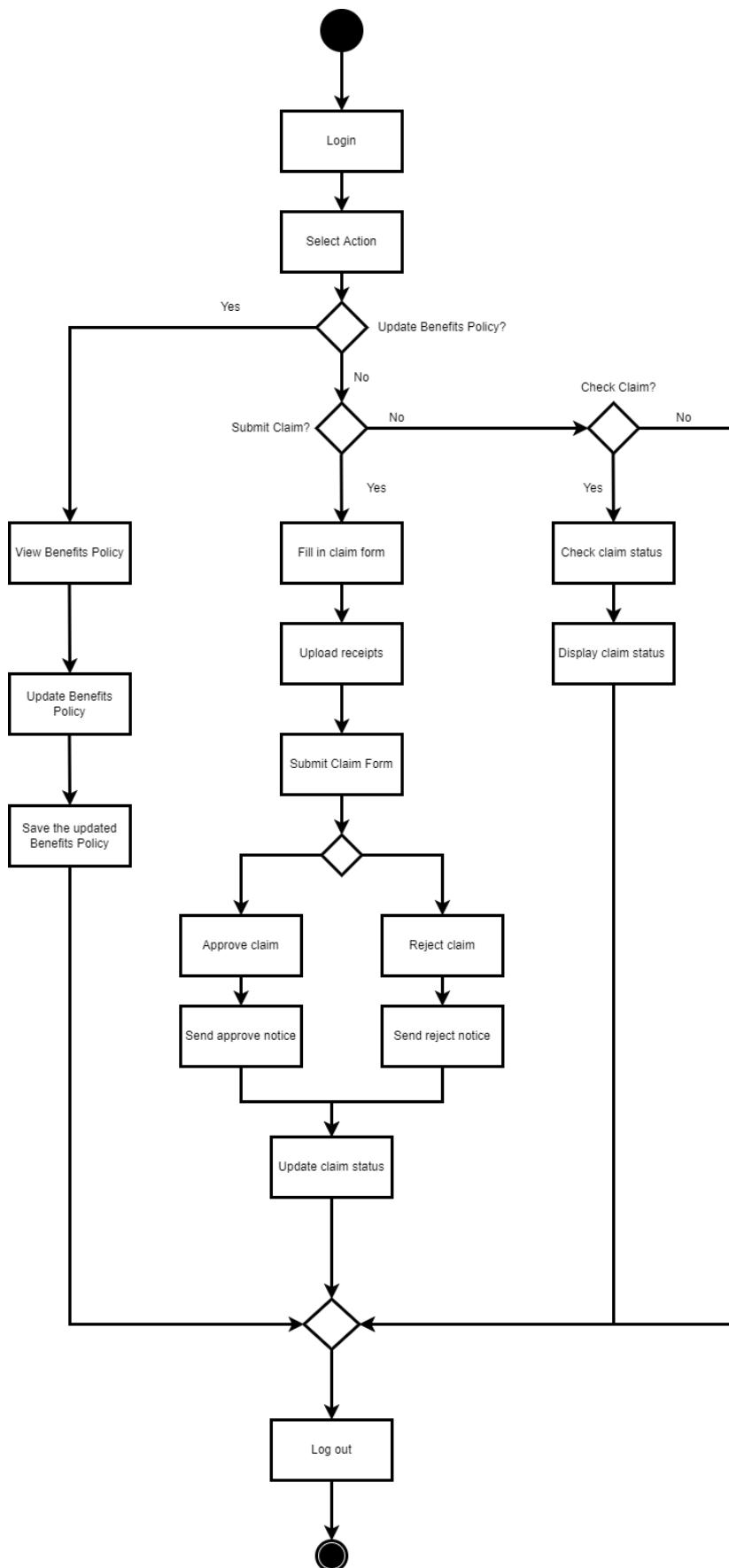
Payroll Module



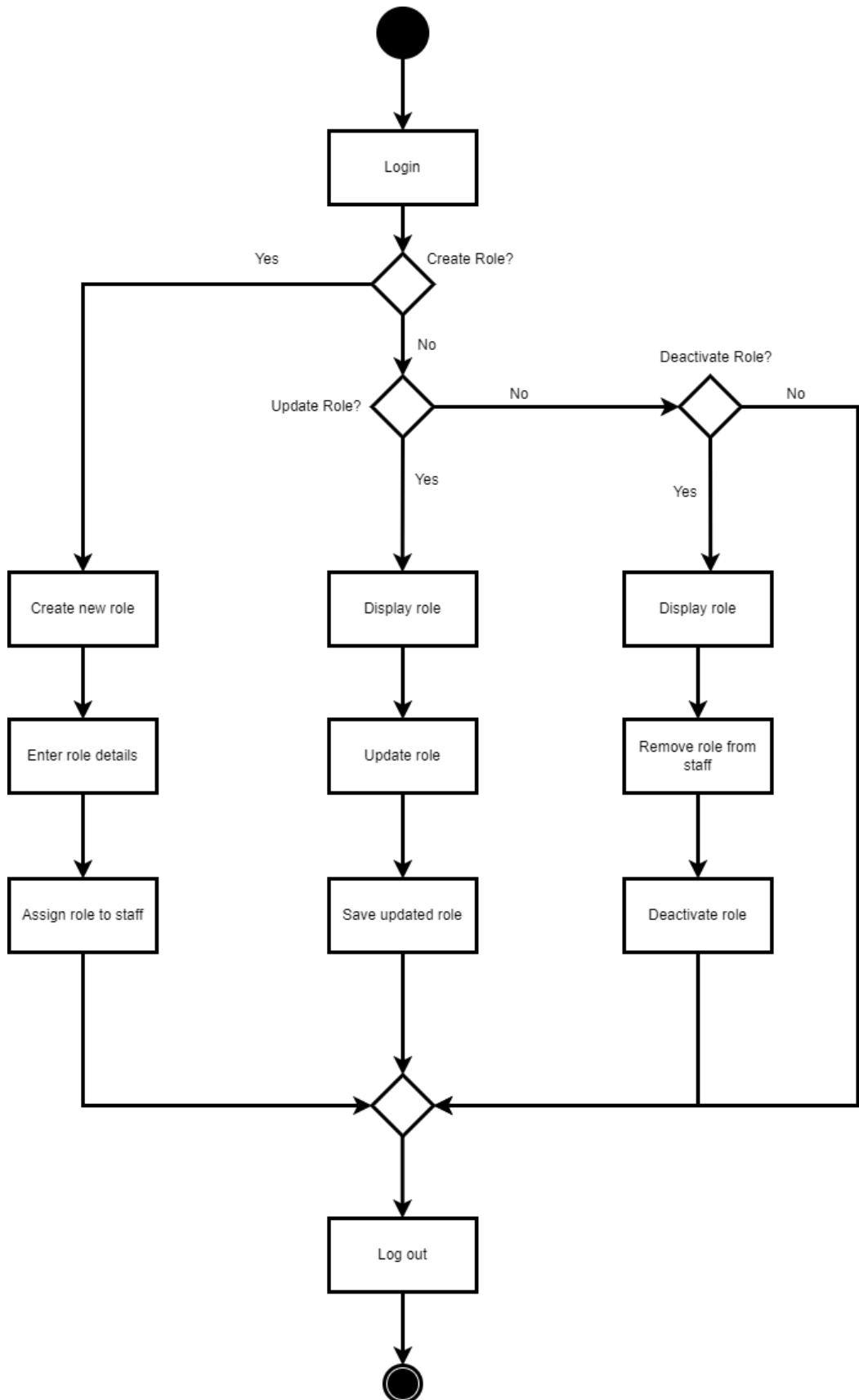
Admin Management



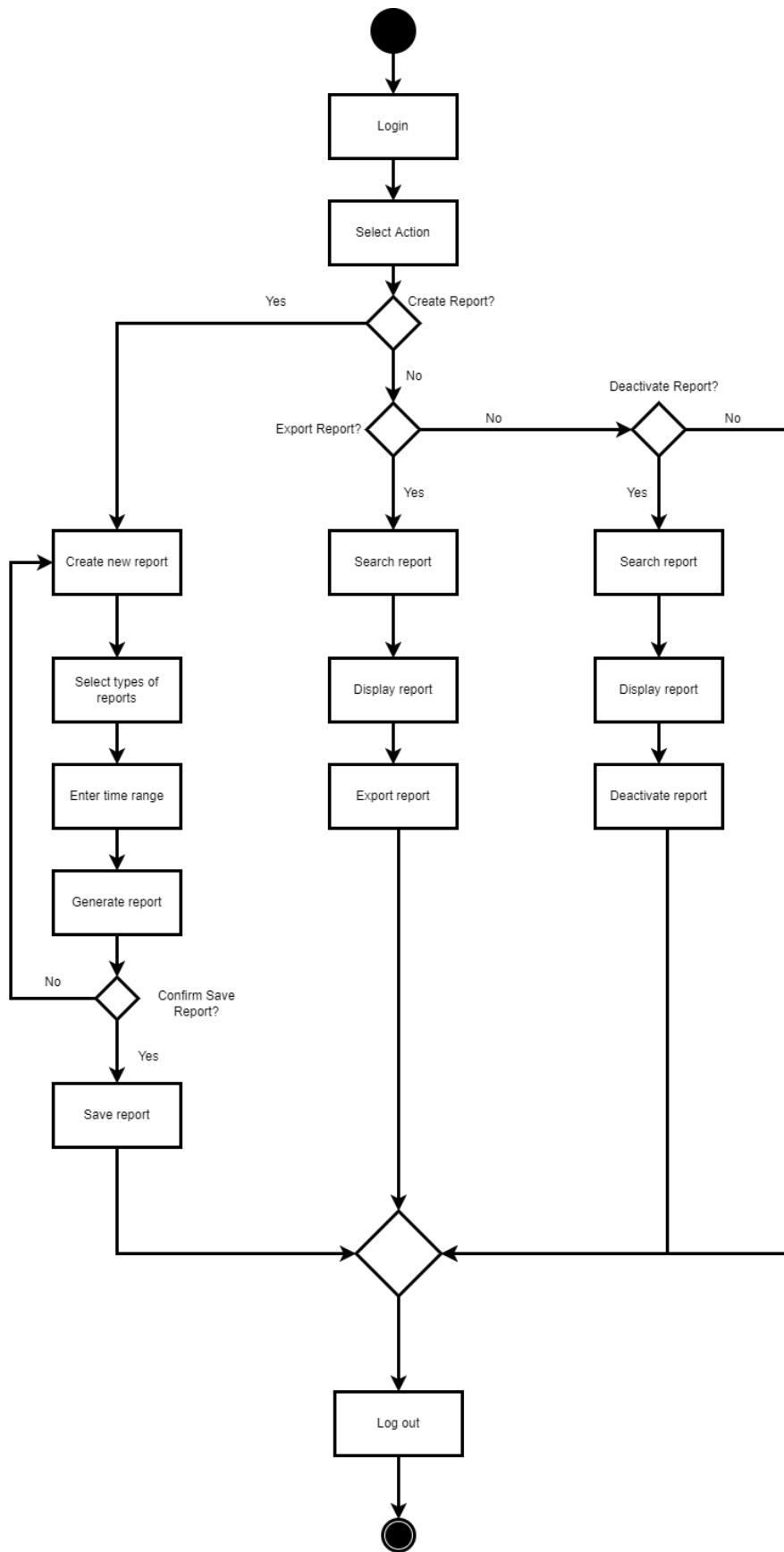
Benefits and Compensation



Role Management

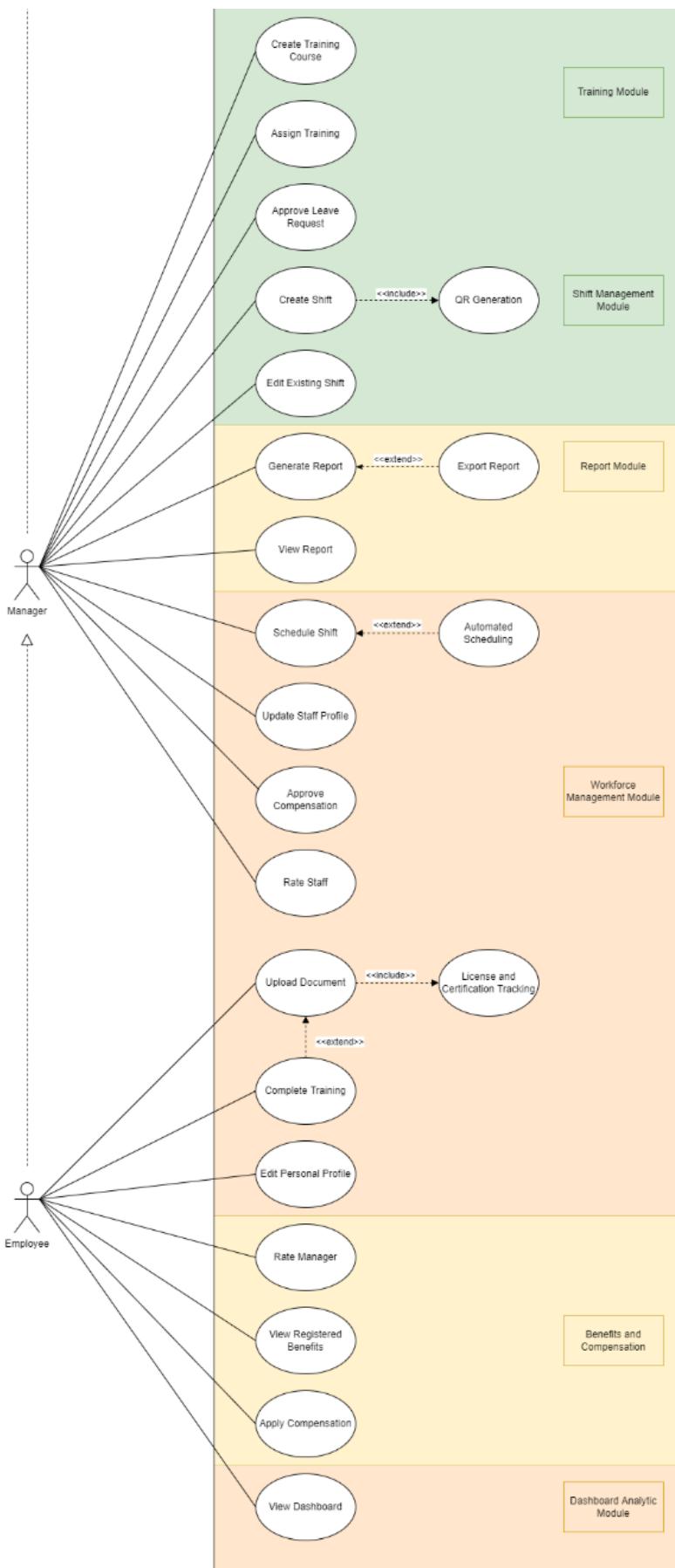


Reporting



4.6.2 Use Case Diagram





4.7 Software Architecture Design

4.7.1 ASP.NET Core MVC

The project will adapt the Model-View-Controller architectural pattern by utilising the ASP.NET Core MVC framework.

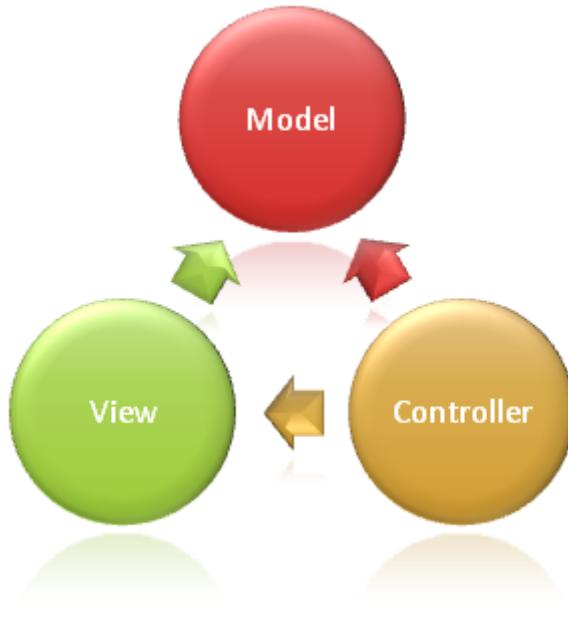


Figure 4.5: MVC Architecture

MVC architectural pattern separates an application into three main groups of components, which are Models, Views and Controllers (Microsoft, 2021).

The Model in the MVC represents the state of an application and any business logic or operation that should be performed by said application. Business logic will be encapsulated in the Model, along with any implementation logic for persisting the state of the application (Microsoft, 2021).

The View in the MVC represents the user interface that presents the content to the user. In ASP.NET Core MVC, they use the Razor view engine to embed .NET code in HTML markup. A view contains minimal logic and only logic that relates to content presentation (Microsoft, 2021).

The Controller in MVC handles user interaction, works with the model and ultimately selects a view to render. In an MVC application, the controller is the one that handles and responds to user input and interaction, while the View only displays information. This makes the Controller an initial entry point and is responsible for selecting what Model to work with and what View to be rendered (Microsoft, 2021).

The ASP.NET Core MVC framework provides a patterns-based way to build dynamic websites that enables a clean separation of concerns and gives developers full control over markup and uses the latest web standards. This delineates responsibilities and helps in scaling the application in terms of complexity. The application becomes easier to code, debug and test since everything has a single job. For example, the Model depends on neither the View nor the Controller even though the two depend on the Model. This allows the Model to be built and tested independent of the visual representation (ardalis, n.d.).

4.7.2 Monolith

The system will adapt a monolithic architecture, which is a traditional unified model for design of a software program. A monolithic software is designed to be self-contained, with tightly coupled components and operations. A monolithic software must have every component and its associated components present for execution and compilation (WhatIs.com, n.d.).

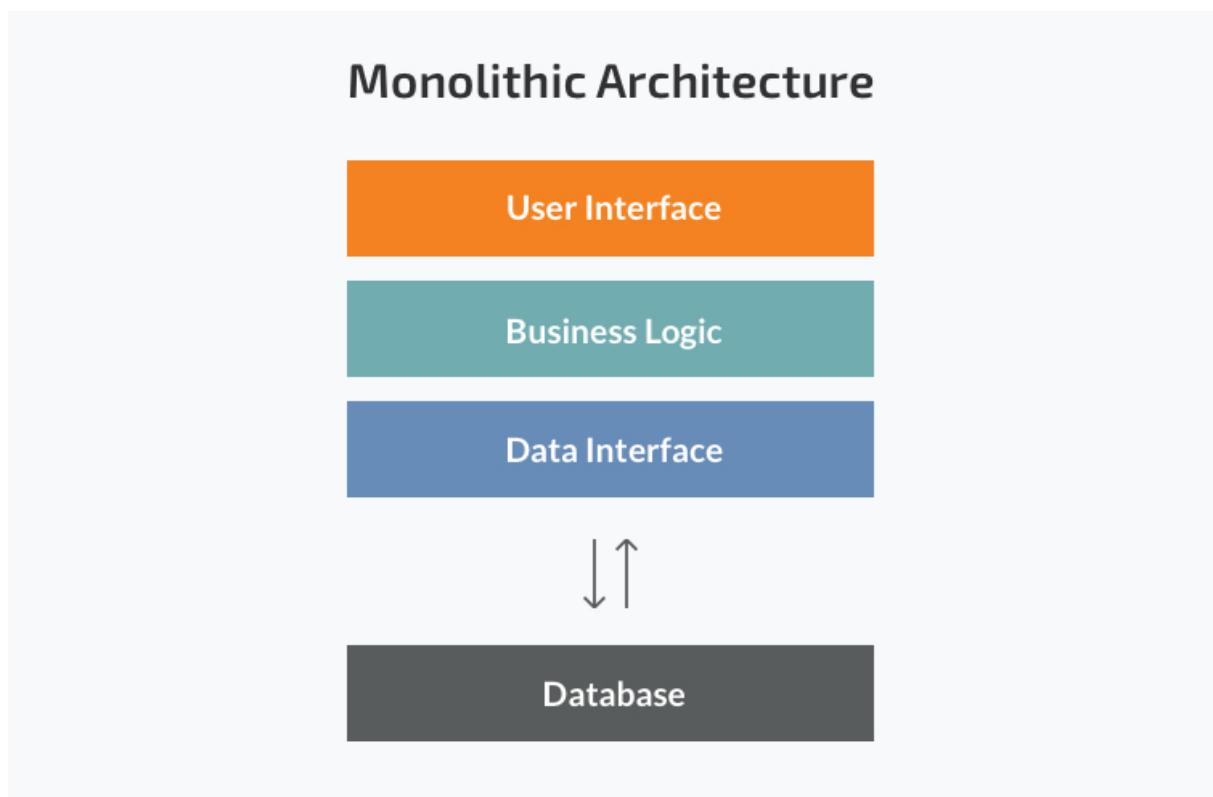


Figure 4.6: Monolithic Architecture

A monolithic application is built and deployed as one single application independent of how a customer uses it. It does not matter if the application is accessed from their desktop or mobile devices, its components and modules remain tightly coupled. A single data source is used for such applications, commonly utilising a relational database management system (WhatIs.com, n.d.).

Monolithic programs have better throughput, and are easier to test and debug since there are less elements and variables. A single codebase also simplifies several development concerns such as logging, configuration and performance.

4.8 Algorithm Design

4.8.1 Case-Based Reasoning

An artificial intelligence based technique, Case-Based Reasoning (CBR) adapts past cases to guide new problem solving through an analogical reasoning process. CBR has been widely used to address a variety of problems such as production cost estimation. The general process of CBR starts with case representation, continues with case organisation and management then ends with case retrieval and matching (Wang et al., 2015).

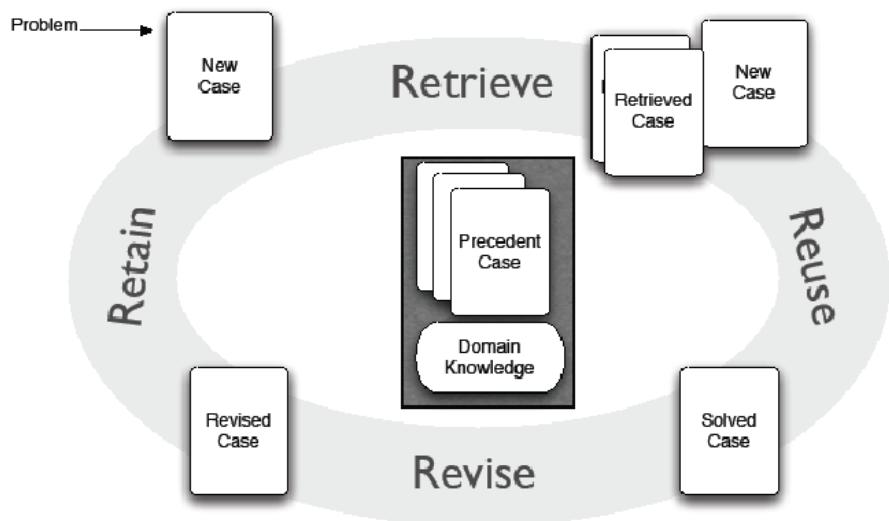


Figure 4.7: Case-Based Reasoning

CBR is based on the paradigm of human thought in cognitive psychology that human experts derive their knowledge from solving multiple cases in their problem domain. Although humans usually generalise patterns of cases into rules, the principal unit of that knowledge is derived from the case. Thus, CBR mimics human reasoning by analogy or association with the solutions for previous similar cases. In situations where traditional rule-based reasoning is relatively weak, such as knowledge acquisition, machine learning, and reasoning with incomplete information (www.sciencedirect.com, n.d.).

4.9 Chapter Summary and Evaluation

In this chapter, an overview of the proposed system's system design is given. This chapter also explained the system's eleven modules, workforce management, shift management, leave

self-service, dashboard analytics, training module, payroll module, admin management, company management, benefits and compensation, reporting and role management.

Next, this chapter included initial concept design of the user interfaces planned for the system. The designs are revealed in the form of wireframes.

Then, the data structure that will be used in the system is presented. A detailed class diagram and an entity relationship diagram is provided for better understanding.

Following that, several reports that will be included in the system are given initial concept design. Some report templates that have been designed are salary slip, payroll report, individual attendance report and weekly attendance report.

Continuing, security practices implemented in the system are explained. OAuth 2.0 is used to grant external websites information without giving passwords. ASP.NET identity will provide membership control to the system. Lastly, database encryption will be implemented to further improve privacy.

Aside from that, a detailed process design for the system is given. Activity diagrams are used to show the different flow of activities a user may undertake in the system while use case diagrams are provided to show all the possible functionalities users can make use of.

In the next section, this chapter provides a clear picture of the software architecture design that will be adapted by the system, which is the ASP.NET Core MVC framework, providing separation of concern. The system will also use a monolithic architecture, which is self-contained, with tightly coupled components and operations.

Finally, several algorithms that are used to provide predictive analytics to the system are introduced and explained. CBR is useful to predict singular cases since it draws conclusions from similar cases in the past.

Chapter 5

Implementation and Testing

5 Implementation and Testing

In this chapter, a detailed description of how the system is actually implemented will be given. The framework and the data structure that supports the coding of the system will be explained and described. Following that, certain functions that are deemed notable will be presented and explained on how they are implemented. External dependencies used during the development of this system will be listed as well. The other half of this section will describe the test plan executed for the system for quality assurance purposes. The main strategy for testing will be given as well as test data needed to perform these tests. Finally, a collection of test cases executed will be provided.

5.1 Implementation

The system is coded into existence using Microsoft Visual Studio Community 2022. A framework and a data structure as well as several external dependencies are used in the development of this project. The following section will describe some of the prominent implementation method of the system.

5.1.1 Framework

The system is based on the ASP.NET Core, a cross-platform, high-performance, open-source framework for building modern, cloud-enabled, Internet-connected applications. The version being used is ASP.NET Core 7.0. The system structure follows the typical design of an ASP.NET Core MVC web application, where the system is split into models, controllers and views.

5.1.2 Data Structure

The data structure used for the system is coded as an object model within the system. Data objects strictly follow the design decided in the class diagram revealed prior. Once the attributes and relationships between the classes are defined clearly, Entity Framework Core (EFC) will be used to transform the objects into SQL database tables. Entity Frame Core is a modern object-database mapper for .NET Core software. Using the application database context, it is possible to define which object classes should be included within the database. Everytime a modification is made towards the classes, EFC can automatically detect the changes since it keeps track of the current database by maintaining a snapshot of the entire database structure and generating migration files which alter the database to match the current classes' attributes. Migrations can then be applied via the Package Manager Console.

```

16 references
public class Payrate
{
    [Key]
6 references
public string? payrate_id { get; set; }

[Required]
8 references
public string? payrate_name { get; set; }

9 references
public float? payrate_ratePerHour { get; set; }

[Display(Name = "Company")]
6 references
public string? company_id { get; set; }

[ForeignKey("company_id")]
3 references
public virtual Company? Company { get; set; }
}

```

Figure 5.1: Model

```

58 references
public class ApplicationDbContext : IdentityDbContext
{
    0 references
    public ApplicationDbContext(DbContextOptions<ApplicationDbContext> options)
        : base(options)
    {
    }

    0 references
    protected override void OnModelCreating(ModelBuilder builder)
    {
        base.OnModelCreating(builder);

        builder.Entity<TrainingProgress>().HasKey(table => new {
            table.staff_id,
            table.training_id
        });
    }
}

11 references
public DbSet<Admin> Admin { get; set; }
35 references
public DbSet<Company> Company { get; set; }
14 references
public DbSet<Role> Role { get; set; }
97 references
public DbSet<EmployeeDetails> EmployeeDetails { get; set; }
0 references

```

Figure 5.2: Database Context

```
namespace FinalYearProject.Data.Migrations
{
    /// <inheritdoc />
    1 reference
    public partial class documentCompensation : Migration
    {
        /// <inheritdoc />
        0 references
        protected override void Up(MigrationBuilder migrationBuilder)
        {
            migrationBuilder.AddColumn<string>(
                name: "supporting_document",
                table: "Compensation",
                type: "nvarchar(max)",
                nullable: true);
        }

        /// <inheritdoc />
        0 references
        protected override void Down(MigrationBuilder migrationBuilder)
        {
            migrationBuilder.DropColumn(
                name: "supporting_document",
                table: "Compensation");
        }
    }
}
```

Figure 5.3: Migration

The database will be an SQL database hosted on a server provided by Microsoft Azure. The details of the server are as follows:

Server Name	finalyearprojectdbserver.database.windows.net
Connection String	Server=tcp:finalyearprojectdbserver.database.windows.net,1433; Initial Catalog=FinalYearProject_db; Persist Security Info=False; UserID=Nicholas; Password={your_password}; MultipleActiveResultSets=False; Encrypt=True; TrustServerCertificate=False; Connection Timeout=30;

5.1.3 ASP.NET Core Identity

ASP.NET Core Identity (ACI) is a pre-included API that supports login and user authentication functionality. It manages users, passwords, email confirmation and more. ACI

is extensively used throughout the system to implement user authentication and authorization as well as maintaining user access control. When creating administrator and staff, a corresponding ACI user will be created. The administrator and staff may use this ACI user account to access the system and perform their tasks.

Aside from that, ACI also supports logging in using an external login provider. Although ACI supports multiple platforms for logging in, this system has only implemented login via Google Account.

5.1.4 Workforce and Role Management

The Workforce Management allows Create, Read, Update and Delete functionalities of staff and users within the system. When creating a new staff, a role must be assigned to them, which is maintained by the Role Management module. A role is defined by a company, and only that company can use it. It can be treated as a titled job position, for example roles can be Finance, Human Resources and General Manager. Each role could have similar or entirely different permissions. For example, Human Resources may have the ability to create staff, but Finance does not. These are all customizable via the Role Management interface.

These permissions are maintained by ACI. When creating a staff with that specific role, the proper permissions will be assigned to the ACI user account associated with the staff. When accessing certain features and functionalities offered by the system, the system will check whether the current user has the appropriate permissions. Without the appropriate permissions, users will be denied access to the specific functionality. Permissions are defined programmatically based on what functionality of the system requires authorization.

```
[HttpPost]
[ValidateAntiForgeryToken]
[Authorize(Roles = SD.SuperAdmin + "," + SD.Admin + "," + SD.EmployeeRegister)]
0 references
public async Task<IActionResult> Create(EmployeeDetails employeeDetails)
{
    employeeDetails.types_of_wages = "Wages";
    employeeDetails.is_active = true;

    if (ModelState.IsValid)
    {
        var user = new IdentityUser();

        user.Email = employeeDetails.email;
        user.UserName = employeeDetails.user_id;

        var result = await _userManager.CreateAsync(user, employeeDetails.acc_pass);
    }
}
```

Figure 5.4: Create New User

```
//Permissions
public const string SuperAdmin = "SuperAdmin";
public const string Admin = "Admin";
public const string EmployeeView = "EmployeeView";
public const string EmployeeRegister = "EmployeeRegister";
public const string EmployeeManage = "EmployeeManage";
public const string RoleManage = "RoleManage";
public const string ShiftManage = "ShiftManage";
public const string TrainingManage = "TrainingManage";
public const string PayrateManage = "PayrateManage";
public const string PayrollManage = "PayrollManage";
public const string EmployeeDelete = "EmployeeDelete";
```

Figure 5.5: Preset Permissions

5.1.5 Leave Management, Accrual and Attendance Auto-Correct

Leave is tracked by hours within this system. The system tracks two types of leave, one being paid leave and the other being sick leave. Each company has their own yearly allowed paid leave duration and sick leave duration. Each company also maintains a value that determines how many working hours are in a day. For example, Company A may allow its employees to have 14 days of leave per year. Company A works 8 hours per day, thus every employee will have 14 times 8 hours of leave given per year, which is 112 hours.

```

var companies = await _db.Company.ToListAsync();

foreach (var company in companies)
{
    var employees = await _db.EmployeeDetails.Where(e => e.parent_company == company.company_id).ToListAsync();

    int hoursInADay = company.leaveHoursPerDay;
    int paidLeaveCarryOver = company.paidMaxCarryover * hoursInADay;
    int paidLeavePerYear = company.paidLeaveYearly * hoursInADay;
    int sickLeaveCarryOver = company.sickMaxCarryover * hoursInADay;
    int sickLeavePerYear = company.sickLeaveYearly * hoursInADay;

    foreach (var employee in employees)
    {
        if (employee.leaveUpdate.Year < DateTime.Now.Year)
        {
            var paidLeaveLeft = employee.paidLeaveHourLeft + employee.paidLeaveOnBargain;

            if (paidLeaveLeft > paidLeaveCarryOver)
            {
                paidLeaveLeft = paidLeaveCarryOver;
            }

            var newPaidLeave = paidLeaveLeft + paidLeavePerYear;

            newPaidLeave -= employee.paidLeaveOnBargain;

            employee.paidLeaveHourLeft = newPaidLeave;

            var sickLeaveLeft = employee.sickLeaveHourLeft + employee.sickLeaveOnBargain;

            if (sickLeaveLeft > sickLeaveCarryOver)
            {
                sickLeaveLeft = sickLeaveCarryOver;
            }

            var newSickLeave = sickLeaveLeft + sickLeavePerYear;

            newSickLeave -= employee.sickLeaveOnBargain;

            employee.sickLeaveHourLeft = newSickLeave;

            employee.leaveUpdate = DateTime.Now;

            _db.Update(employee);
            await _db.SaveChangesAsync();
        }
    }
}

```

Figure 5.6: Accrual of Leave

When applying for leave of a specific type, the system automatically calculates how many hours of leave are to be used and determines whether the employee has enough leave of that type left and then puts them into pending hours. Let us assume that Employee A has 10 hours of paid leave left. He applies for 8 hours. This 8 hours of leave are now pending and cannot be used, thus unless cancelled or rejected, he can no longer apply for more than 2 hours of leave. When the leave is finally approved by a supervisor or an administrator, the pending hours of leave will be deducted from the employee's accrued leave for good.

The automatic accrual of leave hours of employees are done via implementation of a Cron Job, made possible by the inclusion of the Cronos external library. The Cron Job will run every single day, checking whether a year has passed since leave hours last updated. If a year

has passed, the Cron Job automatically calculates the new accrued leave for the employee, based on what their company has specified. It also automatically calculates the carryover of the employee's leave, if the company allows carryover.

```
2 references
public override Task DoWork(CancellationToken cancellationToken)
{
    updateLeaveAccrual();
    updateTrainingProgress();
    _logger.LogInformation($"[{DateTime.Now:hh:mm:ss}] ScheduleJob is working.");
    return Task.CompletedTask;
}
```

Figure 5.7: Cron Job

When a leave is approved, that means all shifts that are originally scheduled for that worker that overlaps with the duration of the leave must be modified for the leave to take effect. Thus, after approving a leave, all shift attendances that overlap with that leave are retrieved. Assuming Employee A took a leave that starts from 10AM to 12PM. If Employee A is scheduled for a shift at 8AM to 11AM, the check-out time for him will be modified to 11AM. If Employee is scheduled for a shift at 11AM to 1PM, the check-in time for him will be modified to 12PM. If he has a shift from 9AM to 6PM, his attendance will be split into two different records, one for 9AM to 10AM and another for 12PM to 6PM.

```

foreach (var attendance in attendanceList)
{
    if (leave.leave_start <= attendance.start_time && attendance.end_time <= leave.leave_end)
    {
        _db.Attendance.Remove(attendance);
    }
    else if (leave.leave_start <= attendance.start_time && leave.leave_end < attendance.end_time)
    {
        attendance.supposed_start = leave.leave_end;
        _db.Attendance.Update(attendance);
    }
    else if (attendance.start_time < leave.leave_start && attendance.end_time <= leave.leave_end)
    {
        attendance.suppose_end = leave.leave_start;
        _db.Attendance.Update(attendance);
    }
    else if (attendance.start_time < leave.leave_start && leave.leave_end < attendance.end_time)
    {
        var frontAtt = new Attendance()
        {
            attendance_id = attendance.attendance_id + "-1",
            staff_id = attendance.staff_id,
            shift_id = attendance.shift_id,
            start_time = attendance.start_time,
            end_time = attendance.end_time,
            supposed_start = attendance.supposed_start,
            suppose_end = leave.leave_start,
            validity= attendance.validity,
            checkInValid = attendance.checkInValid,
            checkOutValid = attendance.checkOutValid,
            on_leave = true,
            leave_id = leave.leave_id
        };

        var endAtt = new Attendance()
        {
            attendance_id = attendance.attendance_id + "-2",
            staff_id = attendance.staff_id,
            shift_id = attendance.shift_id,
            start_time = attendance.start_time,
            end_time = attendance.end_time,
            supposed_start = leave.leave_end,
            suppose_end = attendance.suppose_end,
            validity = attendance.validity,
            checkInValid = attendance.checkInValid,
            checkOutValid = attendance.checkOutValid,
            on_leave = true,
            leave_id = leave.leave_id
        };

        _db.Add(frontAtt);
        _db.Add(endAtt);
        _db.Remove(attendance);
    }

    await _db.SaveChangesAsync();
    _db.Entry(attendance).State = EntityState.Detached;
}

```

Figure 5.8: Attendance Adjustment

5.1.6 Dashboard using Canva.js

The dashboard consists of several charts that help track workforce status. The chart uses currently available data from the database to present interesting information in various forms of charts such as bar chart and pie chart. The chart is built using a Datapoint class that

contains an X value and Y value. The Datapoints are then fed into a javascript function that invokes a library called Canva.js, a responsive HTML5 charting library.

```
double total = await _db.EmployeeDetails.Where(e => e.parent_company == selectedId).CountAsync();

double maleNo = await _db.EmployeeDetails.Where(e => e.gender == SD.male && e.parent_company == selectedId).CountAsync();
double femaleNo = await _db.EmployeeDetails.Where(e => e.gender == SD.female && e.parent_company == selectedId).CountAsync();
double undefGenNo = await _db.EmployeeDetails.Where(e => e.gender != SD.female && e.gender != SD.male && e.parent_company == selectedId).CountAsync();

var malePer = getPercentage(maleNo, total);
var femalePer = getPercentage(femaleNo, total);
var undefGenPer = getPercentage(undefGenNo, total);

List<DataPoint> empGender = new List<DataPoint>
{
    new DataPoint(SD.male, Math.Round(malePer, 2, MidpointRounding.AwayFromZero)),
    new DataPoint(SD.female, Math.Round(femalePer, 2, MidpointRounding.AwayFromZero)),
    new DataPoint("Not Defined", Math.Round(undefGenPer, 2, MidpointRounding.AwayFromZero))
};

ViewBag.empGender = JsonConvert.SerializeObject(empGender);
```

Figure 5.9: Retrieve and Process Data

```
<div id="empGender" style="height: 370px; width: 100%;"></div>
<div id="empNation" style="height: 370px; width: 100%;"></div>
<div id="empRel" style="height: 370px; width: 100%;"></div>

@section Scripts {
    <script>
        window.onload = function () {

            var chart = new CanvasJS.Chart("empGender", {
                theme: "light2", // "light1", "light2", "dark1", "dark2"
                exportEnabled: true,
                animationEnabled: true,
                title: {
                    text: "Employee Gender Distribution",
                    fontSize: 21
                },
                data: [
                    {
                        type: "pie",
                        startAngle: 160,
                        toolTipContent: "<b>{label}</b>: {y}%",
                        indexLabel: "{label} - {y}%",
                        dataPoints: @Html.Raw(ViewBag.empGender)
                    }
                );
                chart.render();
            });
        }
    </script>
}
```

Figure 5.10: Display Chart

Four types of dashboards are available for the system. The first dashboard is a simple screen that shows demographic information such as gender distribution. This is done via retrieving data stored from the database and dividing it over the total number of employees.

The second type of dashboard shows the several status about how the workforce is currently performing. It records how many employees are working currently and how many employees are currently on leave. It also records how many employees that should be working currently, but are late without applying for leave. This is done by retrieving the attendance record of employees and checking whether they have left or have checked in. This dashboard also records the absent rate and overtime rate for the week. This is done by comparing the actual shift time that is supposed to be worked this week with missing attendance and overtime attendance.

The third dashboard shows the number of employees in training against the number of employees training. This is done by analysing training progress of employees.

The final dashboard shows metrics related to employee performance. Employee performance is based on staff rating, which is managed by the workforce management. The average employee rating is calculated and displayed on top of the dashboard. The next two bar charts show the five highest rated employees and the five worst rated employees.

5.1.7 API for Mobile Application Access

Since the mobile team cannot access the SQL database directly since it is coded in Flutter, the web system has to provide Application Programming Interface (API) for the mobile team to perform CRUD operations on the database. When getting data from the database, the model data will be translated into a list of strings which symbolises the different values in different columns.

```
// GET: api/<APIController>
[HttpGet]

public async Task<ActionResult<IEnumerable<string>>> Get()
{
    var queryList = await dbModel.ToListAsync();

    List<string> resultList = new List<string>();

    foreach (var item in queryList)
    {
        resultList.Add(ModelToString(item));
    }

    string[] result = resultList.ToArray();

    return result;
}
```

Figure 5.11: HTTP GET API

When posting data onto the database, the mobile application will invoke the posting API function and transfer the model's data in JSON format.

```
// POST api/<APIController>
[HttpPost]

public async Task<IActionResult> Post([FromBody] Leave leave)
{
    dbModel.Add(leave);
    await _db.SaveChangesAsync();

    return CreatedAtAction(nameof(Get), new { id = leave.leave_id }, leave);
}
```

Figure 5.12: HTTP POST API

5.1.8 External Dependencies

The system relies on several external dependencies that are not included in the preset ASP.NET framework.

The first being Cronos, a .NET library for parsing Cron expressions and calculating next occurrences. Cronos is distributed as a NuGet package, thus it is installed through the official NuGet Gallery. Using it with hosted services, which is a class with background task logic, it is possible to create tasks that are performed periodically during the lifetime of the system. By getting the delay between current time and the next occurrence of the event decided by the Cron expressions, it is possible to check whether it is time to run specific tasks, and then run said function if it is the time. For example, leave accrual functions works on a “0 0 * * *” Cron expressions, which means it will check daily whether it should update employee’s leave hours.

The second NuGet package installed is SendGrid, a Simple Mail Transfer Protocol (SMTP) service provider. By installing the package and registering for an API key on the SendGrid website, it is possible to send an email automatically within the web system. For example, when changing emails and passwords, the system can send a confirmation email to the user using SendGrid without any manual prompt.

5.2 Testing

The following section will describe in detail the test plan drafted for the HRMS web system. The test plan will include the general strategy chosen for the project, the test data required and the test cases executed. By including the test plan and ensuring that there are no visible

defects or vulnerabilities, it is hoped that the HRMS web system's quality will be assured. It is also the objective of the test plan to demonstrate that the system has fulfilled all functional requirements as well as non-functional requirements laid out for it.

5.2.1 Test Scope

The test plan will only examine the functionalities of the modules listed below:

1. Workforce Management
2. Company Management
3. Leave Self-Service
4. Dashboard Analytics
5. Role Management
6. API Collection

5.2.2 Test Strategy

The main strategy that will be used for the system will be black-box testing. Black box testing involves testing a system with no prior knowledge of its internal workings. To perform this testing, the tester only needs to provide an input and observe the output given by the system. The actual output will be compared with the expected output, which will show if the system actually satisfies certain requirements. By performing black-box testing, it is possible to observe how the system responds to unexpected user actions, its response time and reliability issues. Black-box testing can be applied to every level of software testing, whether it be unit testing, integration testing or system testing. As black-box testing only uses the requirements laid out to see whether the system is working correctly, it is sometimes referred to as specification-based testing.



Figure 5.13: Black-box Testing

The reason for choosing black-box testing is it is less time consuming compared to other methods. Tester does not need to examine the code and understand the inner workings of a module, they can directly start testing based on what they understand about the system. Black-box testing also emphasises on UI/UX elements, which is important since the system target audience consists of low technological literacy people (Imperva, n.d.).

5.2.3 Test Data

To effectively demonstrate that the system works and the test cases can be run smoothly, test data must be generated before the testing begins.

Data Needed	Type of Data	Description	Examples
Login Functionality			
Username	String	The username given for the user.	Jxteo
Password	String	The password set by the user.	p@ssword!
Company CRUD			
Company ID	String	A unique ID the company will be identified under.	ACILIIT
Company Name	String	A unique company name the company will be identified with.	Aciliit Sdn. Bhd.
Address	String	The address of said company.	Kampus Utama, Jalan Genting Kelang, 53300 Kuala Lumpur, Wilayah Persekutuan Kuala Lumpur
Longitude	Double	The longitude of the company location.	-123.094696
Latitude	Double	The latitude of the company location.	44.050934
Daily Leave Hours	Integer	Daily maximum hours of leave permitted by the company.	10
Yearly Paid Leave	Integer	Days of paid leave given by the company yearly.	14
Paid Leave Carryover	Integer	Amount of paid leave that can be carried over into the next year.	7
Yearly Sick Leave	Integer	Days of sick leave given by the company yearly.	14
Sick Leave Carryover	Integer	Amount of sick leave that can be carried over into the next year.	7
Role CRUD			
Role Name	String	The name of the role.	General Manager
Permissions	Boolean	Decide whether the role has a specific permission.	Can edit employees.

Document CRUD			
Document Name	String	The name of the document.	Work Permit
Expiry Date	Date	The expiry date of the document, if any.	2022/12/29
Notify Date	Date	The notification date of upcoming expiry of this document.	2022/12/29
Document File	Document	The actual document file the document is referring to.	A .pdf file.
Employee CRUD			
Name	String	The name of the employee.	Yaw Foong Zeng
Profile Picture	Image	An image that will be displayed as the employee's profile picture.	A .png image.
Username	String	The username given to the employee's account.	Nicholas
Password	String	The initial password given to the employee's account.	P@ssword
Employment Start Date	Date	The date the employee started employment.	2022/12/29
Email Address	String	The email address of the employee, used for confirmation and password reset.	nicolasyaw1828@g mail.com
Phone Number	String	The phone number of the employee.	0169881380
Staff Rating			
Rating	Int	A score between 1 to 5.	4
Leave Applying			
Leave Start Time	Datetime	The start of the leave duration to be applied.	2022/12/29 12:00
Leave End Time	Datetime	The end of the leave duration to be applied.	2022/12/29 15:00
Reason For Leave	String	The reason for applying for leave.	Hospital Visit
Leave Document	Document	Any supporting document to further support the reason for applying leave.	A .pdf file.
Leave Type	Paid / Sick	The type of leave that will be applied.	Sick

	/ Unpaid		
Leave Approve			
Response	String	The response message that should be given to the employee.	Understood, get well soon.
Response Message	Approved / Rejected	Determines whether the leave is approved or rejected.	Approved

5.2.4 Test Completion Criteria

To determine that the software has achieved sufficient quality, several criteria are to be achieved before exiting the testing phase.

- All functional requirements are achieved.
- All planned test cases have been executed at least once.
- A minimum of 95% of test cases have passed or partially passed.
- No showstopper or critical defects have been detected during testing.

5.2.5 Test Cases

To thoroughly test the modules within the test scope, test cases are prepared and executed.

Test Case ID	WM_Login_01	Test Executed By	Yaw Foong Zeng	
Test Case Name	Login	Execution Date	2022/12/29	
System	HRMS	Module	Workforce Management	
Description	Login to the system as an administrative user.			
Pre-condition	The administrative account exists.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the login page.			
2	Input valid username.			
3	Input valid password.			
4	Click the login button.	Successfully logged into the system.	P	

Post-condition	User successfully logged into the system.
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Test Case ID	WM_Login_02	Test Executed By	Yaw Foong Zeng	
Test Case Name	Invalid Login	Execution Date	2022/12/29	
System	HRMS	Module	Workforce Management	
Description	Login to the system with the wrong password.			
Pre-condition	The user account exists.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the login page.			
2	Input valid username.			
3	Input invalid password.			
4	Click the login button.	System shows invalid login attempt.	P	
Post-condition	No changes occur.			

Test Case ID	WM_Login_02	Test Executed By	Yaw Foong Zeng	
Test Case Name	Invalid Login	Execution Date	2022/12/29	
System	HRMS	Module	Workforce Management	
Description	Login to the system with the wrong password.			
Pre-condition	The user account exists.			
Step	Action	Expected System Response	Pass / Fail	Remarks

1	Navigate to the login page.			
2	Input valid username.			
3	Input invalid password.			
4	Click the login button.	System shows invalid login attempt.	P	
Post-condition	No changes occur.			

Test Case ID	WM_Create_01	Test Executed By	Yaw Foong Zeng	
Test Case Name	Register Employee	Execution Date	2022/12/29	
System	HRMS	Module	Workforce Management	
Description	Register a new employee and create a new account.			
Pre-condition	The user is logged into an account that has permission to create an employee.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the employee index page.			
2	Click create new.			
3	Input valid information.			
4	Click the create button.	System created a new employee and is shown at the employee index page.	P	
Post-condition	A new employee is created and an user account associated with the employee is also created.			

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Test Case ID	WM_Create_02	Test Executed By	Yaw Foong Zeng	
Test Case Name	Register Duplicate User	Execution Date	2022/12/29	
System	HRMS	Module	Workforce Management	
Description	Register a new employee with the same username as another employee.			
Pre-condition	The user is logged into an account that has permission to create an employee.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the employee index page.			
2	Click create new.			
3	Input valid information.			
4	For the username, enter the username of an existing employee.			
5	Click the create button.	System warns that the username has been used before and does not do anything.	P	
Post-condition	No changes occur.			

Test Case ID	WM_Document_01	Test Executed By	Yaw Foong Zeng	
Test Case Name	Upload Document	Execution Date	2022/12/29	
System	HRMS	Module	Workforce Management	
Description	Upload a document under an employee.			
Pre-condition	The user is logged in.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the employee index page.			

2	Click on the document button on one of the employees.			
3	Click create new.			
4	Input the document name, expiry date and notify date.			
5	Upload the document file.			
6	Click the create button.	System creates new documents and saves the document file on the server.	P	
Post-condition		A new document is created and saved on the server.		

Test Case ID	WM_Rate_01	Test Executed By	Yaw Foong Zeng	
Test Case Name	Rate Employee	Execution Date	2022/12/29	
System	HRMS	Module	Workforce Management	
Description	Rate an employee that reports to the user.			
Pre-condition	The user is logged in.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the staff rating page.			
2	Click on the view button on one of the employees under the user.			
3	Click rate.			
4	Input a valid score.			
5	Click the create button.	System saves the new rating to the database and updates the rated employee's average rating.	P	

Post-condition	The employee is rated and changes to its average rating is reflected.
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Test Case ID	WM_Rate_02	Test Executed By	Yaw Foong Zeng	
Test Case Name	Rate Invalid Score	Execution Date	2022/12/29	
System	HRMS	Module	Workforce Management	
Description	Rate an employee that reports to the user with invalid score.			
Pre-condition	The user is logged in.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the staff rating page.			
2	Click on the view button on one of the employees under the user.			
3	Click rate.			
4	Input a invalid score.			
5	Click the create button.	System shows the rating must be between 1 to 5 and no further action occurs.	P	
Post-condition	No changes occur.			

Test Case ID	CM_Create_01	Test Executed By	Yaw Foong Zeng
Test Case Name	Create Company	Execution Date	2022/12/29
System	HRMS	Module	Company Management
Description	Create a new company.		

Pre-condition	The user is logged in to an account with super admin privilege.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the company index page.			
2	Click on the create new button.			
3	Input valid information.			
4	Click the create button.	System created a new company and is shown at the company index page.	P	
Post-condition	A new employee is created.			

Test Case ID	CM_Create_02	Test Executed By	Yaw Foong Zeng	
Test Case Name	Duplicate Company ID	Execution Date	2022/12/29	
System	HRMS	Module	Company Management	
Description	Create a new company with the same ID as the previous company.			
Pre-condition	The user is logged in to an account with super admin privilege.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the company index page.			
2	Click on the create new button.			
3	Input valid information.			
4	For company ID, enter an ID that already exists in the database.			
5	Click the create	System shows duplicate company	P	

	button.	ID and no further action occurs.	
Post-condition	No changes occur.		

Test Case ID	CM_Create_03	Test Executed By	Yaw Foong Zeng	
Test Case Name	Missing Longitude	Execution Date	2022/12/29	
System	HRMS	Module	Company Management	
Description	Create a new company without typing longitude.			
Pre-condition	The user is logged in to an account with super admin privilege.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the company index page.			
2	Click on the create new button.			
3	Input valid information.			
4	Leave longitude input as blank.			
5	Click the create button.	System shows that longitude is required and no further action occurs.	P	
Post-condition	No changes occur.			

Test Case ID	CM_Modify_01	Test Executed By	Yaw Foong Zeng
Test Case Name	Modify Admin	Execution Date	2022/12/29
System	HRMS	Module	Company Management

Description	Modify a company's responsible admin to another admin.			
Pre-condition	The user is logged in to an account with super admin privilege.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the company index page.			
2	Click on the modify button on a company.			
3	Change the current admin to another admin.			
4	Leave longitude input as blank.			
5	Click the update button.	System update company's admin and is reflected on the index page.	P	
Post-condition	The company's admin is updated and reflected.			

Test Case ID	RM_Create_01	Test Executed By	Yaw Foong Zeng	
Test Case Name	Create Role	Execution Date	2022/12/29	
System	HRMS	Module	Role Management	
Description	Create a new role with employee related function and workforce management permission.			
Pre-condition	The user is logged in to an account with role management permission.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the role index page.			
2	Click on the create button.			
3	Input valid role name.			

4	Select Employee Related Functions and Workforce Management.			
5	Click the create button.	System creates a new role and is reelected in the role index page.	P	
Post-condition	A role with employee related functions and workforce management is created.			

Test Case ID	RM_Modify_01	Test Executed By	Yaw Foong Zeng	
Test Case Name	Modify Role Permission	Execution Date	2022/12/29	
System	HRMS	Module	Role Management	
Description	Modify an existing role with workforce management permission to not have said permission.			
Pre-condition	The user is logged in to an account with role management permission.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the role index page.			
2	Click on the edit button on one of the roles with workforce management permission.			
3	Uncheck workforce management checkbox.			
4	Click the update button.	System updates the permission of the role and permission of all employees under that role.	P	
Post-condition	The role no longer has workforce management permission and so do all employees under that role.			

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Test Case ID	RM_Denied_01	Test Executed By	Yaw Foong Zeng	
Test Case Name	Access Denied	Execution Date	2022/12/29	
System	HRMS	Module	Role Management	
Description	Access role management with a user that does not have the appropriate permission.			
Pre-condition	The user is logged in to an account without role management permission.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the role index page.	System shows access denied.	P	
Post-condition	No changes occur.			

Test Case ID	LS_Apply_01	Test Executed By	Yaw Foong Zeng	
Test Case Name	Apply Paid Leave	Execution Date	2022/12/29	
System	HRMS	Module	Leave Self-Service	
Description	Apply a leave for a valid duration with sufficient paid leave hours left.			
Pre-condition	The user is logged in to an employee account with employee related functions enabled.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the apply leave page.			
2	Click on create new.			
3	Input valid duration.			
4	Input valid reason.			

5	Select the leave type as Paid.			
6	Click on create.	A new leave application is created under the employee. The appropriate amount of paid leave hours is deducted from the employee's accrued paid leave and switched to bargaining.	P	
Post-condition		A new leave application is created under the employee and duration of leave has been exchanged from accrued paid leave to bargaining paid leave.		

Test Case ID	LS_Apply_02	Test Executed By	Yaw Foong Zeng	
Test Case Name	Apply Invalid Duration	Execution Date	2022/12/29	
System	HRMS	Module	Leave Self-Service	
Description	Apply a leave where the end time is earlier than the start time.			
Pre-condition	The user is logged in to an employee account with employee related functions enabled.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the apply leave page.			
2	Click on create new.			
3	Input a duration where the end time is earlier than the start time.			
4	Input valid reason.			
5	Select the leave type as Paid.			
6	Click on create.	System shows invalid leave duration and no further action is taken.	P	
Post-condition	No changes occur.			

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Test Case ID	LS_Apply_03	Test Executed By	Yaw Foong Zeng	
Test Case Name	Insufficient Leave	Execution Date	2022/12/29	
System	HRMS	Module	Leave Self-Service	
Description	Apply for paid leave when there is insufficient leave left.			
Pre-condition	The user is logged in to an employee account with employee related functions enabled.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the apply leave page.			
2	Click on create new.			
3	Input a duration where the total hours is more than the employee's accrued paid leave.			
4	Input valid reason.			
5	Select the leave type as Paid.			
6	Click on create.	System shows insufficient leave and no further action is taken.	P	
Post-condition	No changes occur.			

Test Case ID	LS_Approve_01	Test Executed By	Yaw Foong Zeng
Test Case Name	Approve Leave	Execution Date	2022/12/29
System	HRMS	Module	Leave Self-Service
Description	Approve a leave application submitted by an employee.		

Pre-condition	The user is logged in to an account that has an employee under them.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the approved leave page.			
2	Click on the decide button on one of the leaves.			
3	Input a response and change the status to approved.			
4	Click on Save.	System updates leave status to approved and deduct the applicant's paid leave hour from bargaining.	P	
Post-condition	Leave request becomes approved and appropriate hours are deducted from the employee's accrued leave.			

Test Case ID	LS_Approve_02	Test Executed By	Yaw Foong Zeng	
Test Case Name	Reject Leave	Execution Date	2022/12/29	
System	HRMS	Module	Leave Self-Service	
Description	Reject a leave application submitted by an employee.			
Pre-condition	The user is logged in to an account that has an employee under them.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Navigate to the approved leave page.			
2	Click on the decide button on one of the leaves.			
3	Input a response and change the status to rejected.			

4	Click on Save.	System updates leave status to rejected and return the applicant's leave hours back to their accrued leave.	P	
Post-condition	Leave request becomes rejected and appropriate hours are returned to the employee's accrued leave.			

Test Case ID	API_Employee_01	Test Executed By	Yaw Foong Zeng	
Test Case Name	HTTPGet Employee	Execution Date	2022/12/29	
System	HRMS	Module	Leave Self-Service	
Description	Get employee details via API.			
Pre-condition	The API is hosted on Microsoft Azure.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Call the employee API get function.	System returns employee details in the format of a string array.	P	
Post-condition	No changes occur.			

Test Case ID	API_Employee_02	Test Executed By	Yaw Foong Zeng	
Test Case Name	HTTPPost Employee	Execution Date	2022/12/29	
System	HRMS	Module	Leave Self-Service	
Description	Post employee details via API.			
Pre-condition	The API is hosted on Microsoft Azure.			
Step	Action	Expected System Response	Pass / Fail	Remarks
1	Call the employee API	System creates a new leave request	P	

	post function and send a leave detail in JSON format.	based on the information posted.	
Post-condition	A new leave request is created.		

5.3 Chapter Summary

To summarise, this chapter explained the underlying framework and data structure used by the HRMS, which are ASP.NET Core version 7.0, Entity Framework Core and SQL database. How certain functions are implemented are also demonstrated, with support from external dependencies such as Cronos and Sendgrid. Code snippets are also provided for further clarification.

The chapter also informed readers about the test plan planned for the system, which is black-box testing because it is less time consuming and focuses on user interaction. The test data required for the testing of the various functions are also described in this chapter. Finally, a collection of test cases, with detailed description of actions to be taken, expected results and whether it passes is provided.

Chapter 6

System Deployment

6 System Deployment

This chapter describes the steps taken to ensure the system can be deployed, implemented and utilised with minimal friction at site of choice. It will first describe how system backup and risk of system failure are managed. Then, it will describe the steps needed to set up the system on-site as well as system training planned to be carried out for the users. Finally, follow-up procedures will be proposed and discussed for possible changeover.

6.1 System Backup and Risk Management

To ensure that the system can recover from disastrous failure in case of errors caused by changes in newer versions, the entire project is uploaded to a Git repository. The repository keeps track of all prior versions and changes made towards the project, making a complete system restore possible. Any changeover planned can be made on top of a new branch pulled from the master branch. After the new branch is tested and proved to work, a merge request can be made to update the master branch. If the branch has a lot of errors, the master branch can be downgraded into a lower commit version.

As for possible database failure, since the database is hosted on Microsoft Azure, it comes with an automatic, geo-redundant backup storage. This means that the database contains three backup copies stored in the current region that database is hosted at and another three copies at another region. This meant that even facing disastrous datacenter failure in one region, the data within the database is still safe and will not be lost completely (SudhirRaparla, n.d.).



6.2 On-site Setup

Little setup effort will be needed to prepare the system to be used in the company. The newest version of the website simply needs to be uploaded to a Microsoft Azure server or any other cloud platform in order to be available to all the companies and employees. If a company requests for a standalone system, which is separate from the one used by multiple companies, the team merely needs to create another Microsoft Azure database and modify the system to use the new connection string.

6.3 Training Procedure

As the concepts of applying leave by hours, automatic leave accrual and role-based authorisation are relatively new compared to common HRMS found on the market, a guidebook detailing how these concepts actually governs the system can be created and distributed to those that are given manager permissions. The guidebook can also include several quick start guides on how to set up a preset template that includes an already created company and roles that users can modify to their needs.

For employees without management permissions, a simple presentation video will be enough detailing the common processes that an employee will use, such as confirming their email, filling in personal information, applying leave and taking attendance.

6.4 Follow-Up

To assess whether further changeovers are needed, follow-up meetings can be conducted every month to see whether the users are satisfied with the current system. Additional requirements can be gathered if users are unsatisfied and planned to be implemented in future versions. If no changeovers are needed, the follow-up meetings can be spaced out, starting from one per two months, one per half a year and finally only conducting meetings as per user request.

6.5 Chapter Summary and Evaluation

This chapter explained that the system source code, including previous versions of the system are stored and maintained on a Git repository. The Azure database also utilises geo-redundant backup storage, which means data copies are preserved across regions. These greatly reduce the risk of system failure and data loss.

Following that, the chapter also explained that little setup effort is needed to set up a system for usage since it is already uploaded to a Microsoft Azure server. As for training the employees, a guidebook explaining concepts new to HRMS will be provided for employees. To increase efficiency of learning, a video presentation demonstrating common processes such as attendance tracking will be given as well. Follow-up meetings will be conducted once per month to gather feedback and plan for further improvements.

Chapter 7

Discussions and Conclusion

7 Discussions and Conclusion

7.1 Summary

To summarise, this project was originally set out to fix the traditional problem of HRM, which is rigidity, has a high learning curve and is a passive system. Thus, this project was proposed, a cloud-based analytical HRM system. The system's objective is to lower hardware cost, ease of access, provide accurate productivity tracking and adaptability. The project is split into three different segments, each segment handled by a team of two members. The report primarily focuses on the website and backend team, which handles backend coding and API providing to the mobile team.

A brief literature review was given on the concepts of HRMS and its importance and details about HR Analytics in previous research works. Notable real life implementations of HR Analytics are also given.

The methodology used to develop this project is the Agile Model, which gives the user a great amount of involvement in this user-centric system. By conducting interviews with the executive of our industrial project's requester, the team is able to elicit the functional requirements and non-functional requirements expected from the system.

To fulfil the functional requirements laid out for the system, the system will include 11 modules. They are workforce management, shift management, leave self-service, dashboard analytics, training module, payroll module, admin management, company management, benefits and compensation, reporting and role management. The system will be built in monolith form and using the ASP.NET Core MVC framework.

For the implementation, the system is coded in ASP.NET Core 7.0, where the system is split into models, controllers and views. The database used is a SQL database table hosted on Microsoft Azure's server and maintained using Entity Framework Core. Authentication and authorization of users are implemented using ASP.NET Core Identity, which maintains user, passwords and role-based access level control. API for the mobile team are also implemented. Several external libraries are used, including Cronos, a library that enables periodically executing a specific function and SendGrid, which makes sending confirmation email possible. The testing of the system primarily uses black-box testing strategy, and multiple use case has been executed to ensure the quality of the system.

To ensure that the system can recover from disastrous failure, all versions of the software system are saved in a Git repository, which performs version control and version downgrading. The database on Microsoft Azure also uses geo-redundant backup storage, which could prevent

data loss even under region wide datacenter failure. To implement the system, it merely needs to be uploaded to a Microsoft Azure server or any other cloud platform. Training can be given in the form of a guidebook for upper management to understand the concepts that are relatively new. For normal employees, a simple presentation video will be sufficient to guide them on common processes in the web system. Follow-up meetings can be conducted once per month to decide on any possible changeover for additional requirements.

7.2 Achievements

The original objectives laid out for this project are lower hardware costs, ease of access, accurate productivity tracking and adaptability. The completion of this project has achieved these objectives in various ways.

7.2.1 Lower Hardware Cost

As the web system only needs to be hosted on Microsoft Azure server or any hosting server that supports ASP.NET Core web application, there is no need for heavy investment on physical hardware in order to support the HRMS. In addition, the database is also hosted on a Microsoft Azure server, which means there is no need for supporting maintenance-expensive data servers. As Microsoft Azure supports scalable storage capacity, organisations that host the HRMS only need to pay what they use and upgrade their subscription whenever needed. Furthermore, the HRMS also supports multiple companies. Organisations that host the HRMS can allow any number of companies to use the HRMS as long as the performance does not degrade due to technical constraints, saving the cost of installing the HRMS on many companies. Thus, it is evident that this project has successfully lowered the hardware costs for implementing HRMS.

7.2.2 Ease of Access

Since the web system is hosted on a Microsoft Azure server, employees can access the HRMS anywhere they want on any devices. The mobile application further provides ease of access by eliminating the need of accessing the web system to use the HRMS. Mobile applications on mobile devices may be easier to use than accessing the website through a browser, lowering the difficulty of using the HRMS. Since the mobile application also operates on the same database as the web system via the API, the data is synchronised across both platforms. Employees may perform a task on the mobile application and resume it on the web application if needed. Thus, it is evident that the HRMS has successfully provided ease of access to its users.

7.2.3 Accurate Productivity Tracking

Using the combined features of both the mobile application and web application of the HRMS, it is possible to accurately track employee attendance based on their assigned shift. Several

layers of security are implemented to prevent faking of attendance, such as biometric authentication and geo-fencing on the mobile application. The web system also features that automatically tracks leaves duration and account employee's leave in attendance tracking. Using this data, the workforce's productivity can be accurately and reliably measured, which is then shown in the form of several pie charts in the dashboard. Thus, it is evident that the system provides accurate productivity tracking.

7.2.4 Adaptability

The freedom of customization offered by the HRMS allows any company from any industry to utilise the system effectively. Shifts can be arranged in days, weeks or even just hours, and the same can be said with leave applications. This allows for a high degree of flexibility that can adapt to the needs of different industries. Employees also enjoy a high degree of freedom as they can see how many hours of leave they need without burning an entire day. Thus, it is evident that the HRMS has a high degree of adaptability.

7.3 Contributions

Shift management, attendance tracking and leave self-service remains the primary innovation done in this HRMS project compared to other software on the market. The creativity of tracking attendance individually based on duration that takes into account shift assigned and leave applied grants the HRMS a competitive advantage over other software currently available on the market. It allows much needed flexibility for shift-based industries such as manufacturing companies and construction companies that prefer to track pay by shifts that only last a few hours. Thus, it is presumed that the HRMS will contribute the most towards shift-based industries and will be well received by the market there.

Current workforce management module of the system allows for employees to be placed under another employee without restriction of roles, which allows for multiple types of organisation chart possible. The role management system also introduced role based authorization, which restricts what a user can do based on the role given to him and permissions given to that role. Thus, flexibility on how the organisation is structured is guaranteed while not compromising the system's security measures.

Aside from that, the HRMS is also a cloud-based application that syncs with a mobile application. With the ability to support multiple companies, organisations which own multiple companies will benefit from the HRMS, as a single software allows for unity and standardisation. As most of the features are also accessible through the mobile application, employees that do not own a laptop can also use the HRMS effectively. All in all, the HRMS

introduced multiple new concepts to how a workforce can be managed, such as shift and leave by hours.

7.4 Limitations and Future Improvements

Although the project can be stated as complete and quite successful, several limitations remain in the system. Some of the limitations are identified during the planning phase of the project, while some are realised while advancing the progress of the project.

7.4.1 Unable to Identify Chain of Command: Missing Organisational Chart

The first limitation lies in the workforce management module. Current workforce management module allows an employee to see themselves as well as the employee under them. If an employee under them has an employee under them, their details will be shown as well. Although it is convenient to realise which employee is under their command, as the number of employees increases, it may become difficult to figure out the actual chain of command, especially for upper management employees that have many employees under them and many more employees under them, leading to confusion and frustration.

To solve the problem, an automatic dashboard can be created to generate an organisational chart with the employee on the top. The organisational chart will link an employee to their employer, and the employer to their employer until the link ends at the current user. This will allow for clarity on the chain of command the employee is responsible for and make it easy to find out which employee is under which employee's command.

7.4.2 Unable to Locate Data Quickly: Missing Advanced Search Options

The latest version of the software only allows keyword searches on item names on most indexes. None of the index supports advanced searching methods such as sorting and filtering based on multiple attributes. As the number of data increases in the system, keyword search may not be enough to quickly identify the needed data, leading to loss of productivity.

The solution stated when describing the problem. Future versions of the HRMS may include advanced searching methods such as sorting based on item attributes in ascending or descending form and searching based on numerical value range such as training days left. For items that involve date and time, a filter can be used to focus on data generated on a specific date range only. With more searching tools provided, identifying a specific item will be much easier and convenient.

7.4.3 Potential for Improvement: Dashboard Analytics

Finally, the dashboard analytics only shows data and information gathered from the current database. Although useful for gaining insight on how the workforce is performing currently in real time, there is much potential for improvement. For example, possible employees for development as well as turnover rate are important metrics for a company HR department, but are not included within the system.

To improve upon this issue, future versions can implement predictive algorithms and pseudo Artificial Intelligence to generate more information and insights based on currently available data. These algorithms may be used to determine whether an employee is going to quit their job and predict the company's turnover rate. There may exist algorithms that predict the total employee pay for the month even during the middle of the month as well. These will allow a company to peer into possible future issues and take measures for prevention or mitigation.

7.5 Issues and Solutions

Several issues were faced during the implementation of this system. However, these issues are handled correctly and eventually solved without critically affecting the progress of the project.

7.5.1 Miscommunication of Functional Requirements

The first issue is miscommunication of functional requirements of both the web system and mobile application between the web system team and mobile application team. The requirements stated by both parties demanded features from the opposite party that are not originally in the party's project scope. For example, the mobile application team assumed that signing up as an employee is possible, however the web system team assumed that employees can only be created via the web system only by another employee with permission. The required API was not provided, and it causes conflicts between both parties' requirements. Another example would be different assumptions on how cross-platform processes such as attendance tracking and shift assignment would work by both parties. If unreconciled, it could lead to two different systems instead of the same system supported by both applications.

To solve the issue of miscommunication, both parties decided to enhance our communication rate by conducting regular meetings where both parties would discuss conflicts within the requirements or general questions about how things actually work. Diagrams such as process flow would be drawn to further clarify how both parties would handle a cross-platform process request. By brainstorming ideas and compromise from both parties, the requirements of both systems are able to be standardised, with an agreed version of project scope. Further conflicts would go through the same process, meeting, brainstorming and providing solutions. With this, the issue is effectively solved without further action needed.

7.5.2 Microsoft Azure Server Error

Another issue faced was the inability to start the web system on a Microsoft Azure server in the earlier stages of development and only showing Error 500 when accessed. As the API needed to be hosted in order for the mobile team to actually access CRUD operations on an SQL database, failure to host the API on the server would lead to project failure, as the mobile team cannot access the database to track attendance and attendance cannot be taken through the web system. This issue was the most prominent and difficult to solve as both teams are unfamiliar with Microsoft Azure and little feedback or guide is available.

By going through the Microsoft Azure documentation and external resources such as Stack Overflow forums, it is discovered that detailed error messages can be generated by an API service provided by Microsoft Azure itself. Following the tutorials provided, an application insights API is created and attached to the project itself, which shows that the database has not been uploaded onto the server. To solve that, a SQL database was created at the same Azure server and Entity Framework Core is used to upload the current database structure onto the server. However, that need not solve the problem as an external dependency, SendGrid API needs an API key to operate, and that key is only stored on a local secret dictionary. By uploading that key as well, the web system successfully ran on Microsoft Azure and can be accessed anyway via the link provided by Azure.

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Chapter 1

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