A WEB-BASED SYSTEM FOR MANAGING EMPLOYEE'S EXPENSES

BY

THANESH RAM A/L SELVA SUNDER

A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfillment of the requirements

for the degree of

BACHELOR OF COMPUTER SCIENCE (HONS)

Faculty of Information and Communication Technology

(Kampar Campus)

JANUARY 2020

UNIVERSITI TUNKU ABDUL RAHMAN

REPORT STATUS DECLARATION FORM

Title: A WEB-BASED SYSTEM FOR MANAGING EMPLOYEE'S EXPENSES

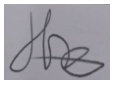
Academic Session: JANUARY 2020

I THANESH RAM A/L SELVA SUNDER

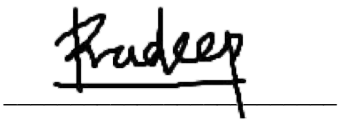
declare that I allow this Final Year Project Report to be kept in Universiti Tunku Abdul Rahman Library subject to the regulations as follows:

1. The dissertation is a property of the Library.
2. The Library is allowed to make copies of this dissertation for academic purposes.

Verified by,



(Author's signature)



(Supervisor's signature)

Address:
NO. 36 Jalan 8/119,
Taman Taynton View,
Cheras 56000, Kuala Lumpur.

PRADEEP ISAWASAN

Supervisor's name

Date: 23/04/2020

Date: 23/04/2020

A WEB-BASED SYSTEM FOR MANAGING EMPLOYEE'S EXPENSES

BY

THANESH RAM A/L SELVA SUNDER

A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfillment of the requirements

for the degree of

BACHELOR OF COMPUTER SCIENCE (HONS)

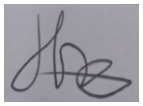
Faculty of Information and Communication Technology

(Kampar Campus)

JANUARY 2020

DECLARATION OF ORIGINALITY

I declare that this report entitled "**A WEB-BASED SYSTEM FOR MANAGING EMPLOYEE'S EXPENSES**" is my own work except as cited in the references. The report has not been accepted for any degree and is not being submitted concurrently in candidature for any degree or other award.

Signature : 

Name : Thanesh Ram A/L Selva Sunder

Date : 23/04/2020

ACKNOWLEDGEMENTS

I would like to present my sincere appreciation to my supervisor, Dr Pradeep A/L Isawasan who has given me the opportunity and strongly guided me throughout the entire duration of this project. A sincere appreciation also goes to his strong patience, act of kindness, motivational support and morale support that he had given to me to make sure this project turns out to be successful.

A special thanks goes to my moderator Ts Dr Ku Chin Soon for giving me constructive feedbacks and ways that I can improve on my project for the better. A special thanks to both of my parents mental and financial support and friends that have given a helping hand.

ABSTRACT

This project is about an expense management system that is focusing towards achieving the objectives of helping to increase efficiency and reduce cost for managing employees' expenses. Over the years, the traditional way of managing employee's expenses are normally by manually passing the receipts to the finance department of a company. Later on, this changed to uploading them to a software system which required many steps such as uploading them to specific categories. In order to solve this issue, this project has proposed two main objectives, which is to create a classification functionality where when a user uploads the receipt, the system will handle the sorting of the receipt type automatically for the user. By having this classification functionality, user can just upload a receipt without the need for considering which category does the receipt fits into and this indirectly increases the efficiency and reduce time wastage. The other objective is to create a visualisation functionality, which can provide good insight into the company's expenses. This functionality helps to reduce, manual labour in performing data collection and visualisation manually. This functionality in the system will help users to save time and reduce cost on hiring a separate employee to perform this task as the system can do it for us automatically. In order to develop this project successfully, the Agile Methodology is being adopted, which is a commonly used methodology for software development projects. Agile development requires series of steps and phases to be executed in order to achieve a good quality and successful project outcome.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

1.1 Problem Statement

The challenge of manually categorizing expenses according to types of claims upon receiving the digital receipts.

In some organizations, employees are required to manually sort their receipts and upload them according to their respective claim categories. This introduces an increase in manual human error where an employee uploads the receipts into the wrong category. Due to such issues, some organizations solve this by having a finance department employee to first do a review on the receipts to check whether they are in their respective categories. Indirectly, this causes an efficient use of the finance department's labour with redundant work tasks.

The problem of providing a good insight for employee's expenses.

The finance departments of a company often must manually do all the painstaking calculations by using a calculator or a software tool like Microsoft excel in order to have an insight of the monthly or yearly expenses of that company. Such a method requires a large number of labour hours and often lead to poor insight. Without a proper tool, which can help to perform these tasks automatically the finance departments will have trouble to look for key insights manually, which indirectly leads to poor decision making that can incur additional costs to the organization.

1.2 Background Information and Motivation

Managing an organisation's employee expenses efficiently and accurately is a challenge that has been around for decades towards many organisations, as their organisation grows bigger, so will their expenses. Over time this causes an increase in difficulty to be able to keep track and manage every expense submitted by employees. A great portion of organisations still rely heavily on a more traditional approach, where employees are required to submit a copy of their physical receipts to the finance department for review for their expense claims. This method relies on manual labour, which is highly prone to human errors, such as the finance department employees accidentally using the incorrect

values for the expenses. Small mistakes like this can eventually add up to a bigger cost where the organisation is affected directly. To solve this issue, some organisations use a multilayer procedure, whereby each receipt are crossed checked by more than one employee in order to reduce the mistakes. Unfortunately, such a solution causes the finance department to use their labour in a very inefficient manner where they spend too much time for just checking and managing these expenses which causes them to reduce spending their efforts in other more important responsibilities.

Most companies nowadays have chosen to upgrade to a solution that demands for a lesser amount of manual labour in order to manage these expenses, which is to use an expense management system. A great majority of organization often prefer to buy or rent an expense management system from other parties instead of developing their own because it is sometimes more cost friendly depending on situations. Expense management systems generally works by where an employee is only required to upload a copy of their receipt into the system and the finance department employees can directly view the uploaded receipts from the system itself. This eliminates the need for physically being present in order to submit the expenses, which indirectly saves up time and is a more efficient approach. Certain expense management systems still rely on the users of the system to manually key in the expense values while providing the receipt only as proof of authenticity. Some existing systems takes advantage of implementing Optical character recognition (OCR) technology which helps to automatically scan and recognize text or digits that are on the receipt and automatically populates them into the system without the need for manual labour to key in the values.

Although, the use of OCR helps to greatly reduce the need for manual labour in managing the employee's expenses, this solution does not help to eliminate the need for manually sorting the receipts according to their respective categories such as medical claims, business accommodation claims, transportation claims and others. Sorting the receipts according to specific criteria and categories is a painstaking and time-consuming procedure, that no employee likes doing. The need for employees to upload their receipts following their specific categories and for finance department employees to manually check whether the uploaded receipts are in their respective categories is an additional

inefficient process. Furthermore, the finance department is also required to manually check the validity of the receipts to avoid frauds to occur. Despite the things that expense management systems lack of, there are a few features that some existing systems have that is worth mentioning which helps to improve work quality in overall. Features such as providing a function to allow users to view their expense analytics, generate an expense report based on certain rules provided by the user and allowing users to automate expense recording.

1.3 Project Objectives

The following are the objectives of this project:

- **To implement a classification algorithm that will automatically sort digital receipts uploaded according to their respective expense category.**

  The expense management system to be created will include a text classification algorithm that will help to reduce or eliminate the need for manual labour when sorting employee's receipts that are uploaded. This functionality will be able to classify documents that are uploaded to the system and then sort them according to their respective categories. The classification is done by using specific keywords that has been extracted and pre-processed from the document itself, which is then pushed into the classification model to perform the prediction.

  Subobjective

  - **To be able to automatically extract only the final value of a receipt uploaded.**

- **To create a functionality that provides visualization to users on expenses which can be used for analytic purposes.**

  The expense management system to be created will have a feature where users can visualize their expenses with ease and clarity. Users will be allowed to control the type of visualization based on certain fields and parameters. The system will provide mainly

2 different types of views, which is one for the user view and another for the manager view. This feature will help its users to better understand their expense flow.

1.4 Project Scope and What is to be achieved

1.4.1 Receipts Classification Module

This module will use a classification algorithm in order to automatically classify receipts and sort them accordingly to their respective categories. By default, there will be 5 categories available in the system namely medical, transport, accommodation, communication and business expense. Whenever an employee uploads a receipt into the system, the texts on the receipts will be captured and the algorithm will classify and sort the receipts accordingly based on certain keywords found from the receipt. This module is to automate and reduce the need for manual labour in sorting the receipts.

1.4.2 Expense Visualization Module

This module will present a summary of the employee's expenses using visualization so that employees will be able to view and monitor all of the employee's expenses in one single page directly. There will be mainly two different types of views which is one for the manager view and another for normal employees' view which differs in a slightly different layout and parameters available. The visualization will be done automatically by the system itself whenever an employee uploads a receipt. The necessary values will be retrieved directly from the database and be used to generate some visualization that give users a better understanding of their expenses flow whenever a user requests for this function.

1.5 Impact, significance and contribution

The system proposed to be developed will be very beneficial mainly in terms of aiding a company to have an easy to use and well-maintained expense management system that can help to reduce cost and increase efficiency. Both functionalities proposed in the objectives helps in achieving a long-term solution for increase in efficiency and reduce in cost.

By having an expense management system that supports a receipt classification functionality that can help to sort the digital receipts uploaded according to their respective category, helps to eliminates the need for manual labour. The availability of the classification functionality allows user to just simply upload any valid digital receipt that is wanted to be claimed for and the system will perform the backend sorting to classify the type of claims and group them accordingly. The user is not required to manually identify and upload their receipts to respective categories, which is a very tedious and time-consuming process. On the other hand, the finance staffs and upper management staffs that perform the approvals of expenses submitted process will also no longer require to manually check the receipts and sort them.

Besides that, the second functionality proposed is to provide a good visualisation to users on expenses based on certain criteria, which can be used for analytic purposes. This functionality helps a company to perform analytics on their yearly or even monthly expenses easily, without the need for an additional employee that manually goes through the expenses and perform the required analytics. In the long run, this functionality helps to increase efficiency and help to reduce cost on hiring an additional labour just for the purpose of performing the data analytics.

Therefore, by having both the classification and visualisation functionality being implemented in an expense management system, companies can save on cost and increase their expense management efficiency. Companies will also be able to cut down on overspending, with the help of a proper visualisation of their expenses and make necessary changes accordingly with ease.

1.6 Report Organization

In chapter 1, a project introduction is discussed which included the problem statement of the project, some background information and motivation regarding why the project is done. Besides that, the objectives, project scope and what is to be achieved throughout this project is also discuss under this chapter. Having all of the above listed down helped in giving a clearer direction of how and what to do during this entire project. The report

organization was then discussed in this chapter, which talks about a brief summary of the content of this entire report.

In chapter 2, existing systems on the market that are related to Expense Management Systems are reviewed and summarized in key areas such as a brief introduction about the system, their strengths and weaknesses and also a recommended solution to solve their issues. Reviewing these systems helped in identifying the core functionalities that an expense management system requires. Based on the reviews done, a system functionality comparison table was created in order to better provide an overall view of the available and required functionalities of an expense management systems. By performing the reviews, this also enables a better understanding of real world demands and expectations of an expense management system. Along with that, things that existing systems lack of and things that needs to be improved was also determined throughout this chapter. The reviews also benefited in providing a better insight of the challenges faced by the creators of the existing system when they were making the system.

Besides that, a general concept of what and how a classification algorithm works was discussed in this chapter. Subsequently, since Naïve Bayes classification algorithm was chosen for this project, a short explanation of how the algorithm actually works, which was explained using this project as an example in order to make the explanation clear enough. Overall, by performing this chapter it has helped to make the decision making for determining the project scope of this project a lot easier and clearer. Besides that, this chapter also helped in understanding how does the classification algorithm actually works in general, along with a deeper understanding of how does the Naïve Bayes classification algorithm works.

In chapter 3, the system design was discussed in detailed, which mainly contained unified modelling language diagrams such as the activity diagrams, use case diagrams and entity-relationship (ER) diagrams of the system that is to be built. All of the diagrams created in this chapter is used as a guide for developing the system and making sure that the system requirements were correctly developed. Besides that, in this chapter the system framework diagram was also created. This diagram was to give an overview of all of the system’s features and functionality. Along with that, this chapter also shows a rough draft of the

project timeline of what is needed to be done and the amount of expected time is needed to complete them.

In chapter 4, the proposed method and approaches were discussed, which mainly includes details of the system design specification. The type of methodology that was implemented to develop this system was also discussed in this chapter. Along with that, the tools that were needed to be used in order to develop the system was also discussed in this chapter. The user requirements were then listed down in order to give a clear understanding of the final outcome of the system. Finally, in this chapter, system specifications and the verification plan were also discussed in this chapter.

In chapter 5, two main things that were highlighted are the testing done and also screenshots of the work that is done throughout this project. The chapter is begin with a short summary of what are the verification plans, which is then followed by with all of the test cases and results of the tests done in a table form. The 2 types of testing that was done were, unit testing and usability testing. After all of the testing related stuff were discussed, the screenshots of the actually system that was developed were shown. The screenshots were done on a module by module bases.

Finally, in chapter 6, there are 3 different sub-section which are the project review, project contribution and highlight, and the future work. In project review, the process of how this project was done is discussed, which consists mainly of three parts, Proposal writing, FYP1 and FYP2. In the project contribution and highlight section, the systems features were discussed, along with how the developed system and features will be useful in a real-life environment. Lastly, in the future work section how some of the things that the system developed can be improved to be more efficient and more interactive are discussed.

CHAPTER 2: LITERATURE REVIEW

2.1 Classification Algorithms

2.1.1 Classification Algorithms General Concept

Classification is a technique that can be used in order to identify and categorize a set of data into a distinct and wanted number of groups. Classification algorithms in general work with the same basic concept as follow:

1. The data set is first split into two which is the test set and the training set.
2. Each of the records in the training set is then characterized by a tuple (x, y), where x represents the input variables and y represents the output.
3. The training set data is then fed into a learning algorithm which helps to create a learning modal.
4. The model created is then used to determine and map each of the input set, x to the output, y for the test set data.

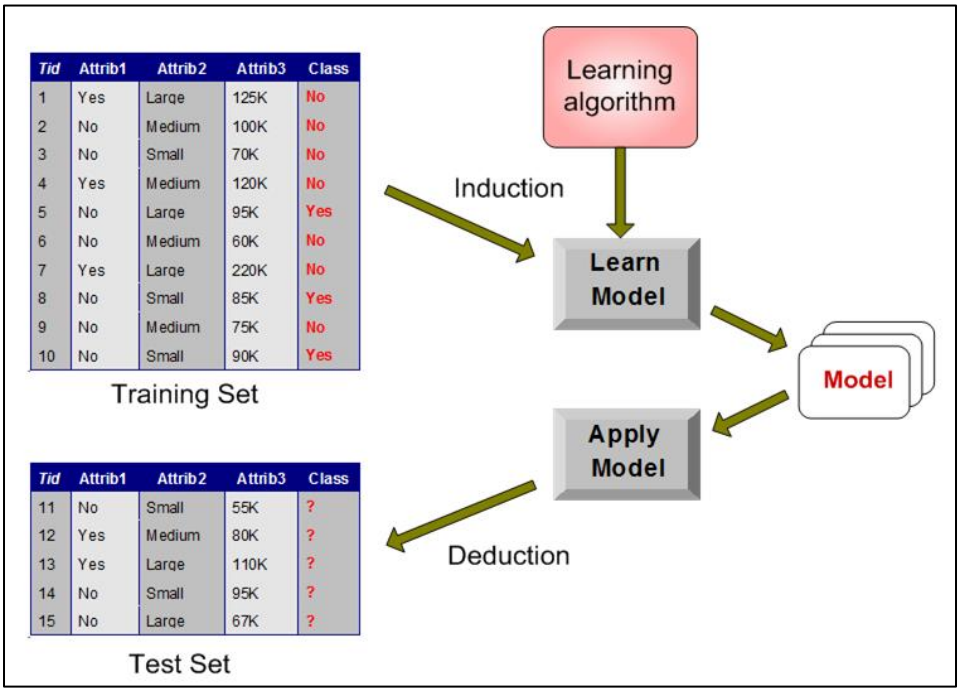


Figure 2-1 Classification concept. *(Tan, et al., 2018)*

Implementing a classification algorithm for this project will bring several benefits. One of which is that, by having a classification algorithm to automatically perform the categorization of receipts process, this enables a better efficiency in terms of time and

labour cost. The need for manually sorting the receipts according to the their respective categories of expense can almost be discarded entirely. (Sheela & Nalini, 2014)wrote that, text classification is a significant application area in text mining, because classifying a huge number of documents is very time intensive and expensive.

2.1.2 K-Nearest Neighbour Classification Algorithm

K-Nearest Neighbour classification algorithms assumes that things that are the same exist in close proximity between each other. The algorithm will first accept a dataset which is used for training the classification modal. The algorithm will plot the input dataset onto a 2D plane as points. The data that are similar to each other are plotted closely to each other on the plane. Once the plots are set, whenever there is a new data incoming that needs to be classified, that data is also plotted onto the plan. The "K" value is then set to a specific number, which represents the number of nearest neighbour vote that are to be taken into count. The nearest neighbour votes are determined by finding the shortest distance of plots between the input plot and the training dataset plot. This distance is determined by using the Euclidean distance formula as shown below:

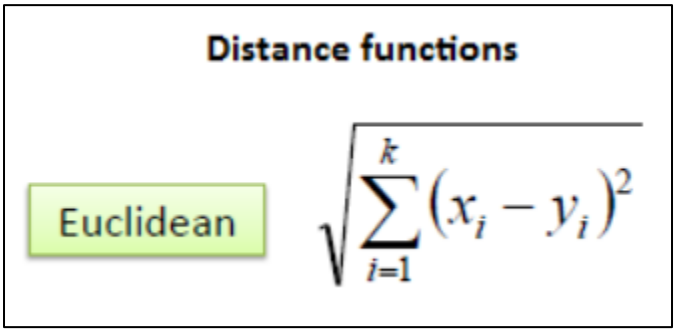


Figure 2-2 Euclidean Distance Formula.

An example of how the formula above is applied is shown below, where the distance of 2 points can be found when inputting their respective values into the formula:

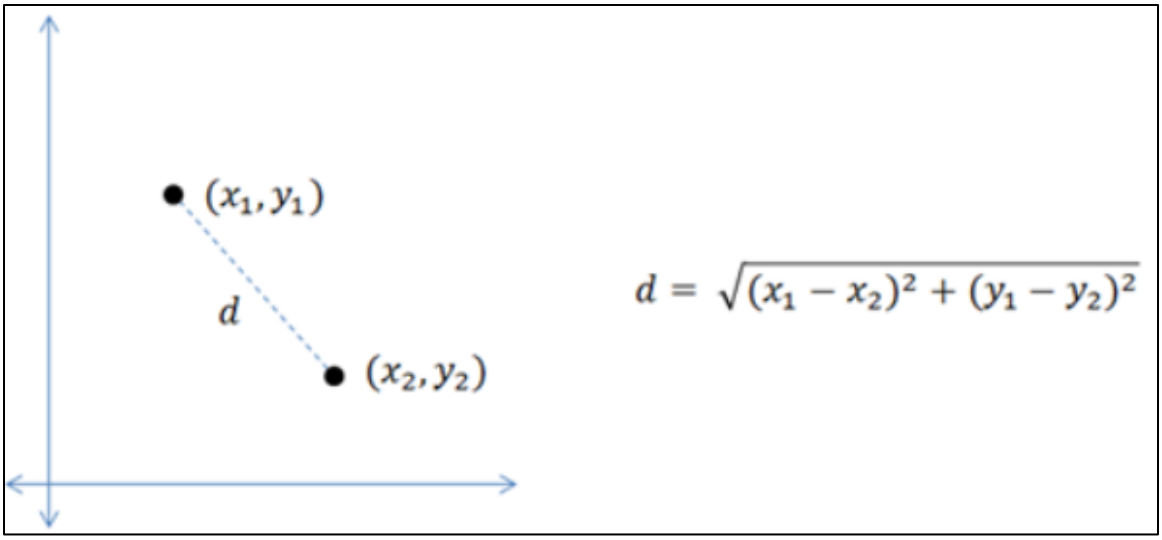


Figure 2-3 Example of calculating the distance between 2 points.

Once the distance between the input plot to be classified and the training dataset plots are identified, the distance are compared to find the shortest distance for a total number of K plots. The following figure is an example with input being the blue star which needs to be classified to be either a red circle or a green square:

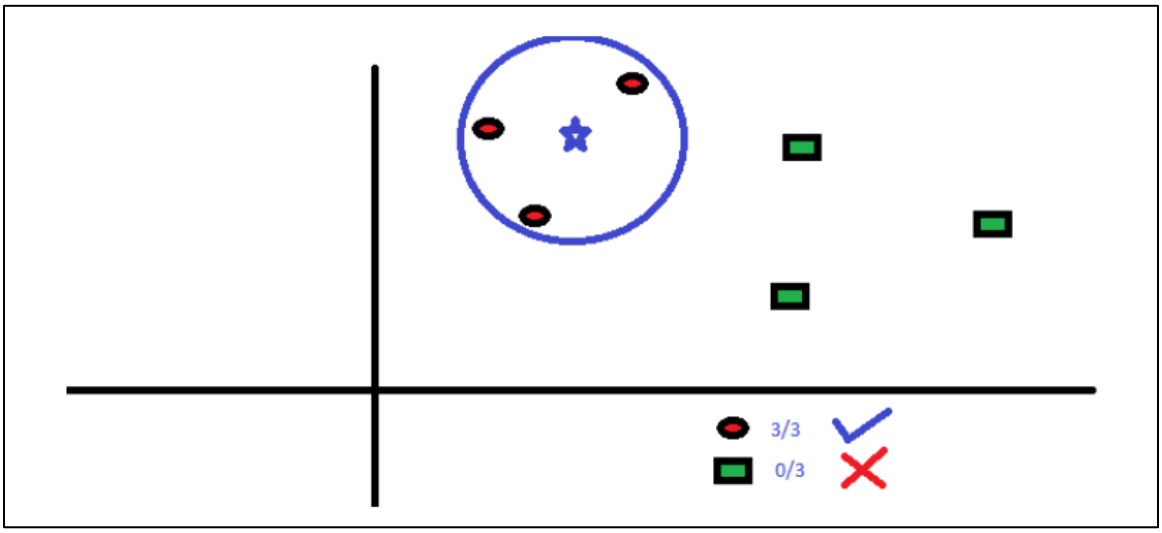


Figure 2-4 K-Nearest Neighbour example *(Harrison, 2019)*

In the figure above the K value is set to 3, which means 3 of the points that are nearest to the blue star will be taken as the voting class. In order to find the 3 nearest points, a Euclidean distance function formula is used to count the distance between the points. The class with the largest number of votes will be the output of which category does the input

belongs to. In this particular example, since all 3 of the points are red circles, the blue star will be classified as a red circle.

2.1.3 Support Vector Machine (SVM) Classification Algorithm

Support Vector Machine algorithm can be used to perform and solve classification problems as it is a typed of supervised machine learning method. This algorithm works by first plotting each of the training dataset onto a n-dimensional space, where the value of 'n' represents the number of features available. The plotting is done based on the values of each feature that represents a specific coordinate. After plotting the training dataset, a hyper-plane which will help to differentiate between the different types of output classes will be determined. A hyper-plane is essentially a line that will divide the different classes. Determining a good hyper-plane is a very important step, as the hyper-plane is what will be used to perform the classification, in other words it is the deciding boundary. A good hyper-plane is one that has the maximum amount of margin from its closest points. Take the figure below as an example:

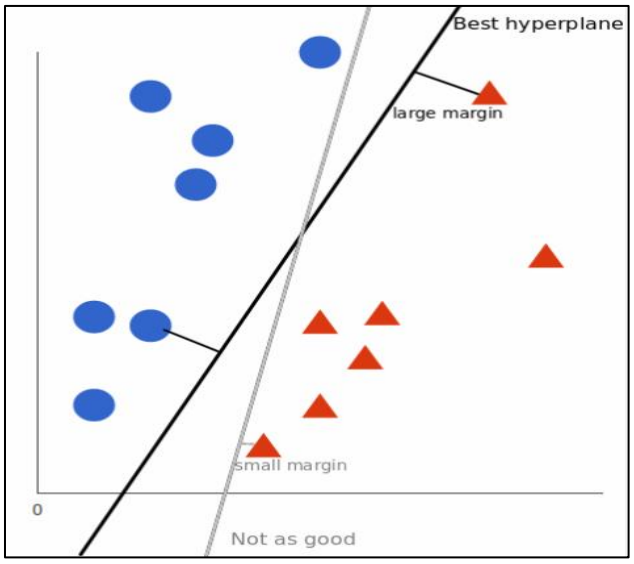


Figure 2-5 Support Vector Machine example *(Gandhi, 2018)*

The example above shows a hyper-plane being determined, where there are two different classes namely the blue circle and the red triangle. The solid line shown represents a good hyperplane, where it has a large margin between the two different classes. The slightly

faded line represents a poor hyper-plane which has a small margin towards the red triangles class. The margin is basically the distance of the points and the hyper-plane. The two points that are closest to the hyper-plane are known as the support vectors which are used to find the best possible margin. In a non-linear dataset cases, finding the hyper-plane is not as straightforward. The figure below shows an example of this:

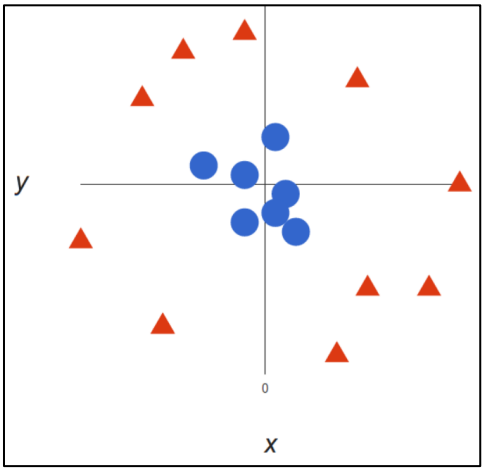


Figure 2-6 Non-Linear Dataset SVM

To solve this issue in the example above, the Kernel trick is introduced where an additional dimension, 'z' will be added to the original dataset. The formula used to find the z value is "$z = x^2 + y^2$". By adding in this new dimension, the figure below shows how the points will look like in respect to its x and z dimension on the plane. With this new perspective a hyper-plane can be deduced easily as shown in the figure below:

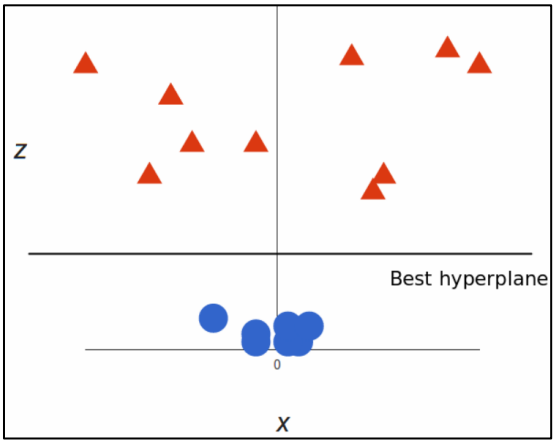


Figure 2-7 Kernelled Dataset SVM

2.1.4 Naïve Bayes Classification Algorithm

Naïve Bayes classification algorithm is an algorithm that uses Bayes Theorem and some probabilistic calculations in order to perform the classification. Naïve Bayes classification algorithm is known to work best for natural language processing (NPL) situations because it is a relatively simple but reliable and accurate solution in most cases. Bayes theorem's and probabilistic theory are the core concept for this algorithm which uses conditional probability and tells us the probability of something to happen, given that something else has already happened before (Gandhi, 2018). The formula derived to explain this is as shown in the figure below:

$$P(H \mid E) = \frac{P(E \mid H) * P(H)}{P(E)}$$

Figure 2-8 Bayes Theorem Formula

Representation	**Meaning**
P(H)	probability of hypothesis H to be true
P(E)	probability of evidence E
P(E|H)	probability of E given that the H is true.
P(E|H)	probability of H given that the E is true.

Table 2-1 Bayes Theorem formula representation

Before the formula above is applied, first feature engineering is needed to be done. This process simply means that all of the feature/class that is needed are identified first. A simple example would be, let's say if the classification modal is to be done on health-related terms, then the features would be gender, weight and height of a person. In terms of this project a feature here means the type of categories of expenses like medical, accommodation, transportation and etc. The features identified will be the output variables, where based on the Bayes Theorem formula it is known as the P(H). The input variables will the text extracted from the receipt file uploaded, which is represented as P(E). Let's use the

following example to better understand how it works. A set of training data is used which contains the following keywords respective to their expense type:

CATEGORIES	Medical	Transport
KEYWORDS	medicine	car
	ICU	drove
	dosage	taxi
	cough	petrol

Table 2-2 Training Data Set for Classification Modal Example

Given the available types of expenses are "medical" and "transport". The input variable text which is extracted from the document is "drove to ICU for medicine". Based on the Bayes Theorem's formula, the probability of the extracted text belongs to either the medical category or the accommodation category is to be found out. The equations that can be formed for each category will be as follow:

$$\mathrm{P}(\text{medical} \mid \text{drove to ICU for medicine}) = \frac{\mathrm{P}(\text{drove to ICU for medicine} \mid \text{medical}) * \mathrm{P}(\text{medical})}{\mathrm{P}(\text{drove to ICU for medicine})}$$

$$\mathrm{P}(\text{transport} \mid \text{drove to ICU for medicine}) = \frac{\mathrm{P}(\text{drove to ICU for medicine} \mid \text{transport}) * \mathrm{P}(\text{transport})}{\mathrm{P}(\text{drove to ICU for medicine})}$$

Since, it is only needed to find out whether the probability of medical category or accommodation category is higher, the divisor can be discarded from the equation since they are both the same and compare only the following:

$$P(\text{drove to ICU for medicine} \mid \text{transport}) * P(\text{transport})$$

Compare with

$$P(\text{drove to ICU for medicine} \mid \text{medical}) * P(\text{medical})$$

Now, in order to calculate the probability, the Naïve Bayes algorithm have to solve 2 issues beforehand. The first one is that, if the input sentence is directly compared to the training data set there won't be any matches available unfortunately. In order to solve this the sentence will first be broken down into individual words so that it can perform the comparison and calculation more accurately tally to the training data set. By doing so, the

input sentence probability calculation is broken down from P(drove to ICU for medicine) to become the following respective to the "transport" and "medical" category:

$$P(\text{drove}|\text{transport}) * P(\text{to}|\text{transport}) * P(\text{ICU}|\text{transport}) * P(\text{for}|\text{transport}) * P(\text{medicine}|\text{transport})$$
$$P(\text{drove}|\text{medical}) * P(\text{to}|\text{medical}) * P(\text{ICU}|\text{medical}) * P(\text{for}|\text{medical}) * P(\text{medicine}|\text{medical})$$

The second issue that is needed to be solve is that some of the words in the input sentence does not exist in the training data set at all, such as the word "to" and "for". This would mean if the probability of those words is counted, a probability of 0 will be obtained. This then causes the entire equation to become nullified because anything multiplied to 0 will equate to 0. So, in order to solve this issue, a technique called Laplace Smoothing is implemented which is used to smoothen categorical data. What Laplace smoothing basically does is that a value of 1 is added by default to every word count. Then the total number of possible words is also added to the divisor of counting the probability. With two of the solutions stated above applied, the probability can then be calculated as below:

Words	**P(word | transport)**	**P(word | medical)**
drove	$\frac{1+1}{4+8} = \frac{1}{6}$	$\frac{0+1}{4+8} = \frac{1}{12}$
to	$\frac{0+1}{4+8} = \frac{1}{12}$	$\frac{0+1}{4+8} = \frac{1}{12}$
ICU	$\frac{0+1}{4+8} = \frac{1}{12}$	$\frac{1+1}{4+8} = \frac{1}{6}$
for	$\frac{0+1}{4+8} = \frac{1}{12}$	$\frac{0+1}{4+8} = \frac{1}{12}$
medicine	$\frac{0+1}{4+8} = \frac{1}{12}$	$\frac{1+1}{4+8} = \frac{1}{6}$

Table 2-3 Probability of word frequencies for classification example

Now with the probability calculated above and with the probability of P(medical) being 4/8 and P(transport) being 4/8, the next step is to simply multiply them. The results obtained are as below:

$$P(\text{drove}|\text{transport}) * P(\text{to}|\text{transport}) * P(\text{ICU}|\text{transport}) * P(\text{for}|\text{transport}) * P(\text{medicine}|\text{transport}) * P(\text{transport})$$
$$= \frac{1}{6} * \frac{1}{12} * \frac{1}{12} * \frac{1}{12} * \frac{1}{12} * \frac{4}{8}$$

$= 4.0187757 * 10^{-6}$ **(Transport category probability)**

$P(drove|medical) * P(to|medical) * P(ICU|medical) * P(for|medical) * P(medicine|medical) * P(medical)$

$= \frac{1}{12} * \frac{1}{12} * \frac{1}{6} * \frac{1}{12} * \frac{1}{6} * \frac{4}{8}$

$= 8.0375514 * 10^{-6}$ **(Medical category probability)**

With the probability calculated above, when compared the probability of the medical expense type is higher than the transport expense type. Hence, the Naïve Bayes classification algorithm will conclude the document uploaded with input sentence "drove to ICU for medicine" is classified under the "medical" expense type category. In theory this is how the Naïve Bayes classification algorithm will work and in practical the scale of the calculation will be much larger as compared to the example given above.

2.1.5 Classification Algorithms Comparison

When comparing K-Nearest neighbour, Support Vector Machine and Naïve Bayes algorithm with each other there were some factors that will cause an effect to the final outcome. Although all 3 algorithms are able to perform their core task which is to classify an input item to its respective class, each algorithm will work best for specific reasons. For the case of this project where expense receipt documents are needed to be classified immediate as whenever the user uploads it, the Naïve Bayes works best.

Some of the reasons being, is such that for K-nearest neighbour algorithm has a very high computational cost because it needs to compute the distance of each plots that is added. This means that every time there is a new input that needs to be classified, the algorithm requires to compute the distance of the plot to the plots of the training samples, which can be very computationally heavy when the dataset is very large, or datasets that has the nature to grow over time. Besides that, although K-nearest neighbour classification is easy to be implemented, it still does not work well on datasets with high dimensions. Since, the nature of this project will grow overtime as more and more categories and keywords will be added,

using K-nearest neighbour will significantly affect the performance of the classification over time.

Support Vector machine algorithm is also not very suitable for this particular project, mainly because it requires a long training time for large data sets. As in the case of this project, the dataset will be growing over time with regular updates being done to the classification model. Besides that, Support Vector Machine algorithm also does not directly provide probabilistic estimations, which in the case of this project is desirable. This is because with some probabilistic values, the user of the classification model can better understand the model and make adjustments to the model easier whenever needed.

Along with that, Support Vector Machine is also not very suitable for non-linear datasets. In the case of this project, some of the categorical classes will have overlapping datasets. An example of this would be like both the medical and accommodation class will have keywords such as "room" and "beds". Having these keywords that overlap between classes, an additional kernelling is needed to be done for Support Vector Machine algorithm in order to find the hyper-plane to perform the classification accurately. Naïve Bayes algorithm however, does not require this additional step, as Naïve Bayes treats each keyword as an individual where their probability is calculated using word frequency. Theoretically, Naïve Bayes would work best for this project as Naïve Bayes is suitable for a growing dataset that might be updated regularly, without causing performance to suffer.

2.2 Existing Systems review

2.2.1 ZOHO Expense

ZOHO Expense is a platform which automates a variety of expenditure management related procedures that assists to record down transactions very quickly. This system can convert receipts into expenses automatically and also group them together where it would be easier for generating reports whenever needed. This system helps to eliminate confusions related to allowed expenditures and spending limits while still complying with the company's expense policies and are consequently enforced. This system provides a hassle-free and functional graphical user interface which is interactive and offers several

streamlines ways to monitor or enter information. The presence of flexibility to be able to use the system in various types of devices is a bonus to most users where they can submit expenses or reports on their smartphones directly. This system allows users to add every detail that seems relevant to the expenses reports at any point of time. Furthermore, this system provides separation in terms of user roles such as administrators, approvers, and submitters where each role is given specific authorities.

Strengths

This system has a function where receipts and credit card statements are scanned automatically, so users don't have to re-key in receipts. This creates a reduction in potential costs from errors caused by manually keying in the data and decreases time wastage during the manual process. Besides that, this system also provides a functionality whereby its approval reminders are automated for managers and one-click approvals. Having an automated reminder is very useful for making sure submitted expenses are reviewed based on a fixed schedule and not delayed which ultimate makes the rejecting, forwarding and approving process much more efficient and quicker. Furthermore, this system is available for a free trial, a basic free plan with limited benefits, and a standard plan which is relatively cheap for only $15 monthly.

Weakness

This system does not have a method of automatically sorting the receipts uploaded in the system. Hence, employees are required to manually sort the receipts and upload them according to categories themselves.

Recommendation

The system should improve or modify the method that is used for their receipt scanning feature. One way to solve this is by using a better "Optical Character Recognition" software and implement a function that can help to automatically sort the receipts according to their respective categories. This helps to produce a more accurate and efficient result when receipts are uploaded.

2.2.2 BreatheHR

Strengths

This system provides a functionality that can allow users to monitor expenses against specific projects or clients, monitor budgets and project expenditures in an efficient manner. Several different types of dashboards are provided such as the HR dashboard which shows the user a summary of expenses report that needs to be reviewed. This gives greater visibility and control of business to users. The pricing scheme for this system varies according to the number of users which is charged on a monthly basis. Although the pricing scheme is averaging for £10 for every 10 users, which is a little pricey, it is still relatively cheap for the number of functionalities that comes with the software.

Weakness

This system does not include a function where uploaded receipts are automatically scanned, and relevant fields are populated into the system.

Recommendation

The system should include a feature where uploaded receipts are automatically scanned, and relevant fields will be populated into the system. By having this feature, the need for manual labour to check the receipts one by one can be cut down where users only need to just review the important values instead of the entire receipt itself.

2.2.3 REPLICON Time & Gross Pay

Brief

REPLICON provides a simplified expense management system that provides an easy-to-use expense tracking whereby reimbursement of employees can be easily incurred and get control over business costs. This system provides the flexibility to integrate your own expense policies instead of a fixed policy provided by the system itself. Users can use this to set up expenses to be rate-based or flat amounts, define tax formulas for tax calculations to be done automatically and even manage multiple currencies and exchange rate for accurate tracking. Besides that, this system also provides a functionality to track expenses,

currencies, tax codes and others. Users are also able to create approval workflows that match the business requirements, which helps to ensure timely approvals and submission with the aid of notifications and alerts. A reporting functionality is also available for this system whereby users can get a good insight of their expenses by viewing the dynamic dashboards which are updated in real-time.

Strengths

This system provides flexibility in terms of platform where the system can be run on. The system is available on both desktop and mobile platforms. By having the system to be cross-platform compatible, users are given more choices in terms of how they can interact with the system. The mobile platform version of the system also allows its users to be able to update their expenses on the go, with ease and minimal amount of hassle.

Weakness

This system's reporting function is lacking in terms of flexibility and functionalities. Some reporting type does not allow its users to be able to make changes to the parameters that they wish to view.

Recommendation

This system should provide a reporting function that can be manipulated based on certain parameters which can give its users a better flexibility in how they want to view their reports. By providing such flexibility, a better insight can be acquired regarding a company's expenses. This helps the users to be more efficient in terms of organizing their expense records and also be able to monitor all the expenses with ease while reducing time consumption for manual labour to perform analysis.

2.2.4 SAP Concur

Brief

SAP Concur is an integrated expense management solution that is mainly focused for managing a company's travel expenses, business expenses and invoices. This system is available on both a website and mobile application for mobile devices. By being able to use the system in a mobile device this helps user to manage the entire expense reporting process with easy and convenience. The use of an Optical recognition technology helps to simplify the expense reporting process by automating most of the intermediate tasks. Users that are responsible to approve or reject expense reports can do so within the mobile application itself with minimum hassle and time needed to review the reports. Besides that, this system also provides a functionality called "Card Integration" where it automates the corporate card transactions from processing, account posting to payment. It also helps to match pre-approved expenses to invoices for accurate and fast settlement. This feature will automatically categorize and capture corporate card transactions for employees while providing great visibility into all expenses.

Strengths

This system provides a good expense analytics and reporting functionality where users can view all their expenses in a clear manner. A graphical representation of the expense analytics is displayed for users to be able to view. Besides that, this system is also able to automatically populate expense claims for electronic receipts from hotels, airlines, ground transportation, restaurants and many more categories. This feature is able to automatically sort the expenses uploaded accordingly to its specific categories without the need for an additional physical labour to manually sort them.

2.3 Table of System Features Comparisons

FEATURES	SYSTEM NAME			
	ZOHO Expense	Replicon	breatheHR	SAP Concur Expense
Cross-Platform Application	☑	☑	☐	☑
Mobile Receipt Upload	☑	☐	☑	☑
Auto Scan receipts	☑	☐	☐	☐
Automate expense recording	☑	☐	☐	☐
E-receipt scanning	☐	☐	☐	☑
Data Visibility	☑	☑	☑	☑
Expense Reporting	☐	☑	☑	☑
Expense Analytics	☑	☐	☐	☐
Budget Monitoring	☐	☐	☑	☐
Stremline Approvals	☐	☑	☐	☐
Multi stage workflow	☑	☐	☐	☐
Mileage tracking	☑	☐	☑	☐
Multi currency expensing	☑	☐	☐	☐
Business Expense Tracking	☑	☐	☐	☐
Global Administration	☐	☑	☐	☐
Real Time Notifications	☐	☑	☑	☐
Card Integration	☑	☐	☐	☑
Data Security	☐	☐	☐	☑

Table 2-4 System features comparison

CHAPTER 3 SYSTEM DESIGN

3.1 System Functionality Diagram

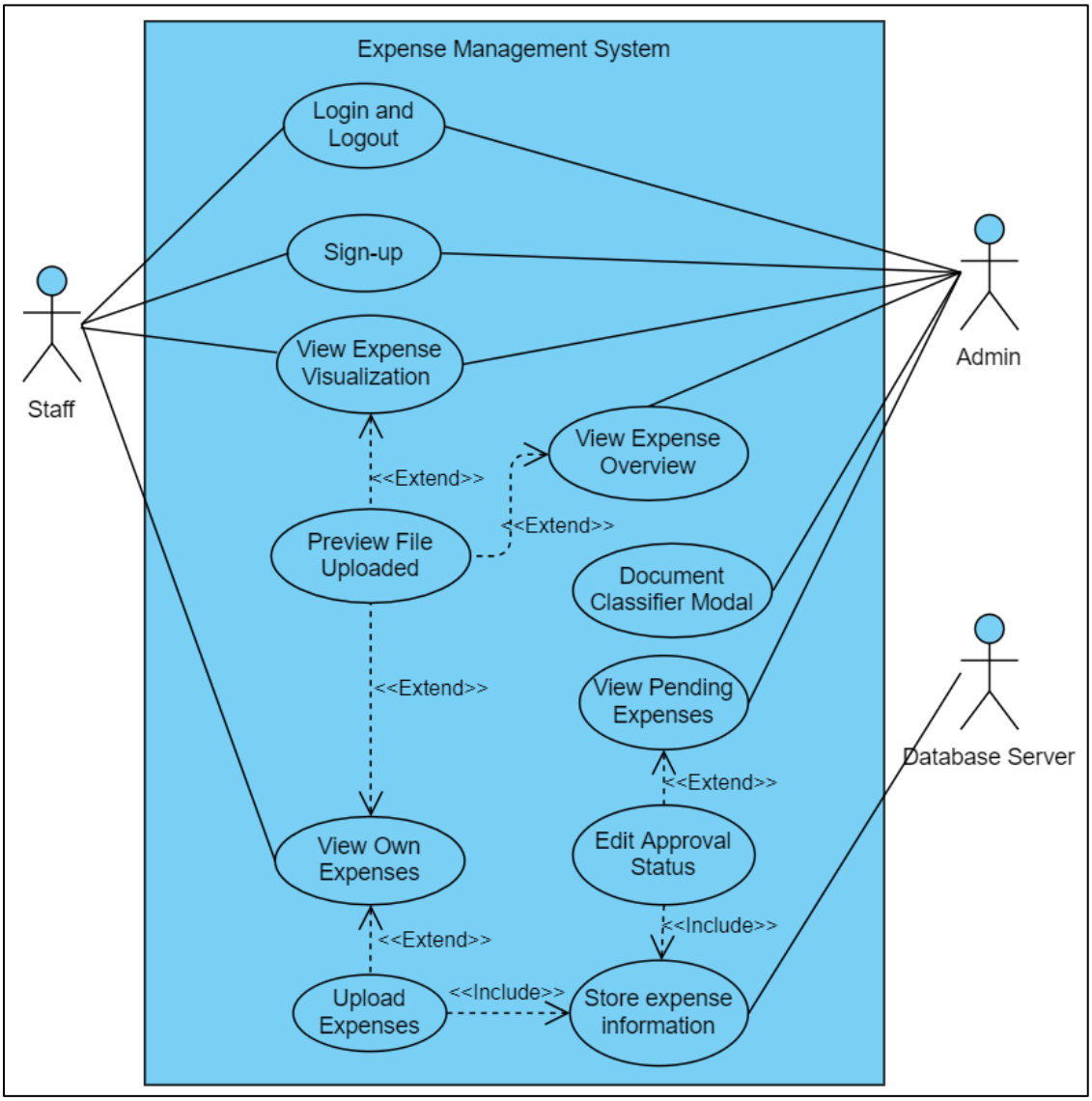


Figure 3-1 System Functionality Diagram

The figure above illustrates the Use Case diagram for this system. In the use case diagram above, it can be seen what a user of the system can perform. A normal staff user is allowed to perform login, sign-up, view their own expense visualisation and view own expenses with the option of uploading a new expense into the system. The admin user is allowed to login, sign-up, view the expense visualisation, make changes to the classifier model and view all staff's expenses with the added privilege of approving and rejecting a user's expense claims.

3.2 Activity Diagrams

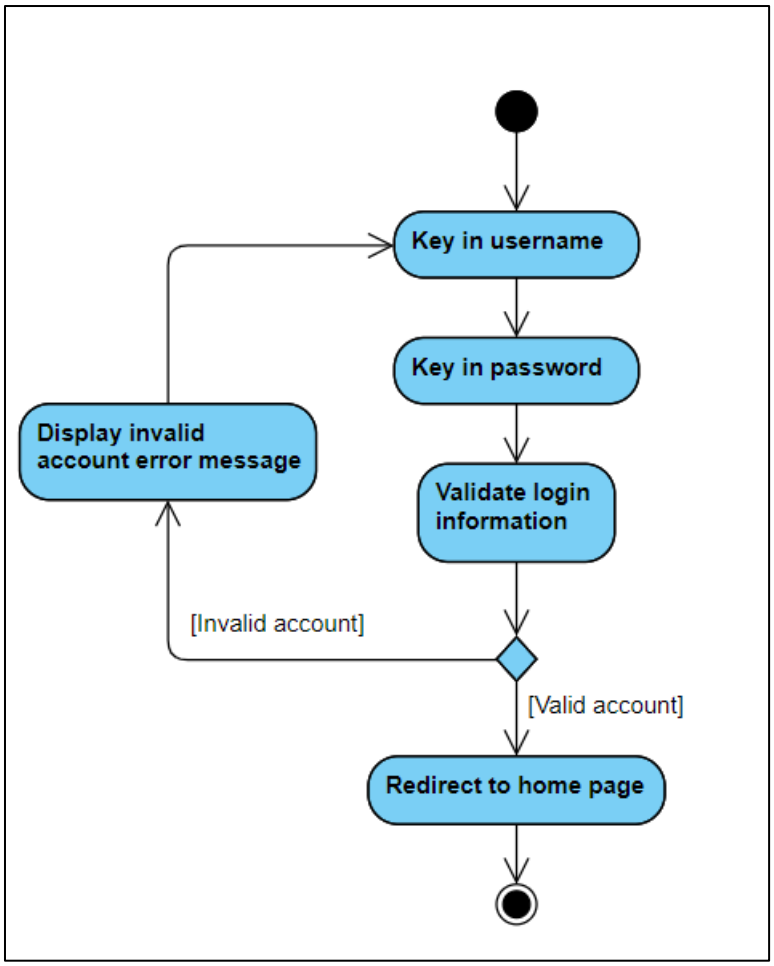


Figure 3-2 Login Page Activity Diagram

The figure above illustrates the activity diagram for the login page. The login module works by a user is required to key in their valid and registered username and password into the system. The system will then validate the information inputted according to the database. If the username or password does not match with existing records in the database, the system will show an error message and also prompt the user to try again.

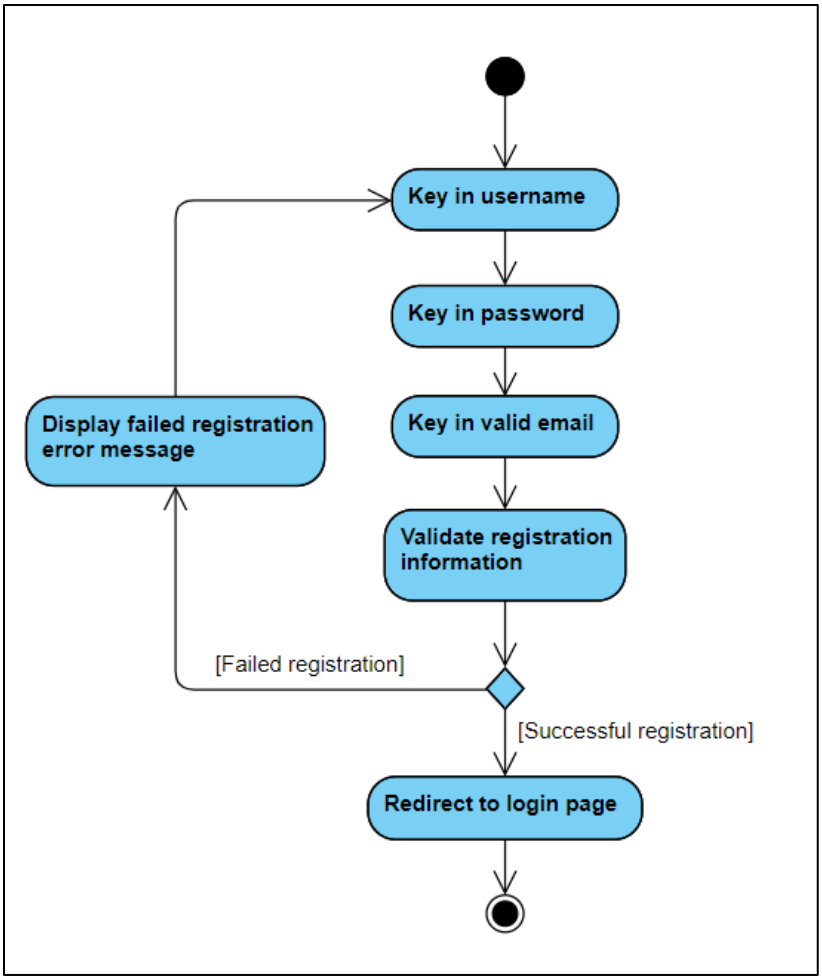


Figure 3-3 Sign-Up Page Activity Diagram

The figure above illustrates the activity diagram for the sign-up page. The sign-up module works by a user is required to key in a valid username, password and email into the system. The system will then check the database to see whether the input information already exist in the database. If the account information already exists or the input information does not meet the requirement, then the system displays an error message and request the user to try again.

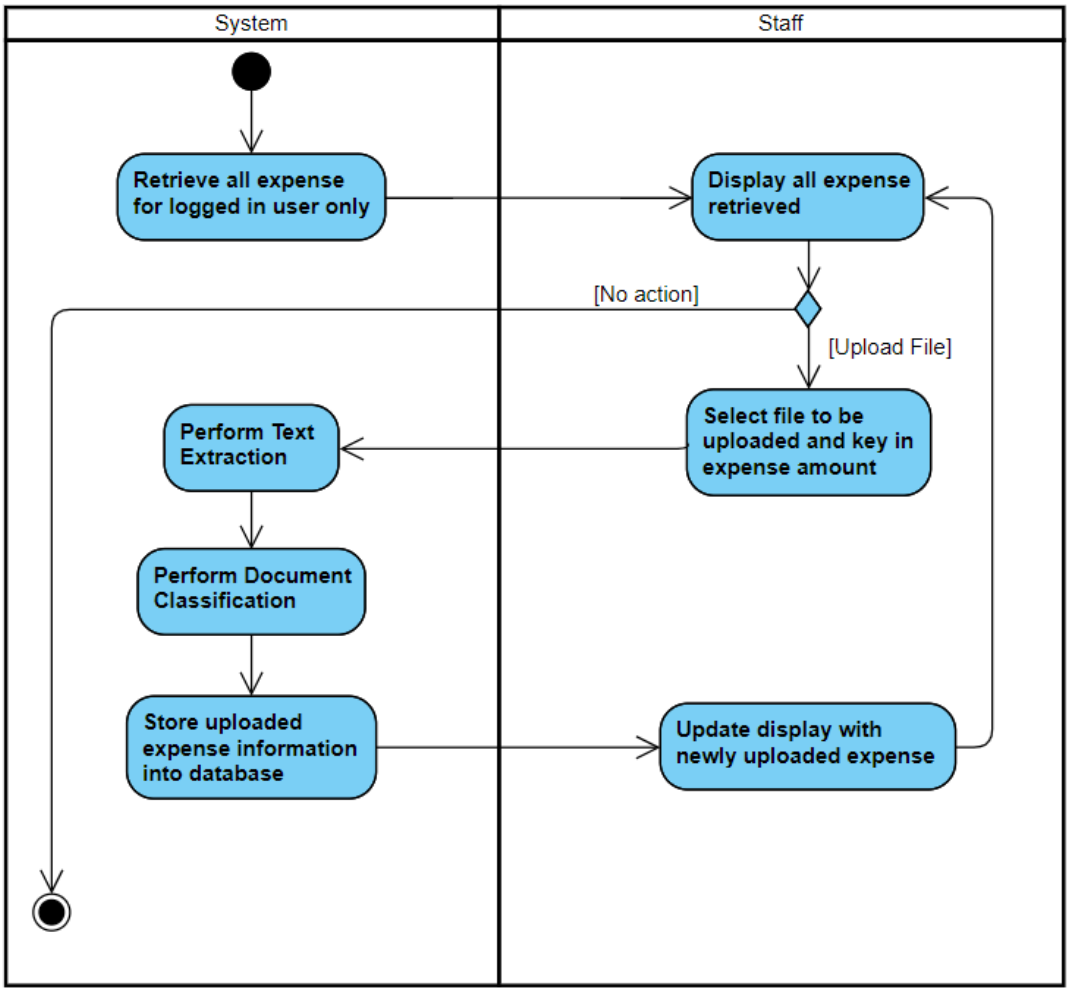


Figure 3-4 Upload Expenses Activity Diagram

The figure above illustrates the upload expenses activity diagram. The upload file works when the user selects the “Overall Expenses” page, the system will first retrieve all the expenses for the logged in user only. The system will then display them to the user along with the option to upload a new expense. If the user selects the upload new expense button, then the system will prompt the user to select a file to be uploaded and also the expense amount. After the user has selected the file, the system will first extract all the text from the file, which is then user to be feed into the classification modal to perform a classification in order to identify whether the expense uploaded belongs to which type of expenses. Upon identifying the type of expenses, the output label (type of expense) is then store into the database along with the file uploaded and all other necessary information. The system then updates the display to include the newly added receipt.

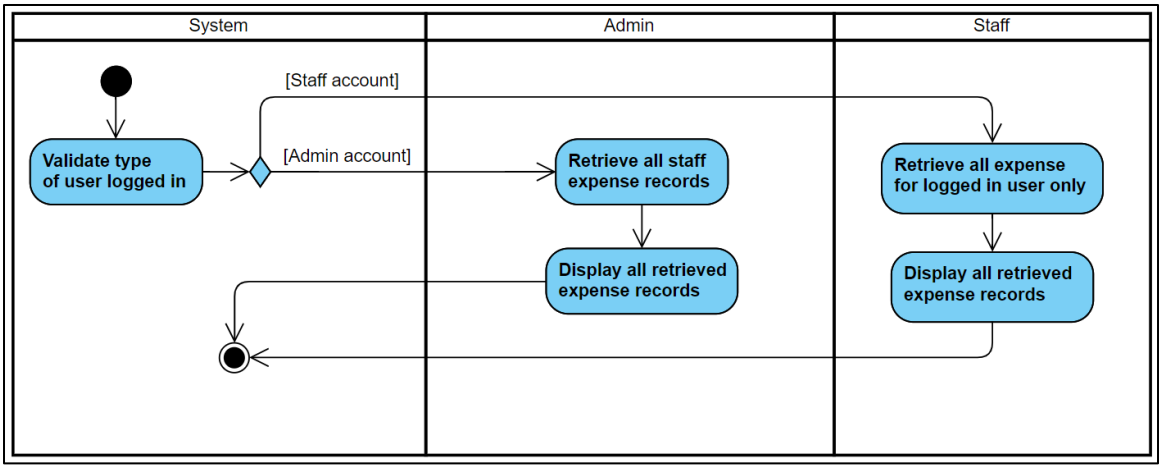


Figure 3-5 View Overall Expenses Activity Diagram

The figure above illustrates the view overall expenses activity diagram. The view overall expense function works by when the user selects the “Overall Expenses” page, the system will first validate the currently logged in user to check the type of user. If the logged in user is an admin, then the privileges of this account differs from a normal staff account. An admin gets privileges to be able to view all of the staff’s expenses. Whereas, a normal staff account is only allowed to view their own expenses and given privilege to upload a new expense.

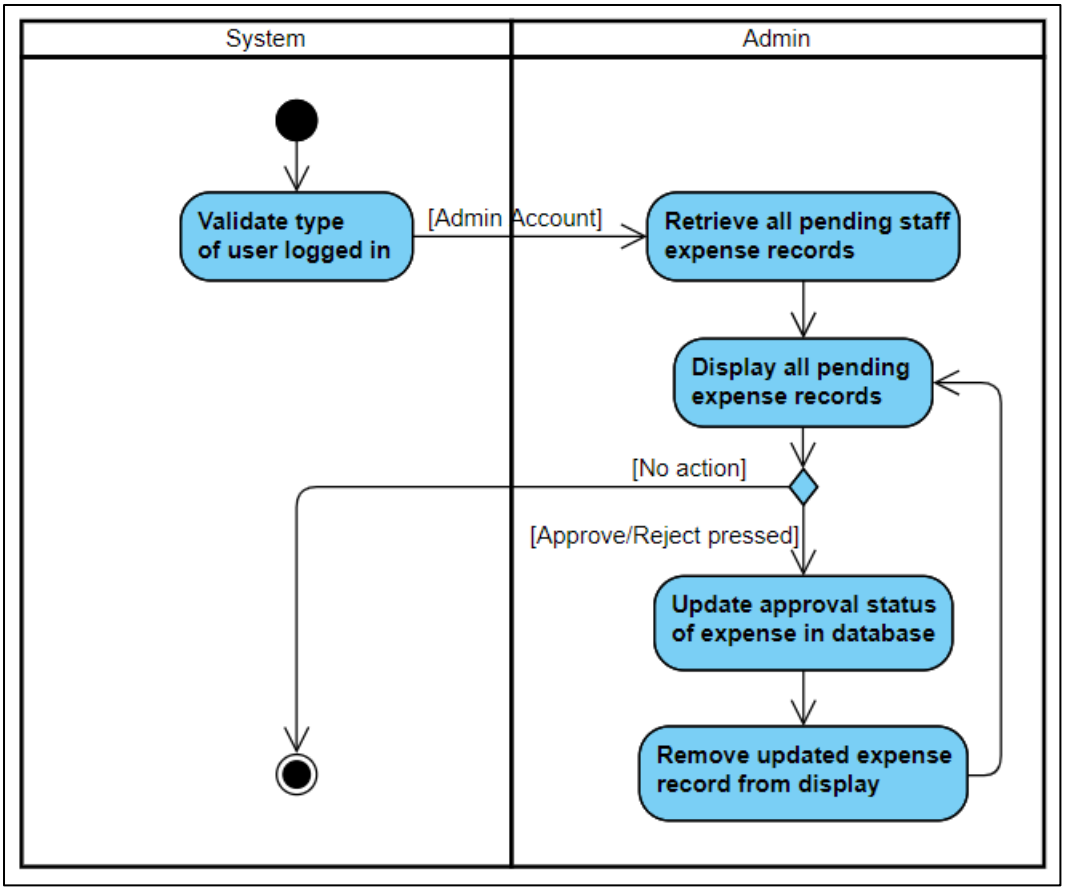


Figure 3-6 Admin View Pending Expenses Activity Diagram

The figure above illustrates the admin view pending expenses activity diagram. The view pending expenses function is only allowed for admins to use. An admin that wants to approve and reject a pending expense can do so by clicking the accept of reject button available on the list of pending expenses. Once the admin performs an action on the pending expense, the record will be removed from the displayed table and the status is updated to no longer being pending.

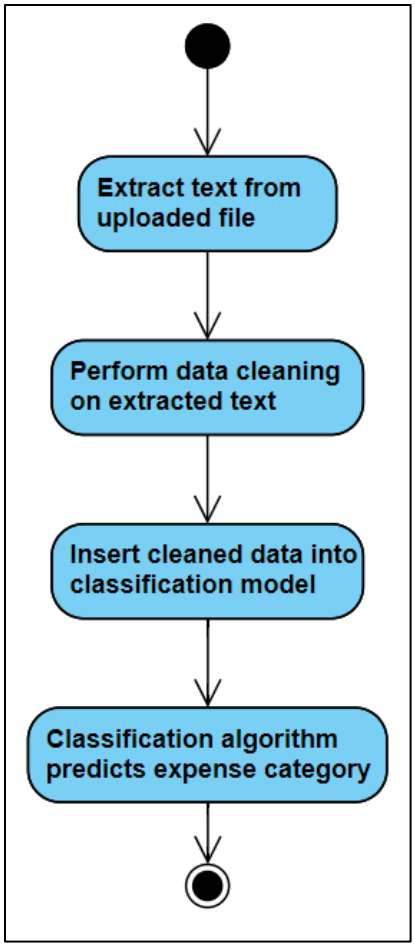


Figure 3-7 Classify Uploaded Expenses Activity Diagram

The figure above shows the pipeline of activities that occurs when a new expense file is uploaded into the system by a staff. The entire text available on the uploaded expense file is first extracted. The extracted text is then passed into several data cleaning steps such as removing stop words, special symbols, irrelevant words and numbers. The cleaned data is then pass into the classification model that was created in order for the classification model to perform prediction of which expense category does the uploaded expense belongs to. The predicted label output is then stored into the system along with all of the other necessary information needed.

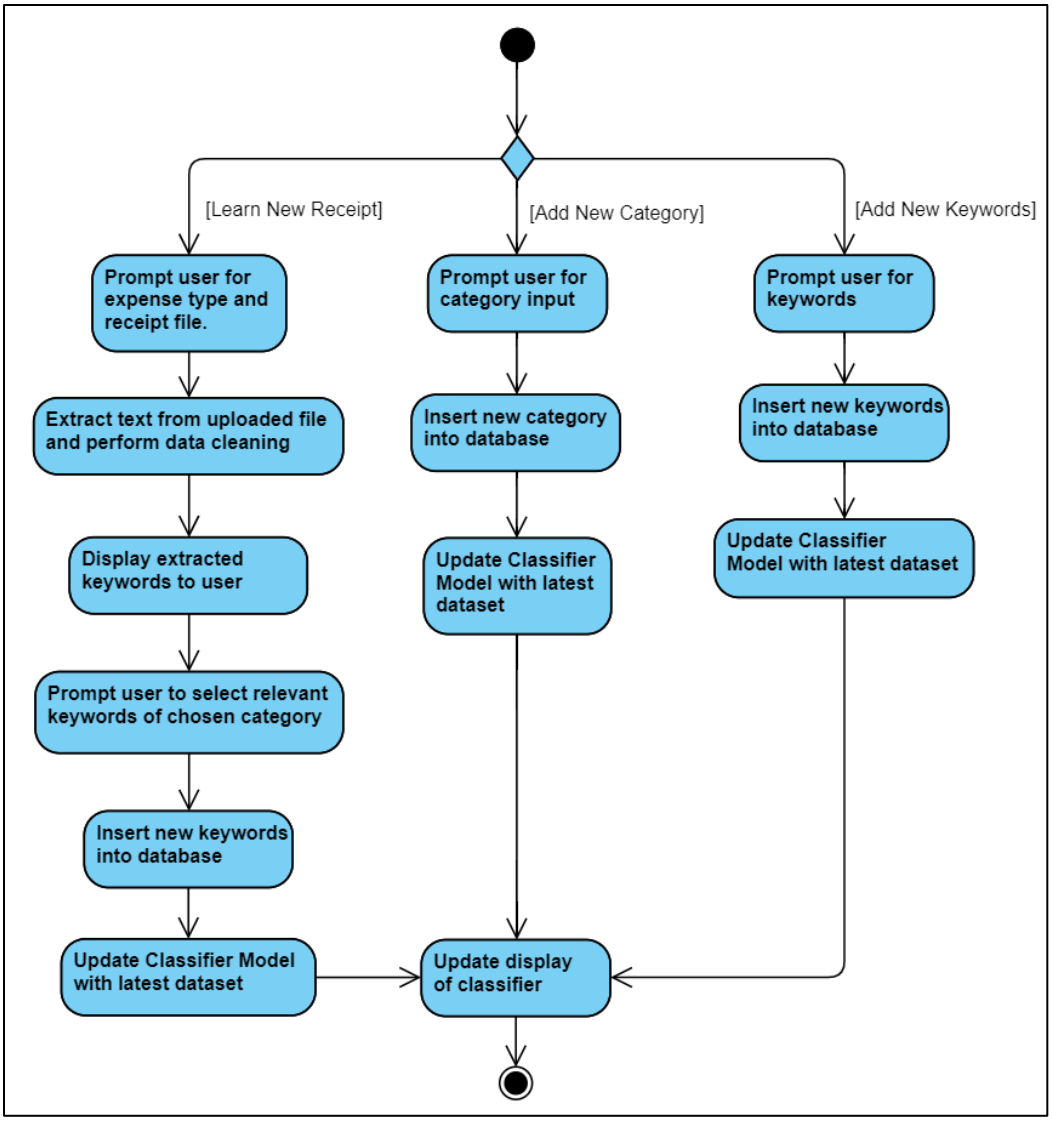


Figure 3-8 Update Classifier Model Activity Diagram

The figure above shows the update classifier model activity diagram. The first flow is to add a new expense category into the database, which the classification algorithm uses to update the model using the updated dataset. The next is to provide a new receipt template that the user would like the algorithm learn. The user is needed to provide the category type and the expense template, which the system then performs text extraction and data cleaning. The system will then display and prompt the user to select the list of words that are related to the expense category. The system will then update the database which is then used to update the classifier model. The third way is to manually provide the keywords and the category type, which is then saved and used to update the classification model.

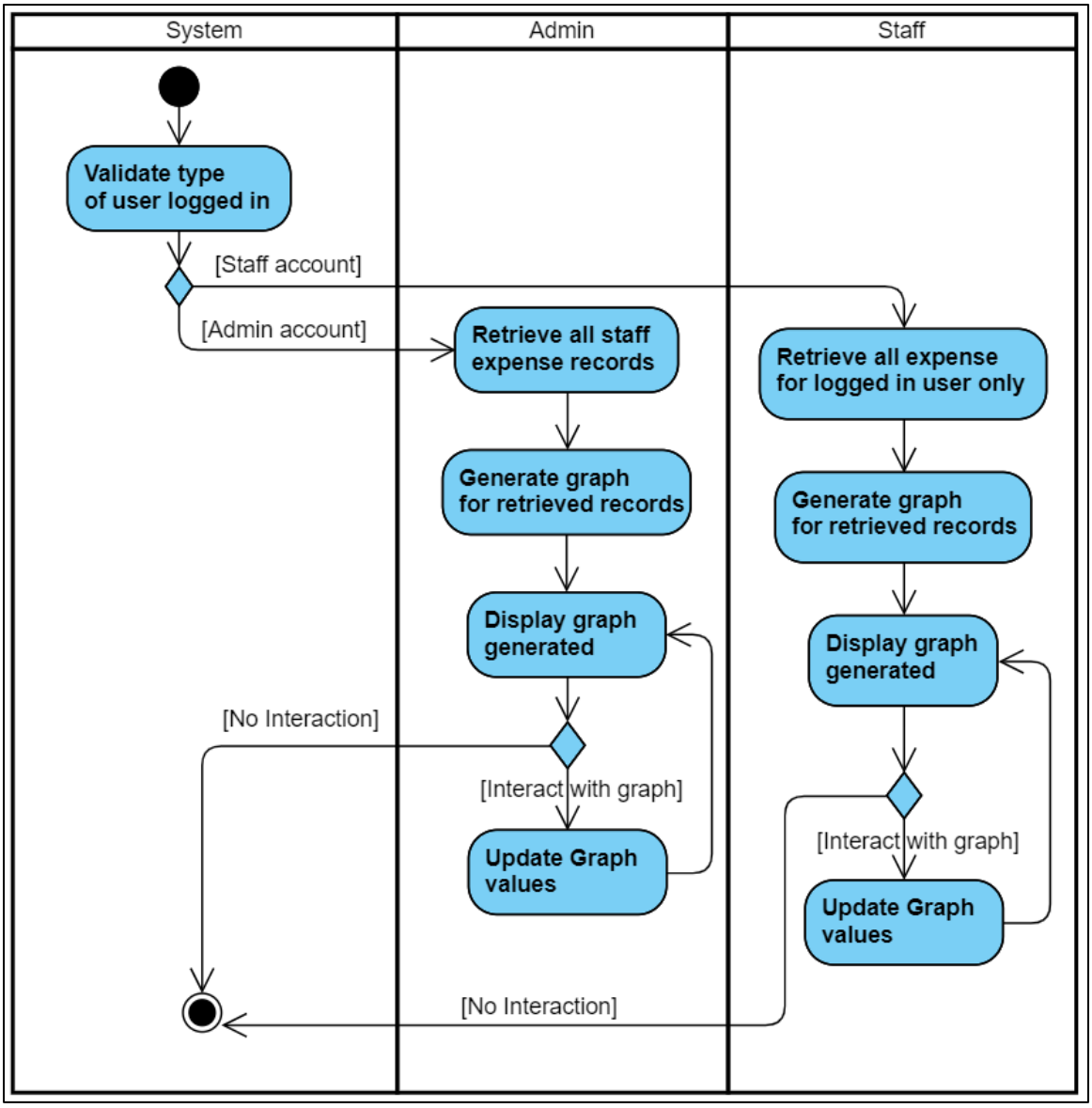


Figure 3-9 Expense Visualisation Activity Diagram

The figure above illustrates the expense visualisation activity diagram. This works by the system first validating the type of user logged in. If the logged in user is an admin type, the system will first retrieve all the staff's expenses and then populate them into a graphical representation. Admin user type are provided with several types of visualization. On the other hand, if the logged in user is a normal staff type, then the system will only provide the user with one type of graphical representation based on their own expenses only. If there is any interaction on the graphs, the respective values on the graph will be updated automatically to provide user to view in details.

3.3 Entity-Relationship (ER) Diagram

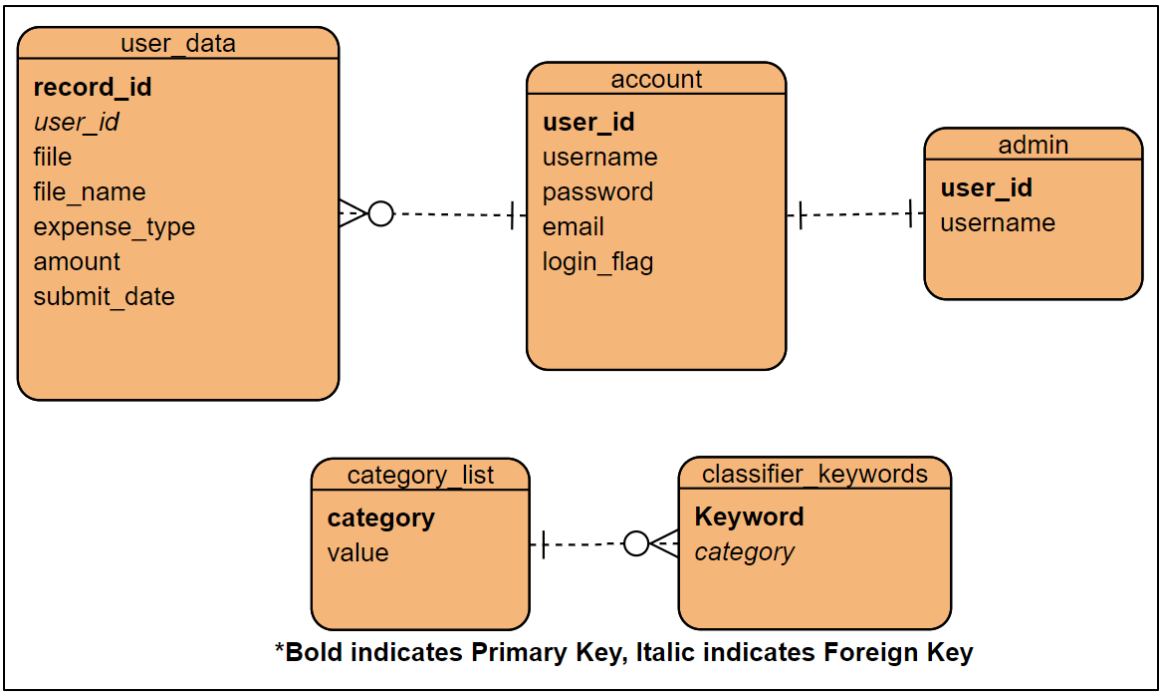


Figure 3-10 Entity-Relationship Diagram

The figure above illustrates the Entity-Relationship Diagram for this system. In this system there are 5 different tables involved, which are the “user_data”, “account”, “admin”, category_list and classifier key_words. The “user_data” table is used for storing all of the data inserted by the user, which in this case is the information regarding the uploaded receipts for expenses. The “account” table is used to store all the accounts information of registered accounts. The “admin” table is used for storing account information of admin users only, which is used to check for privileges. The “category_list” table is used to store all the different types of expense category available, which is used for building the classification model. The “classifier_keywords” table is used to store the dataset of the classifier keywords, which is used for building the classification model to perform the document classification.

3.4 System Framework Diagram

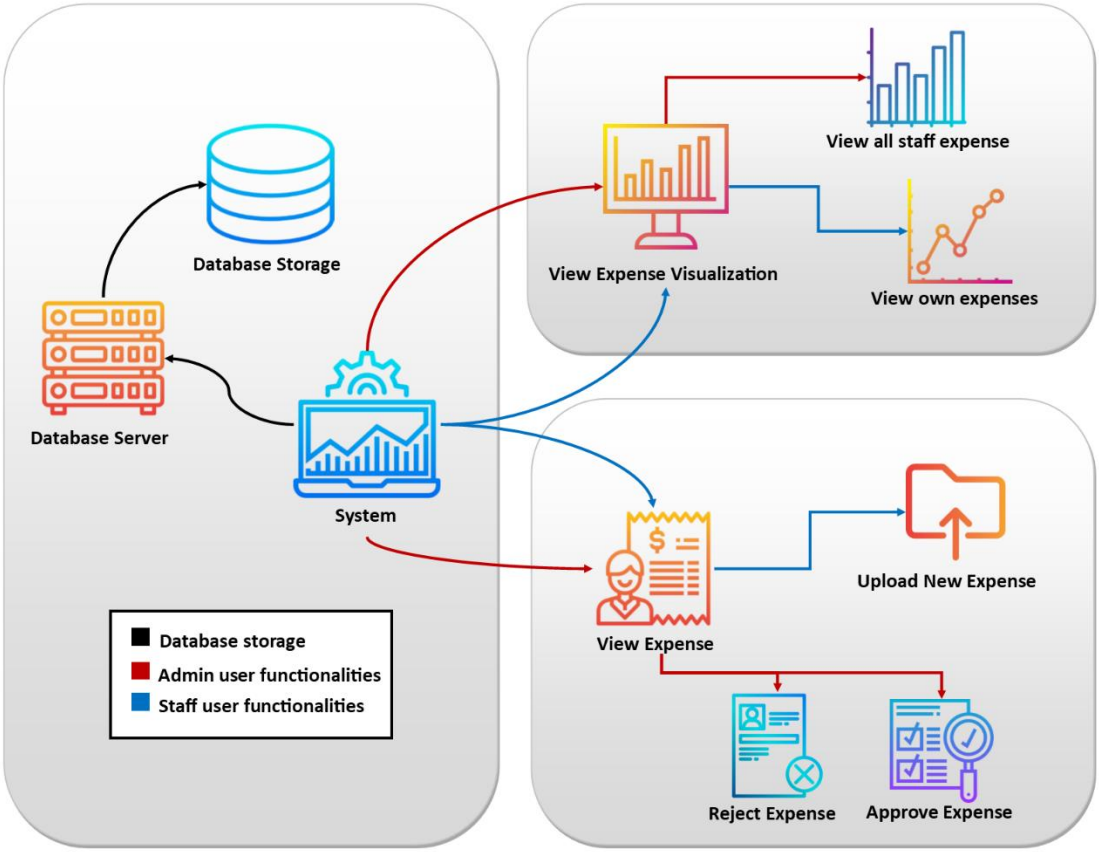
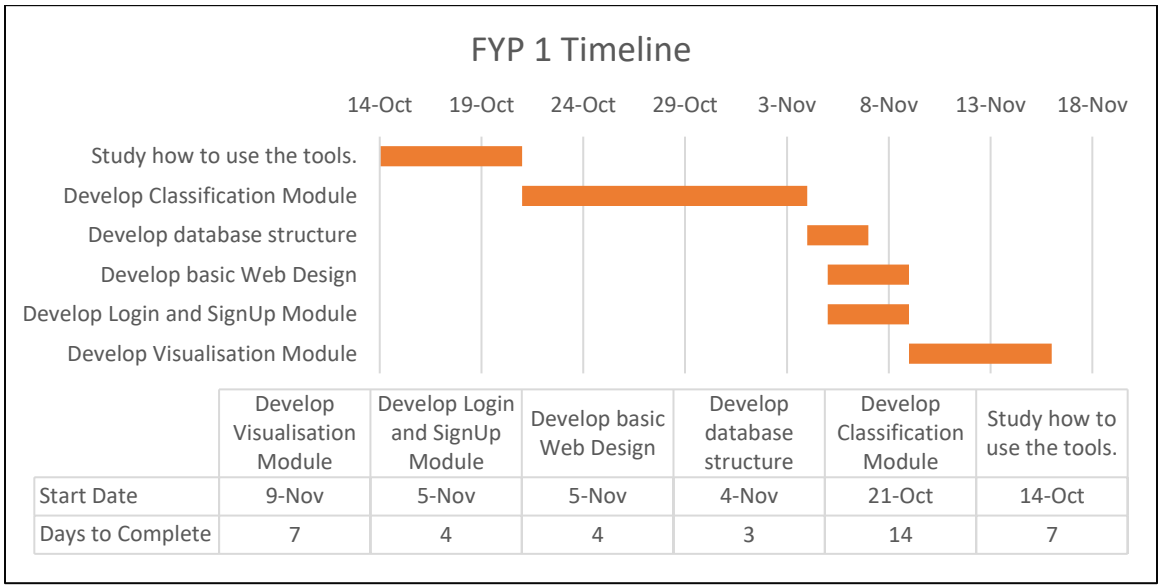


Figure 3-11 System Framework Diagram

The figure above illustrates the system framework of the developed system. In the system framework, there are mainly 3 different types of flow, which are differentiated by the colours of the flow arrows. The black arrow indicates the flow of how the system captures or updates information into the database. The red arrow indicates, the flow and functionalities allowed for an admin user, where the admin is allowed to view all of the staff's expenses in graphical form, view staff's expenses in table form and also have the privilege to approve or reject an expense submitted. Finally, the blue arrow indicates the flow and functionalities allowed for a staff user. The staff users are allowed to view only their own total expenses in a graphical form, view their expenses uploaded in a table form and also allowed to upload new expenses.

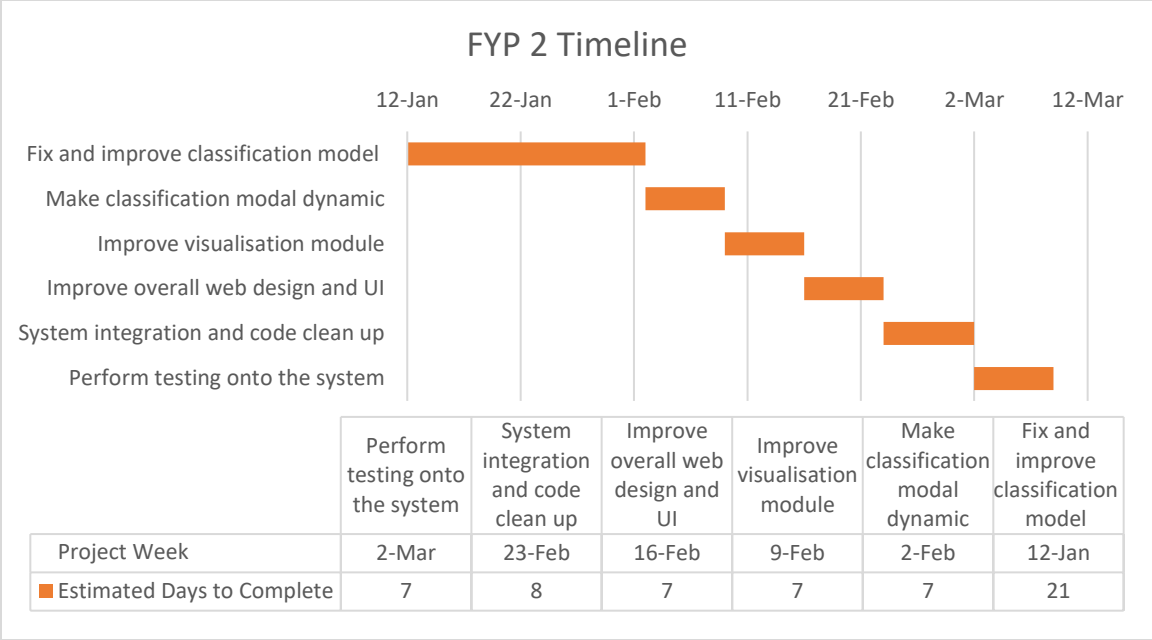
3.5 Project Timeline



	Develop Visualisation Module	Develop Login and SignUp Module	Develop basic Web Design	Develop database structure	Develop Classification Module	Study how to use the tools.
Start Date	9-Nov	5-Nov	5-Nov	4-Nov	21-Oct	14-Oct
Days to Complete	7	4	4	3	14	7

Figure 3-12 FYP 1 Timeline

The above shows the tasks completed and the duration it required to complete the given tasks. The entire workflow took about 6 to 7 weeks of development.



	Perform testing onto the system	System integration and code clean up	Improve overall web design and UI	Improve visualisation module	Make classification modal dynamic	Fix and improve classification model
Project Week	2-Mar	23-Feb	16-Feb	9-Feb	2-Feb	12-Jan
Estimated Days to Complete	7	8	7	7	7	21

Figure 3-13 FYP 2 Timeline

The figure above shows the tasks completed and the rough duration it required to complete the given tasks for FYP 2. The entire workflow took about 8-9 weeks of development, which is followed by another 2 weeks for writing the report.

CHAPTER 4: PROPOSED METHOD / APPROACH

4.1 Design Specifications

4.1.1 Methodologies and General Work Procedures

Agile Development approach

The reason for using an agile development approach is because agile development practices incremental design. This method is suitable for this project because by developing the system incrementally, the features to be built can be done in an efficient and simple but working manner. The features developed can then be slowly improved along the way by further getting a clearer picture and requirements that are to be incorporated into the system. Production cost in terms of time and effort can be reduced significantly, as with a clearer system requirement used as a guide the need for changes during and after development can be kept at a minimum. Agile development also requires breaking down the project into manageable units, where development, and testing can be fully focused on, which produces a higher-quality system. By producing regular builds and version, the system can be reviewed and tested during each iteration, which also aids in detecting bugs or issues that are in the system early on during development. This approach also embraces change in anytime during the project.

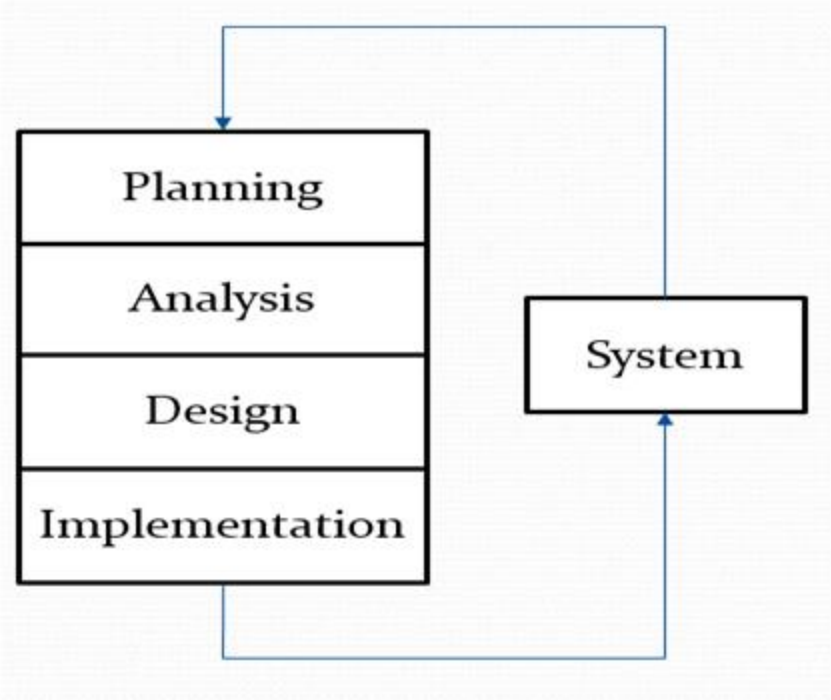


Figure 4-1 Agile Methodology

Planning Phase

In the planning phase, the title of the project was chosen and decided based on some research conducted online. Based on the title chosen, it was then proposed to the supervisor for consideration to identify whether the supervisor is willing to accept the topic. Once accepted, the chosen title was then further refined by the project supervisor, to make the title more specified and make the direction of the project clearer. The total duration of this project is set to be carried out within three trimesters. During this phase, the user requirements are also determined by surveying existing systems.

Most of the basic functionalities that an expense management system must have was gathered by comparing to several existing systems. The user requirements were also gathered by reading some articles and journals online in order to get a more accurate user requirements that will better fit to the real-life system. The user requirements will be used as a functional requirement that system should include in the final product. Using the requirements gathered, questions like in what manner will they utilize the system, who is

going to utilize the system, what should be outputted by the system can be answered and what type of data should be entered into the system.

Analysis Phase

During the analysis phase, several meet ups and discussion sessions were held with the supervisor throughout several weeks, to be able to identify the problems and challenges faced by existing systems that might be faced in the future during this project. Going through some existing systems available and some research papers also helped to provide a better explanation and understanding regarding the project. Several methods to solve the problems identified was then proposed to the supervisor which he reviewed and approved. Features, strengths and weaknesses of the existing systems researched were also compared to give a better understanding of the basic requirements needed for the expense management system.

Besides that, a table of system features comparison was created for the purpose of providing a clearer illustration. The project scopes, and objectives are also identified, which will be carried throughout this project lifecycle. Identifying them helped to provide a more specified and help to further narrow down the project's scope. This helps to avoid unnecessary changes to be made during the next two phases of this project, which indirectly saves time and avoid a waste of effort being made.

Along with that, classification algorithms were also studied, in order to better understand how does the classification algorithms work, and which one them will work best for this particular project. Three different algorithms were compared and contrasted to see which provided the best output in terms of accuracy and processing speed of the algorithm.

Design Phase

During this phase, all the necessary unified modelling language (UML) figures like an activity diagrams, ERD diagram, and use case diagrams is drawn. By drawing these diagrams, it helps to further clarify the system requirements, functionality and operations

of the planned system, while also creating a high-level view of the entire project. The diagrams also serve as a guide for reviewing, documentation and design of the application's function development, which helps to show the relationship among modules of the system and present a convenient picture of the solution architecture.

The diagrams is used during the next phase of the system where it acts as a guide that can be mapped to the code development. Indirectly, this helps to reduce or even avoid confusion and scope creep to occur anytime during this project. The diagrams will be created with the aid of a software tool called Visual Paradigm which can help to ease the creation effort and time needed.

Implementation Phase

In this phase, the coding for the system was started, according to all the requirements gathered during the previous phases. The tasks were divided in several sprints where the modules of the system were broken down to be developed and reviewed on a weekly or fortnightly basis by the supervisor for monitoring and compliance purposes. All developments were done based heavily on the UML diagrams created so that the project's direction is kept constant and avoid scope creeps to occur. After all the modules of the system is developed, it will then be integrated into one working system. While integrating the modules together, any issues that arises will be attempted to be solve immediately.

During the first 1 week of development, most time was spent into learning how to use the tools such as Flask, MySQL, Anaconda and Spyder. On the 2nd and 3rd week, focus was shifted into developing the receipt classification module first. A classification modal was created based on Multinomial Naïve Bayes classification algorithm, and the data extracted from the receipts uploaded was feed into the classification modal to perform the classification. The modal was built on a data set of keywords that has a corresponding label of expense category such as "medical", "accommodation" and etc.

The initial data set of keywords was created in two ways, one of which was to manually create them and the other was by searching them from online sources. The data set was first, pre-processed to be cleaned to remove out noise data such as stop words, special

symbols, numbers and also by using an encoder library and the TfidVectorizer library before being used to create the actual classification modal. The TfidVectoriser function performed a data cleaning process where it removes commonly used English words such as “are”, “a”, “and”, “but” and etc. Along with that, a database and table structures were also created to store all of the necessary data.

After the data cleaning process, the modal was then created and exported to a file using existing library functions calls available in python. The classification modal created was then imported and called into the upload files method where it was used to perform the predictions on the expenses uploaded by the user. Subsequently, when the classification function was working, the development of other modules was started such as the login & registration, visualisation module, other important necessary functionalities needed for an expense management system and finally the overall website design. A classification module was also then created in order to allow the admin user of the system to be able to make updates to the classification model. The admin was allowed with 3 different options which are, to add a new expense category, add a new receipt template for the classification algorithm to learn from and also allow the admin to manually add in new keywords so that the model can be improved in terms of its accuracy.

Upon completion of all the modules, it was then integrated into one working system in small portions. When the entire system integration has been done, several different types of testing was performed on the system to assure the correctness of output. A testing strategy and test plan is created first in order to have a clear direction of what is to be done to test the system created. The details of the testing plan regarding the required test cases was created which was used as a guide for testing the system.

Firstly, unit and functional testing will be performed where the individual modules and processes of the system will be tested. Followed by a system integration testing by integrating different modules together to check whether there won’t be any compatibility issues to occur during the deployment of the finished system. Actual data will be uploaded into the system to test whether the system is able to handle a real-life situation. Usability testing is then performed to test the complete set of processes, along with execution times, data quality and usability of the system.

By performing these tests, the performance of the system can be better improved and bugs or any issues of the system can be earlier identified before the system is prepared for deployment. Once the system, is in a working condition it will then be presented to the supervisor for review.

4.1.2 Tools to use

Hardware

TYPE	SPECIFICATION
Hardware	Windows 10, 64-bit Operating System
	NVIDIA® GeForce® MX130 with 4GB GDDR5
	Installed memory (RAM): 8GB DDR4 2666MHz
	Intel i7 Processor (8MB Cache)
	Hard Disk Space: 128GB SSD, 1TB HDD

Table 4-1 Hardware specifications

Software

Anaconda Navigator

Anaconda Navigator is comprised in the Anaconda distribution that permits applications to be launched and manage channels, conda packages and environments to be easily managed without the use of command-line commands. Navigator can find packages in Anaconda Cloud or in a local repository in Anaconda. This software is chosen to be used for managing most of the development tools like Flask and Spyder environments all in one place easily.

Python

Python is a good high-level programming language which can be used for developing desktop GUI applications, web applications and even websites. This programming language allow its users to focus on essential functionality of applications by helping on common programming tasks for the user. The reason why choosing Python as the default programming language is because of its many benefits provided such as, easy to read code syntax, supports several programming models such as object oriented and structured programming. Besides that, python is also supported in major platforms and systems which reduces compatibility issues, and even provide many open source frameworks and tools which can be used for various types of application to be built.

Spyder

Spyder is an open source cross-platform interactive and Python integrated development environment (IDE), providing MATLAB-like features in software that is lightweight and simple. Since it is preinstalled in the Anaconda Navigator software and no additional downloading is required, this is the most convenient and will be used as an IDE for this project. This software is chosen for the development because it can support Python programming language.

Flask

Flask is a micro web framework that is written using Python, which does not require specific libraries or tools. Besides that, it can handle extensions that can enhance application features to Flask itself. The reason for choosing Flask is because it is a highly flexible framework that is simple enough to be learned and used to develop this project. Furthermore, it is also not a resource heavy framework whereby it has a small core and can easily be extensible. By using Flask, development of web-based applications can be done using a short amount of time.

MySQL

MySQL is chosen because it is a database with good data security and reliability. MySQL also provides support for transactional processing which enables high performance for whether it is a web-based application with large queries size or even high-speed transactional processing. Features like data consistency, data isolation, complete atomic, unrestricted row-level locking and multi-version transaction support helps to guarantees instant detection of the deadlock by means of server-enforced referential integrity. Besides that, MySQL also ensures optimum performance speed, unique memory caches, and full-text indexes.

4.1.3 User requirements

The system requirements were collected by 2 methods, which were conducting a small interview session, and self-research online. A short interview session was conducted with a cooperate company staff to gather some of the user requirements needed for the system. Besides that, online research was also done along with knowledge from personal experience during internship period was compiled to be used as the user requirements. The following are the user requirements gathered:

- The system allows staff users to log in into their respective accounts with their respective username and password.
- Then system allows user to view all of their expenses that has been uploaded to be claimed and those that had already been claimed.
- The system accepts receipt information when user uploads an expense receipt along with the expense amount and respective upload date.
- The system allows staff users to view their expense visualisation in graphical form without any difficulty.
- The system allows staff users to interact with the graphical expense visualisation available in order to get more details.
- The system allows the staff users to preview the file of the uploaded expense whenever needed.

- The system allows admins to log in into their respective accounts with their respective username and password.
- The system allows admins to view the overall expenses uploaded by all staffs easily.
- The system allows admins to be able to manipulate the approval status of the expenses uploaded by normal staffs.
- The system allows admin user to view all the staff's expenses in a graphical visualisation form without any difficulty.
- The system allows admin user to interact with the graphical expense visualisation available in order to get more details.
- The system allows the admin user to preview the file of the uploaded staff expenses whenever needed.

CHAPTER 5: TESTING AND WORK DONE

5.1 Verification Plan

Once the entire system has been completed, there will be several types of verification testing that will be conducted. Some of which consist of usability testing which helps to test whether the final system create is user friendly and able to provide proper feedback to users. Test cases such as "Is there a consistent font design and style treatment across all pages of the system?" and "Does the system notify user what is happening when an interaction is performed on a specific page?" will be performed and tested accordingly.

Besides that, unit testing and integration testing will also be done on the completed system. This type of testing will be focusing on trying check the correctness of input and output of the system. Cases like when a user inputs incorrect data into the system, will the system be able to handle it, is tested. An example of this will be when user tries to log in into the system with an incorrect username or password, and when user tried to sign up for an account with incorrect inputs, will the system behave properly and block the access will be tested. Other cases will be like, when user tried to upload a wrong file format when attempting to submit an expense will also be tested to how does the system handle these errors.

5.2 Unit Testing

5.2.1 Register account functionality

Register Account functionality				
Purpose of Test Case: To check functionality and correctness of input and output.			**Date Created:** 5 March 2020	
Step No.	**Input Values to Execute Test Case**	**Expected Results**	**Actual Results**	**Pass / Fail - Comments**
1.	Type in characters in the "Username" field and leave password field and / or email	An error message should appear to show:	An error message is appeared.	Pass

	empty, then click <Register> button.	*Please fill out this field.*		
2.	Type in characters in the "Password" field and leave username and / or email field empty, then click <Register> button.	An error message should appear to show: *Please fill out this field.*	An error message is appeared.	Pass
3.	Type in an already existing username and password into the username and password fields then click the <Register> button.	An error message should appear to show: *Account already exists!*	An error message is appeared.	Pass
4.	Type in a valid username and password into the username and password fields then click the <Register> button.	The sign-up page should close, and the login page should be opened.	The sign-up page is close, and the login page is opened.	Pass

Table 5-1 Register account unit test

5.2.2 Login account functionality

Login Account functionality				
Purpose of Test Case: To check functionality and correctness of input and output.		**Date Created:** 5 March 2020		
Step No.	**Input Values to Execute Test Case**	**Expected Results**	**Actual Results**	**Pass / Fail - Comments**

1.	Type in characters in the “Username” text field and leave password field empty, then click <Login> button.	An error message should appear to show: *Please fill out this field.*	An error message is appeared.	Pass
2.	Type in characters in the “Password” field and leave username text field empty, then click <Login> button.	An error message should appear to show: *Please fill out this field.*	An error message is appeared.	Pass
3.	Type in an invalid username and password into the username and password fields then click the <Login> button.	An error message should appear to show: *Incorrect username / password*	An error message is appeared.	Pass
4.	Type in a valid username and password into the username and password fields then click the <Login> button.	The login page should close, and the navigation page should be opened.	The login page is close, and the navigation page is opened.	Pass

Table 5-2 Login account unit test

5.2.3 Staff Dashboard functionality

Staff Dashboard functionality

Purpose of Test Case: To check functionality and correctness of input and output.			**Date Created:** 5 March 2020	
Step No.	**Input Values to Execute Test Case**	**Expected Results**	**Actual Results**	**Pass / Fail - Comments**
1.	Click on a specific point (month) on the line graph.	Pie chart showing total expense by category should update accordingly.	The pie chart values are updated accordingly.	Pass
2.	Click on a specific legend (category) on the pie chart.	The selected legend (category) values will be filtered on or off.	The pie chart filters value accordingly	Pass

Table 5-3 Staff Dashboard unit test

5.2.4 Staff Expense Overview Functionality

Staff Expense Overview functionality				
Purpose of Test Case: To check functionality and correctness of input and output.			**Date Created:** 5 March 2020	
Step No.	**Input Values to Execute Test Case**	**Expected Results**	**Actual Results**	**Pass / Fail - Comments**
1.	Click on the <Upload A New Expense> button.	Display pop-up for requesting file and expense value input from user.	A pop up is shown that prompts user for a file and expense value.	Pass
2.	Click on the <Upload Expense> button. Choose a file to be uploaded and leave expense value field	An error message should appear to show:	An error message is appeared.	Pass

	blank, then press the <Submit> button.	*Please fill out this field.*		
3.	Click on the <Upload Expense> button. Leave the file field empty and enter the expense value field, then press the <Submit> button.	An error message should appear to show: *Please fill out this field.*	An error message is appeared.	Pass
4.	Click on a column header in the expense overview table.	The selected column will be sorted accordingly.	Select column sorts the records accordingly.	Pass
5.	Type in a query in the search text box available above the expense overview table.	The searched query is applied to filter the table records accordingly.	The table records are filtered accordingly.	Pass
6.	Click on any one of the record's "Filename".	The selected file will be displayed as a preview to user.	Selected file is displayed a preview to user.	Pass

Table 5-4 Staff Expense Overview unit test

5.2.5 Admin Dashboard Functionality

Staff Expense Overview functionality				
Purpose of Test Case: To check functionality and correctness of input and output.			**Date Created:** 5 March 2020	
Step No.	**Input Values to Execute Test Case**	**Expected Results**	**Actual Results**	**Pass / Fail - Comments**

1.	Click on a specific point (month) on the line graph.	Pie chart and bar chart available should update their values accordingly.	Both pie and bar charts values are updated accordingly.	Pass
2.	Click on a specific legend (category) on the pie chart.	The selected legend (category) values will be filtered on or off.	The pie chart filters value accordingly	Pass
3.	Click on a specific sector on the pie chart.	A pop up should be shown, showing the expense details of the selected sector.	Expense details of selected sector is shown.	Pass
4.	Click on a specific bar on the bar chart.	A pop up should be shown, showing the expense details of the selected bar.	Expense details of the selected bar is shown.	Pass
5.	Click on any one of the records row's "Filename" in the pop-up window which shows the expense details for the selected pie chart or bar chart.	The selected file will be displayed as a preview to user.	Selected file is displayed a preview to user.	Pass
6.	Click on the "Pending Expenses" card.	The Pending Expenses page should be shown.	Pending Expenses page is shown.	Pass

Table 5-5 Admin Dashboard unit test

5.2.6 Classifier Page Functionality

Classifier page functionality				
Purpose of Test Case: To check functionality and correctness of input and output.		**Date Created:** 5 March 2020		
Step No.	**Input Values to Execute Test Case**	**Expected Results**	**Actual Results**	**Pass / Fail - Comments**
1.	Click on the <Add new expense category> button.	A pop up is shown, prompting user to key in the new category.	Pop up shown prompting for new category name.	Pass
2.	Leave the add new expense category input field empty and press the <submit> button.	An error message should appear to show: *Please fill out this field.*	An error message is appeared.	Pass
3.	Enter a valid category name into the add new expense category input field and press the <submit> button.	The new category should be added into the database, the classification model is updated and the pop up is closed.	The database is updated with new category, classification model is updated and the pop up is closed.	Pass
4.	Click on the <Learn new receipt keywords> button.	A pop up is shown, prompting user to select a category and choose an expense file to upload.	Pop up shown prompting for the expense category and file to be uploaded.	Pass

5.	Leave the expense category input field empty and press the <submit> button.	An error message should appear to show: *Please fill out this field.*	An error message is appeared.	Pass
6.	Leave the expense file input field empty and press the <submit> button.	An error message should appear to show: *Please fill out this field.*	An error message is appeared.	Pass
7.	Choose an expense category and a valid file in their respective fields and press the <submit> button.	A pop up showing a list of keywords as checkbox input is shown and prompting user to select	The database is updated with new category and the pop up is closed.	Pass
8.	In the pop up showing list of keywords as checkbox input, select some keywords and press the <submit> button.	The selected keywords should be added into the database and the classification model is updated.	Both the database and classification model are updated.	Pass
9.	Click on the <Add new keywords> button.	A pop up is shown, prompting user to key in the new keywords.	Pop up shown prompting for new keywords.	Pass
10.	Leave the add new keywords input field empty and press the <submit> button.	An error message should appear to show: *Please fill out this field.*	An error message is appeared.	Pass

11.	Enter a valid keyword into the add new keyword input field and press the <submit> button.	The new keyword should be added into the database, the classification model is updated and the pop up is closed.	The database is updated with new keywords, classification model is updated and the pop up is closed.	Pass

Table 5-6 Classifier Page unit test

5.2.7 Admin View Pending Expenses Functionality

Admin View Pending Expenses functionality				
Purpose of Test Case: To check functionality and correctness of input and output.		**Date Created:** 5 March 2020		
Step No.	**Input Values to Execute Test Case**	**Expected Results**	**Actual Results**	**Pass / Fail - Comments**
1.	Click on the <Approve> OR <Reject> button in the "Action" column of the table.	The selected row action should be removed from the pending expenses table.	Selected row was removed from the pending expenses table.	Pass
2.	Click on a column header in the pending expenses table.	The selected column will be sorted accordingly.	Select column sorts the records accordingly.	Pass
3.	Type in a query in the search text box available above the pending expense table.	The searched query is applied to filter the table records accordingly.	The table records are filtered accordingly.	Pass

4.	Click on any one of the record's "Filename".	The selected file will be displayed as a preview to user.	Selected file is displayed a preview to user.	Pass

Table 5-7 Admin View Pending unit test

5.2.8 Admin View Expense Overview Functionality

Admin View Expense Overview functionality				
Purpose of Test Case: To check functionality and correctness of input and output.			**Date Created:** 5 March 2020	
Step No.	**Input Values to Execute Test Case**	**Expected Results**	**Actual Results**	**Pass / Fail - Comments**
1.	Click on a column header in the pending expenses table.	The selected column will be sorted accordingly.	Select column sorts the records accordingly.	Pass
2.	Type in a query in the search text box available above the pending expense table.	The searched query is applied to filter the table records accordingly.	The table records are filtered accordingly.	Pass
3.	Click on any one of the record's "Filename".	The selected file will be displayed as a preview to user.	Selected file is displayed a preview to user.	Pass

Table 5-8 Admin View Expense Overview unit test

5.3 Usability Testing

5.2.1 Register Account page

1. Visibility of Register Account page

Purpose: The system should always keep user informed about what is going on, through appropriate feedback and store necessary information successfully.			
Step No.	**Review Checklist**	**Yes / No / Not Applicable**	**Comments**
1.1	Is there a consistent font design and stylist treatment across the entire page?	Yes	All fonts of that are on the page are kept consistent.
1.2	Are all the fonts on the page clear and consist without over packing the screen?	Yes	All fonts as big enough to be seen and can be read without difficulty.
1.3	Does the system notify user what is happening when an interaction is performed on the page?	Yes	Error messages are prompted to the user when an invalid input is entered.

Table 5-9 Register Account visibility test

2. Usability of Register Account page			
Purpose: The system should allow users to perform the functions available and proceed to the next interface successfully.			
Step No.	**Review Checklist**	**Yes / No / Not Applicable**	**Comments**
2.1	Can users key in their username and password without any issue?	Yes	Users can easily key in their username and password easily.
2.2	Can all the buttons available on screen be pressed and it is functioning properly?	Yes	Both the log in and sign up buttons available on screen

			works without any issues.
2.3	Can the functions on the page bring you to the next interface smoothly?	Yes	A successful log in will allow the user to proceed to the next page without any issues.

Table 5-10 Register Account usability test

5.2.2 Login page

1. Visibility of Login page			
Purpose: The system should always keep user informed about what is going on, through appropriate feedback and store necessary information successfully.			
Step No.	**Review Checklist**	**Yes / No / Not Applicable**	**Comments**
1.1	Is there a consistent font design and stylist treatment across the entire page?	Yes	All fonts of that are on the page are kept consistent.
1.2	Are all the fonts on the page clear and consist without over packing the screen?	Yes	All fonts as big enough to be seen and can be read without difficulty.
1.3	Does the system notify user what is happening when an interaction is performed on the page?	Yes	Error messages are prompted to the user when an invalid input is entered.

Table 5-11 Login Account visibility test

2. Usability of Login page			
Purpose: The system should allow users to perform the functions available and proceed to the next interface successfully.			
Step No.	**Review Checklist**	**Yes / No / Not Applicable**	**Comments**
2.1	Can users key in their username and password without any issue?	Yes	Users can easily key in their username and password.
2.2	Can all the buttons available on screen be pressed and it is functioning properly?	Yes	Both the log in and sign up buttons available on screen works without any issues.
2.3	Can the functions on the page bring you to the next interface smoothly?	Yes	A successful log in will allow the user to proceed to the next page without any issues.

Table 5-12 Login Account usability test

5.2.3 Staff Dashboard page

1. Visibility of Staff Dashboard page			
Purpose: The system should always keep user informed about what is going on, through appropriate feedback and store necessary information successfully.			
Step No.	**Review Checklist**	**Yes / No / Not Applicable**	**Comments**
1.1	Is there a consistent font design and stylist treatment across the entire page?	Yes	All fonts of that are on the page are kept consistent.

1.2	Are all the fonts on the page clear and consist without over packing the screen?	Yes	All fonts as big enough to be seen and can be read without difficulty.
1.3	Does the system notify user what is happening when an interaction is performed on the page?	Yes	Error messages are prompted to the user when an invalid input is entered.

Table 5-13 Staff Dashboard visibility test

2. Usability of Staff Dashboard page			
Purpose: The system should allow users to perform the functions available and proceed to the next interface successfully.			
Step No.	**Review Checklist**	**Yes / No / Not Applicable**	**Comments**
2.1	Can the user click on the graph values for interaction?	Yes	Users can click on the graph's values for a detail information regarding the selected values.
2.2	Can all the buttons available on screen be pressed and it is functioning properly?	Yes	All of the available navigation buttons are working without issues.

Table 5-14 Staff Dashboard usability test

5.2.4 Staff Expense Overview page

1. Visibility of Staff Expense Overview page

Purpose: The system should always keep user informed about what is going on, through appropriate feedback and store necessary information successfully.			
Step No.	**Review Checklist**	**Yes / No / Not Applicable**	**Comments**
1.1	Is there a consistent font design and stylist treatment across the entire page?	Yes	All fonts of that are on the page are kept consistent.
1.2	Are all the fonts on the page clear and consist without over packing the screen?	Yes	All fonts as big enough to be seen and can be read without difficulty.
1.3	Does the system notify user what is happening when an interaction is performed on the page?	Yes	Error messages are prompted to the user when an invalid input is entered.

Table 5-15 Staff Expense Overview visibility test

2. Usability of Staff Expense Overview page			
Purpose: The system should allow users to perform the functions available and proceed to the next interface successfully.			
Step No.	**Review Checklist**	**Yes / No / Not Applicable**	**Comments**
2.1	Can all the buttons available on screen be pressed and it is functioning properly?	Yes	All available functions on the expense overview table works without any issues.
2.2	Can all the navigation function buttons on the page bring you to the next interface smoothly?	Yes	All navigation buttons will route to

			its respective pages without any issues.

Table 5-16 Staff Expense Overview usability test

5.2.5 Admin Dashboard page

1. Visibility of Admin Dashboard page			
Purpose: The system should always keep user informed about what is going on, through appropriate feedback and store necessary information successfully.			
Step No.	**Review Checklist**	**Yes / No / Not Applicable**	**Comments**
1.1	Is there a consistent font design and stylist treatment across the entire page?	Yes	All fonts of that are on the page are kept consistent.
1.2	Are all the fonts on the page clear and consist without over packing the screen?	Yes	All fonts as big enough to be seen and can be read without difficulty.
1.3	Does the system notify user what is happening when an interaction is performed on the page?	Yes	Error messages are prompted to the user when an invalid input is entered.

Table 5-17 Admin Dashboard visibility test

2. Usability of Admin Dashboard page			
Purpose: The system should allow users to perform the functions available and proceed to the next interface successfully.			
Step No.	**Review Checklist**	**Yes / No / Not Applicable**	**Comments**

2.1	Can the user click on the graph values for interaction?	Yes	Users can click on the graph's values for a detail information regarding the selected values.
2.2	Can all the buttons available on screen be pressed and it is functioning properly?	Yes	All of the available navigation buttons are working without issues.

Table 5-18 Admin Dashboard usability test

5.2.6 Classifier page

1. Visibility of Classifier page			
Purpose: The system should always keep user informed about what is going on, through appropriate feedback and store necessary information successfully.			
Step No.	**Review Checklist**	**Yes / No / Not Applicable**	**Comments**
1.1	Is there a consistent font design and stylist treatment across the entire page?	Yes	All fonts of that are on the page are kept consistent.
1.2	Are all the fonts on the page clear and consist without over packing the screen?	Yes	All fonts as big enough to be seen and can be read without difficulty.
1.3	Does the system notify user what is happening when an interaction is performed on the page?	Yes	Error messages are prompted to the user when an invalid input is entered.

Table 5-19 Classifier Page visibility test

2. Usability of Classifier page			
Purpose: The system should allow users to perform the functions available and proceed to the next interface successfully.			
Step No.	**Review Checklist**	**Yes / No / Not Applicable**	**Comments**
2.1	Can all the buttons available on screen be pressed and it is functioning properly?	Yes	All available functions on the classifier page works without any issues.
2.2	Can the user be allowed to input specific information when performing a classifier function available?	Yes	Users are allowed to specify their own inputs in the provided input fields.
2.3	Can all the navigation function buttons on the page bring you to the next interface smoothly?	Yes	All navigation buttons will route to its respective pages without any issues.

Table 5-20 Classifier Page usability test

5.2.7 Admin View Pending page

1. Visibility of Admin View Pending page			
Purpose: The system should always keep user informed about what is going on, through appropriate feedback and store necessary information successfully.			
Step No.	**Review Checklist**	**Yes / No / Not Applicable**	**Comments**
1.1	Is there a consistent font design and stylist treatment across the entire page?	Yes	All fonts of that are on the page are kept consistent.

1.2	Are all the fonts on the page clear and consist without over packing the screen?	Yes	All fonts as big enough to be seen and can be read without difficulty.
1.3	Does the system notify user what is happening when an interaction is performed on the page?	Yes	Error messages are prompted to the user when an invalid input is entered.

Table 5-21 Admin View Pending visibility test

2. Usability of Admin View Pending page			
Purpose: The system should allow users to perform the functions available and proceed to the next interface successfully.			
Step No.	**Review Checklist**	**Yes / No / Not Applicable**	**Comments**
2.1	Can all the buttons available on screen be pressed and it is functioning properly?	Yes	All available functions on the pending expense table works without any issues.
2.2	Can all the navigation function buttons on the page bring you to the next interface smoothly?	Yes	All navigation buttons will route to its respective pages without any issues.

Table 5-22 Admin View Pending usability test

5.2.8 Admin View Expense Overview page

1. Visibility of Admin View Expense Overview page
Purpose: The system should always keep user informed about what is going on, through appropriate feedback and store necessary information successfully.

Step No.	Review Checklist	Yes / No / Not Applicable	Comments
1.1	Is there a consistent font design and stylist treatment across the entire page?	Yes	All fonts of that are on the page are kept consistent.
1.2	Are all the fonts on the page clear and consist without over packing the screen?	Yes	All fonts as big enough to be seen and can be read without difficulty.
1.3	Does the system notify user what is happening when an interaction is performed on the page?	Yes	Error messages are prompted to the user when an invalid input is entered.

Table 5-23 Admin View Expense Overview visibility test

2. Usability of Admin View Expense Overview page			
Purpose: The system should allow users to perform the functions available and proceed to the next interface successfully.			
Step No.	**Review Checklist**	**Yes / No / Not Applicable**	**Comments**
2.1	Can all the buttons available on screen be pressed and it is functioning properly?	Yes	All available functions on the pending expense table works without any issues.
2.2	Can all the navigation function buttons on the page bring you to the next interface smoothly?	Yes	All navigation buttons will route to its respective pages without any issues.

Table 5-24 Admin View Expense Overview usability test

5.4 Screenshots of work done

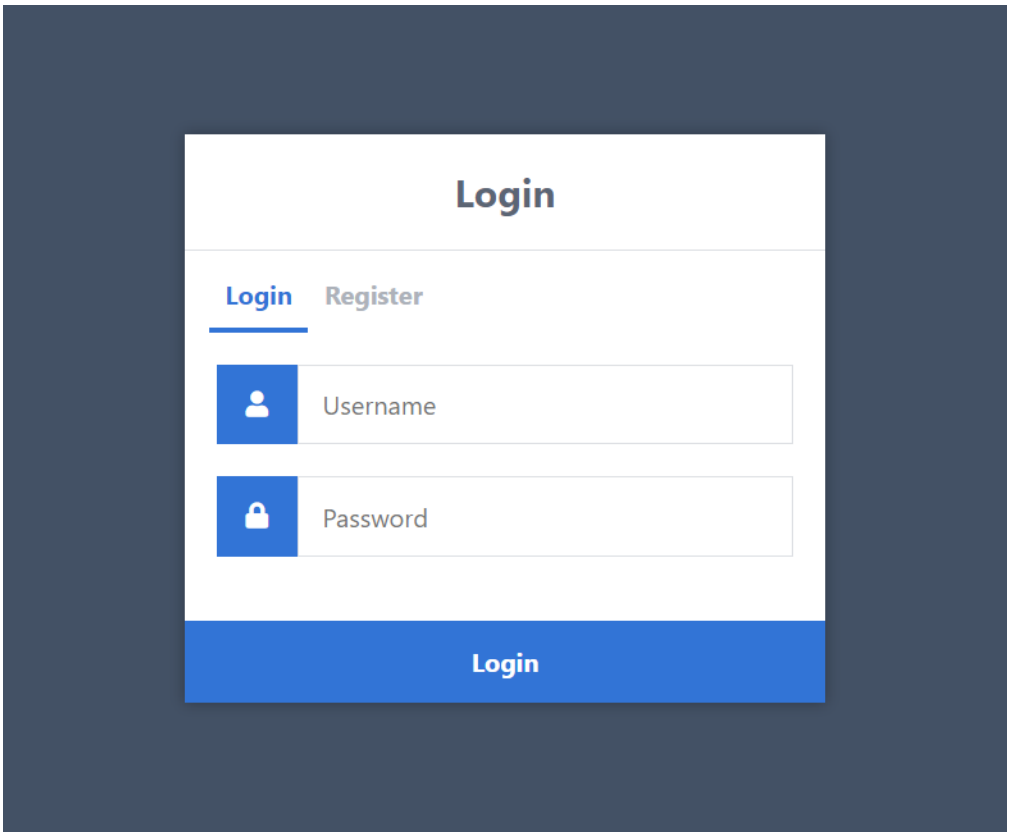


Figure 5-1 Login Page Screenshot

The figure above illustrates the login page of the system. A user is required to fill in both the username and password field before being able to log in into the system. The username field has some basic validation where the field cannot be left empty. The password field also has been set with the basic validation where the field cannot be left empty. When the user has filled both the fields required, the user needs to press the “Login” button and the system will then validate to check whether the keyed in information matches with an existing registered account in the database. The system will also validate to check whether the user is currently logged in or not. If the keyed in account information is found to be already logged in, the system will reject this login session and an error message is displayed.

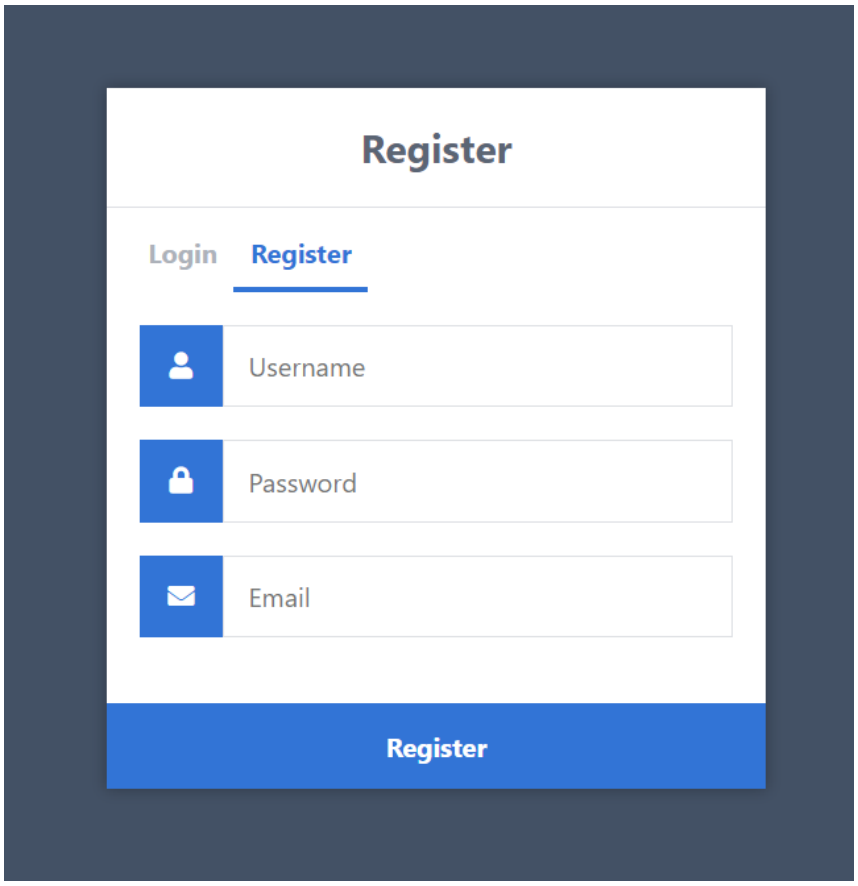


Figure 5-2 Register Account Page Screenshot

The figure above shows the sign-up page of the system. In this page, a user is required to fill in the 3 fields which are the username, password, and email. The system validates to check whether any of the fields are left blank and prompts an error message if a field is found to be empty. The system will also validate to check whether the email entered is an email that follows the general format of a valid email address. When the user has filled all the fields required, the user is required to press the “Register” button and the system will then validate to check whether the keyed in information matches with an existing registered account in the database. If a similar account already exists in the databased, the system will prompt an error message and the user is required to try again with a different account information.

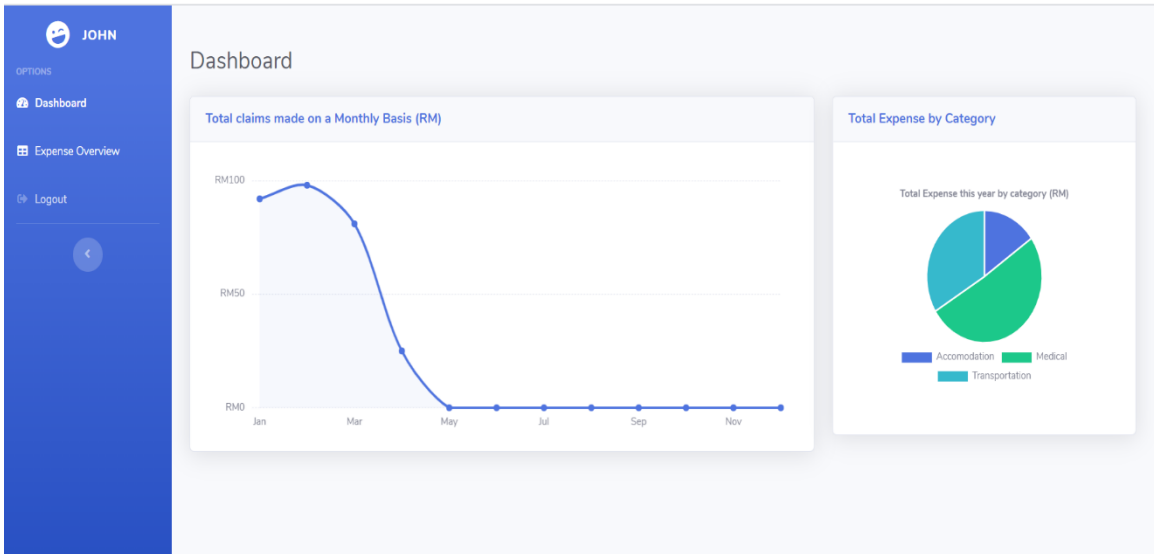


Figure 5-3 Staff User Home Page Screenshot

The figure above shows the "Staff User's Home" page of the system. When a user presses the "Dashboard" button at the side navigation bar, this page is displayed to the user. In this page, the user will be able to view all of their own expense records in a graphical representation. This allows the user to view their expenses easily. The user can hover the mouse onto the graph to view their expense value. The line graph shows the total amount of expense that has been claimed on a monthly basis. The pie chart shows the total expenses claimed based on type of expense category. The user can also click on the line graph value points (month) and the pie chart on the left will be updated according to the selected month.

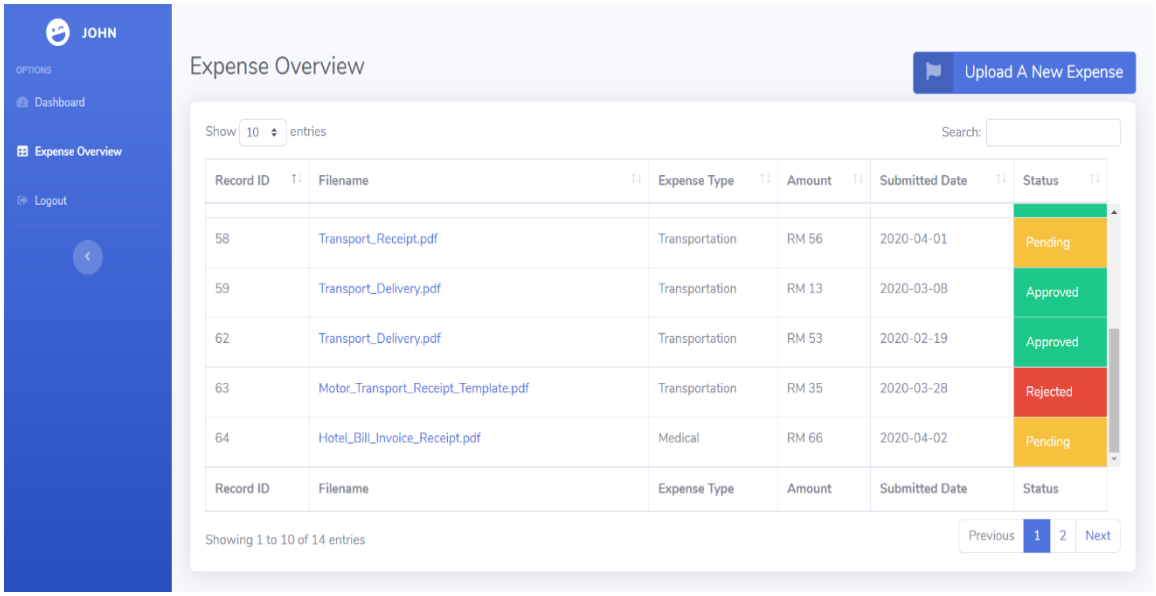


Figure 5-4 Staff Expense Overview Page Screenshot

The figure above shows the “Staff Expense Overview” page of the system. When the user presses the “Expense Overview” button at the side navigation bar, this page will be displayed to the user. In this page, the user can view all of their expenses in a table form, where they can check the approval status of their expense claims. The approval status as indicated with specific colours, where yellow is for pending, green is for approved and red being for rejected. The user is also allowed to sort their expenses according to their preference by clicking on the respective column header. The user can also filter out the expense by using the search query textbox. The user is also given a functionality to upload a new expense. The user is required to press the “Upload New Expense” button in order to upload a new expense.

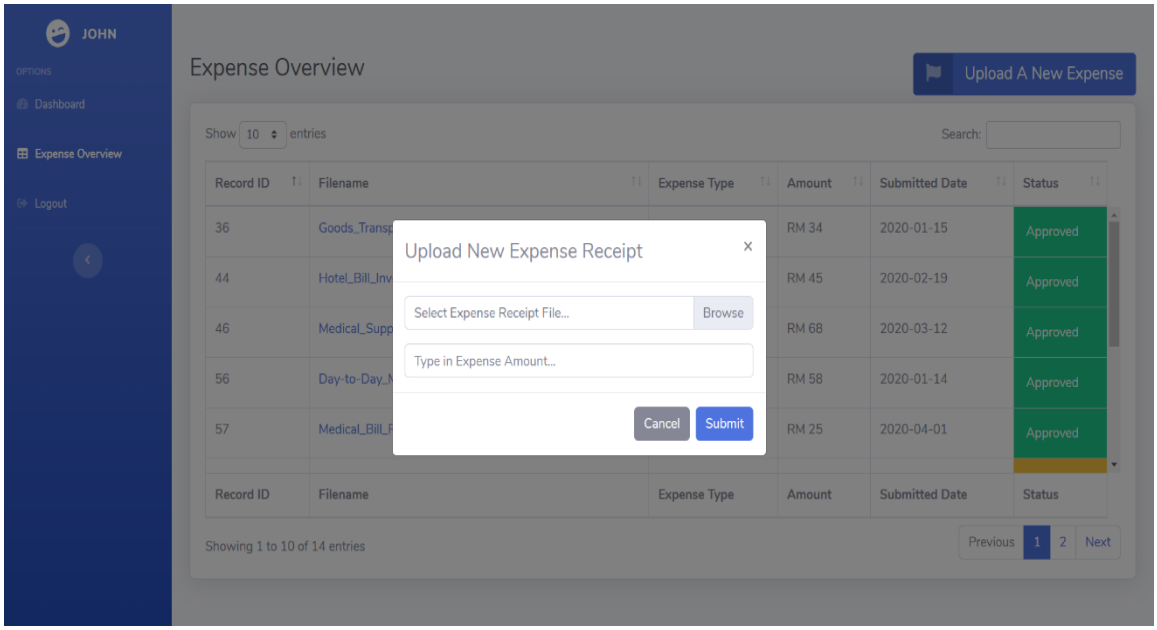


Figure 5-5 Staff Upload Expense Pop-up Page Screenshot

The figure above shows the “Staff Expense Upload Pop-Up” page of the system. When a user presses the “Upload A New Expense” button, the system pops-up a small container where the user is prompts for two fields to be provided in order to upload a new expense. The user is required to press the “Browse” button in order to be able to select a file that they want to upload. The user is also required to fill in the text box with the total value of their expense. The user then needs to press the “Submit” button to confirm the expense submission.

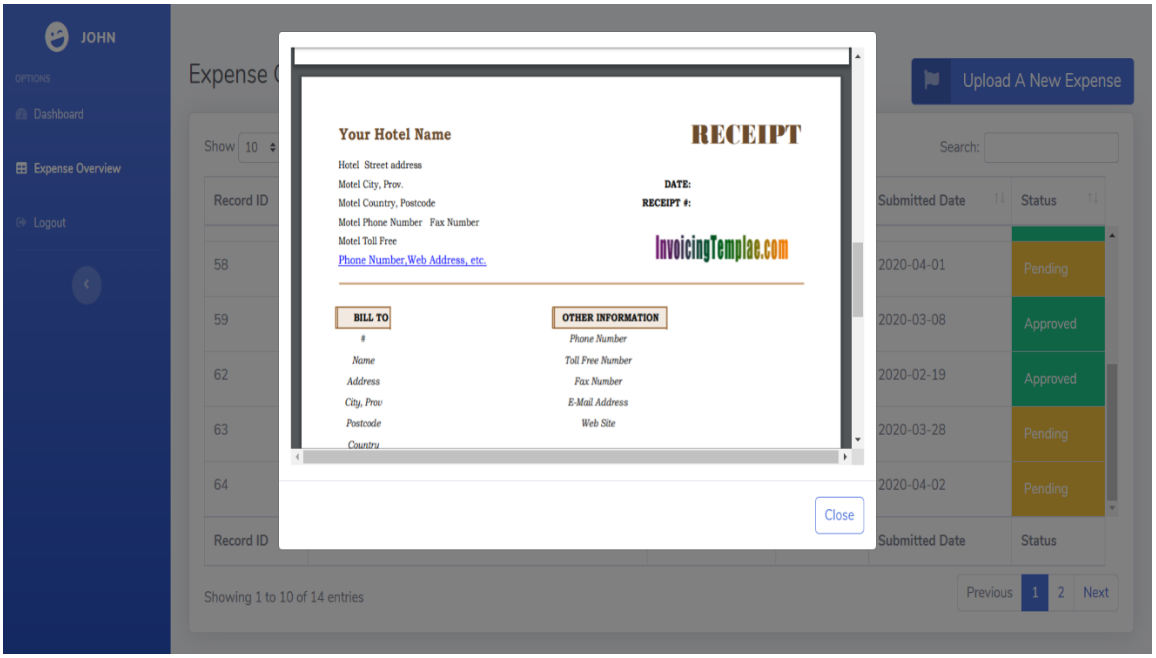


Figure 5-6 Staff Preview Expense File Screenshot

The figure above shows the pop-up window to display a preview of the expense file that has been uploaded. This preview is displayed when the user selects a file name of any one of the records that is in the expense overview table. The user can close this preview by clicking the close button available or by clicking at the faded area in the background.

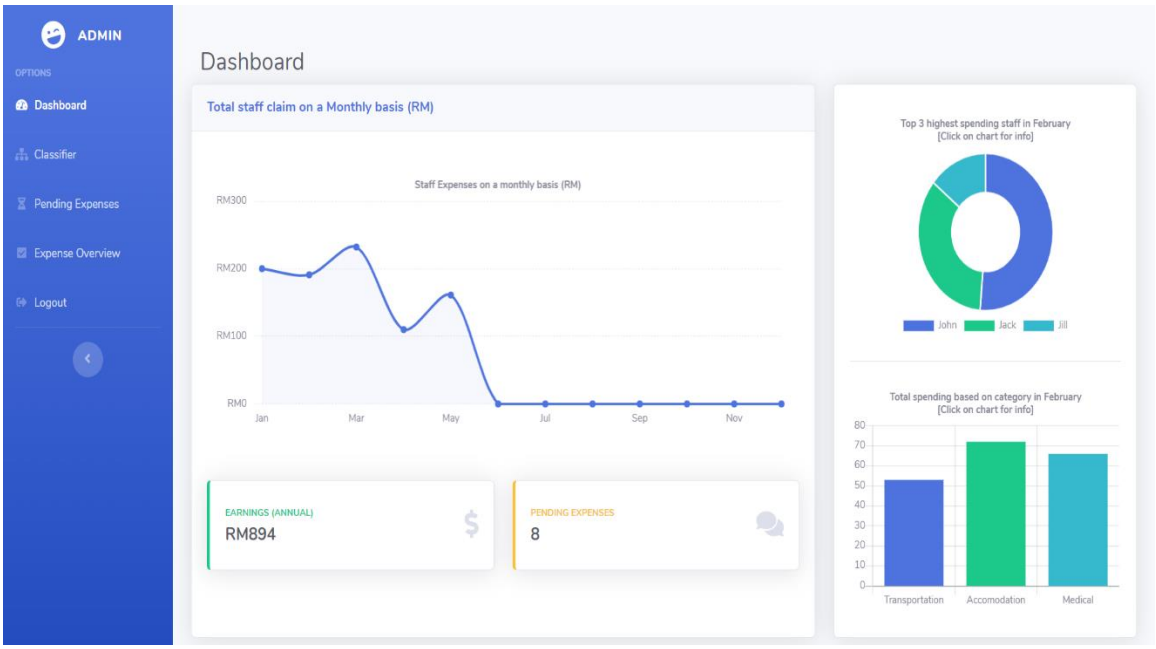


Figure 5-7 Admin Home Page Screenshot

The figure above illustrates the "Admin Home" page of the system. When the user presses on the "Dashboard" button at the side navigation bar or when the user logged into the system this page will be displayed to the user by default. In this page, only accounts with admin privileges are allowed to view the graph of all of the staff's expenses submitted in graphical representation. The line graph shows the total expenses claimed by staffs in a monthly basis. The pie chart shows the top 3 highest claimed staffs of a particular month. The bar chart shows the total expenses claimed by staff by types of expense category. When the user clicks on a particular month value on the line graph, both the pie chart and bar chart will be updated automatically to show details of the selected month in particular. When the user clicks on a particular sector on the pie chart, a pop up is displayed to the user showing further details of the expenses that are claimed on that particular month by the selected employee sector. When the user clicks on a particular bar on the bar graph, a pop up is also displayed to the user showing further details of the expenses that are claimed by the selected expense type category. The user can also click on the "pending expense" card, which will route the user to the Pending expenses page.

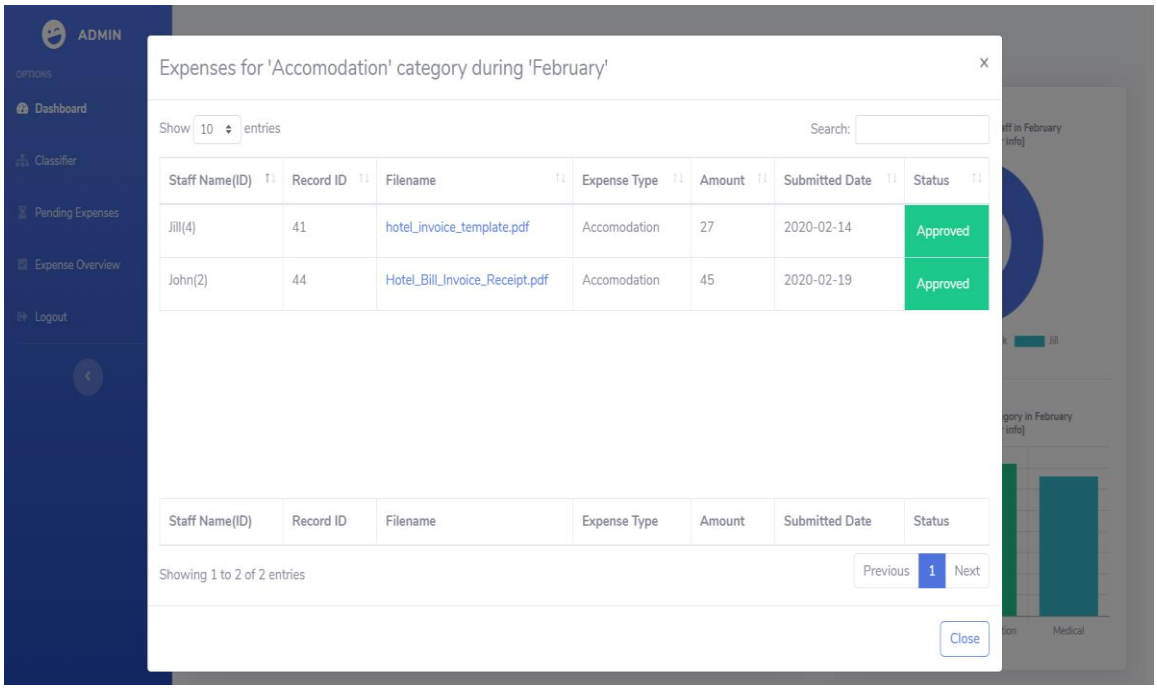


Figure 5-8 Admin Chart Details Popup Screenshot

The figure above shows the pop-up window that is displayed when the user selected on either the pie chart or the bar chart's specific values. The table displayed will contain detailed information of the expenses claimed according to the specific month or expense type based on what the user has selected.

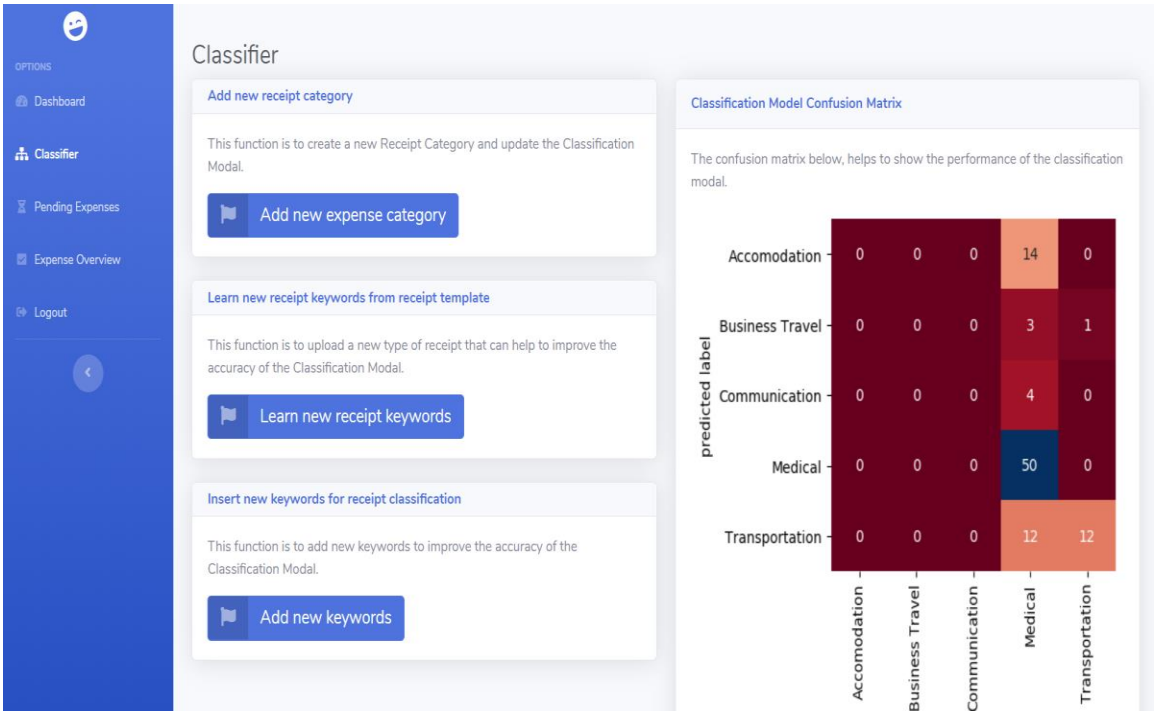


Figure 5-9 Admin Classifier Page Screenshot

The figure above shows the classifier page that is only available for users with admin privileges. In this page there are mainly 3 different functions that can be performed. The first one is the "Add new expense category", where the admin can add a new expense category that is to be added into the classification model. The second is the "Learn new receipt keywords" function, where the admin provides an expense receipt to the system, and the system will perform some pre-processing to extract keywords and the admin is required to label them accordingly. The third function is "Add new keywords", where the admin is needed to provide a list or keywords or just a single keyword that can be added into the classification model's dataset which can help to improve the accuracy of the classification model. The diagram on the left shows, the confusion matrix which is used for evaluating the classification model.

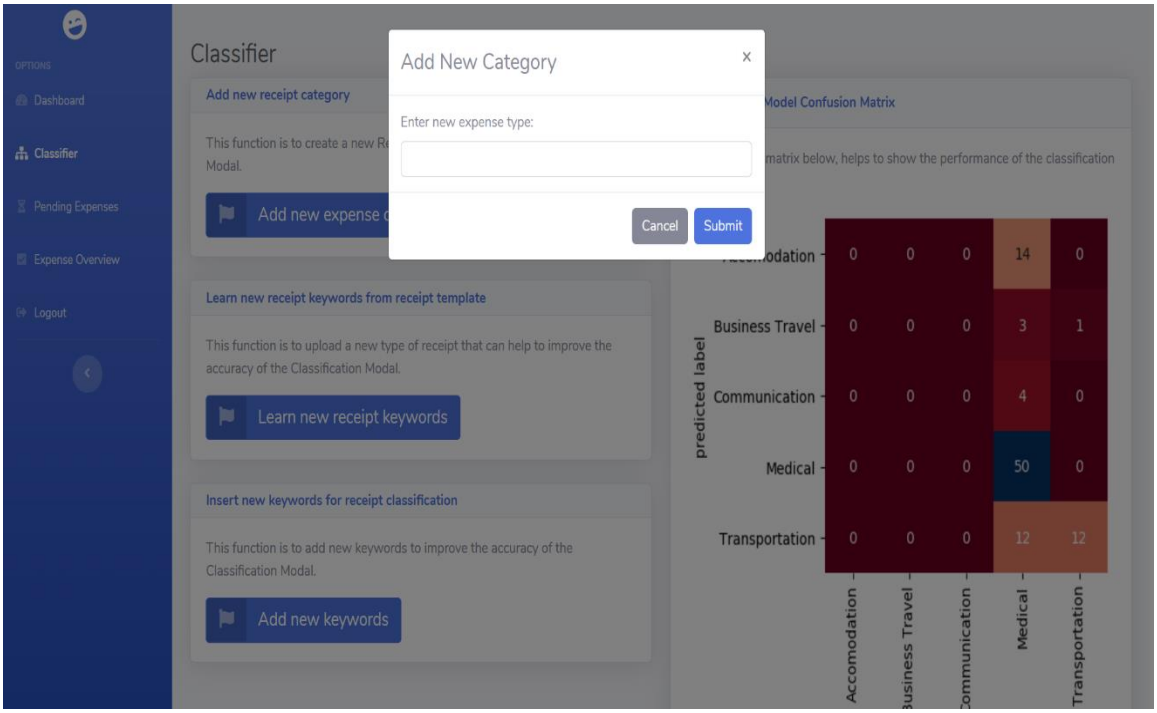


Figure 5-10 Add New Expense Popup Screenshot

The figure above shows the pop-up that is displayed when the user clicks on the "Add New Expense Category" button. In the popup, the user is prompt for a category name to be typed in the text box provided. After the user has provided the category name and press the submit button, the system will update the database and the classification model to implement this new category into the classification model.

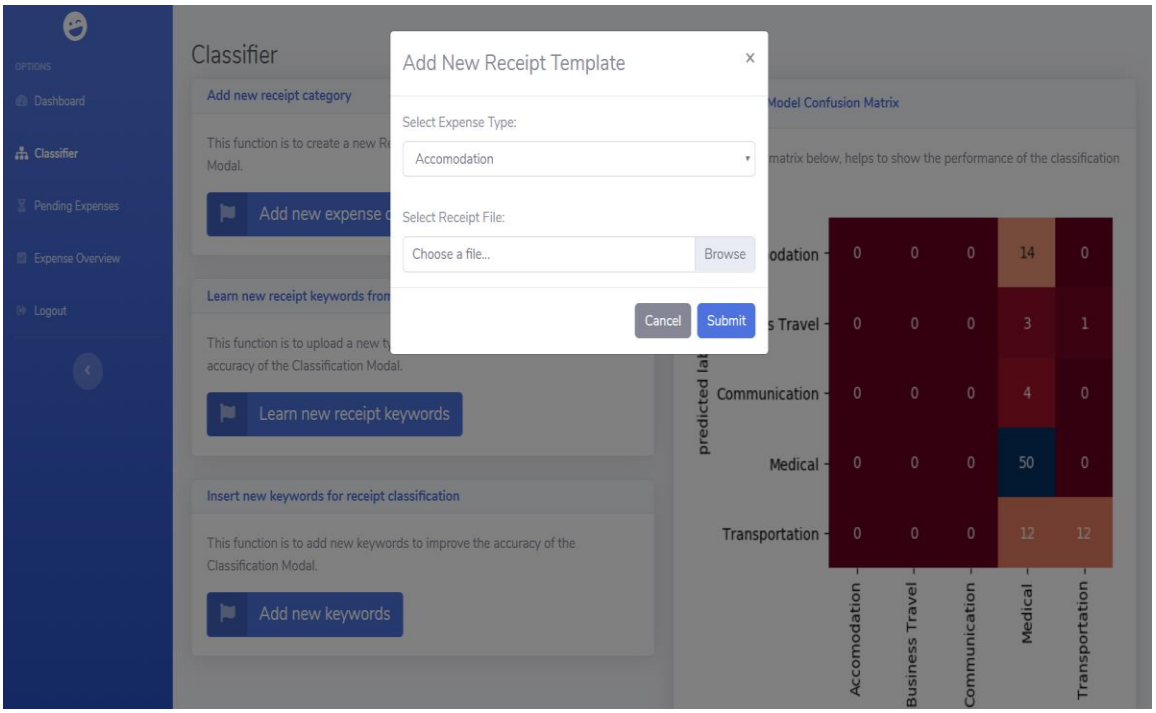


Figure 5-11 Learn New Receipt Keywords Popup Screenshot

The figure above shows the pop up that is displayed to the user when the "Learn new receipt keywords" button is clicked. In the pop up, the system prompts the user to select an expense category and a file to be uploaded. Once the required fields are provided and the submit button is clicked, the system will perform some pre-processing and then display another pop-up window. In this new pop up window, the system prompts the user to choose the keywords that they desire to add into the system by labelling them manually. The selected keywords are then added into the database and the classification model is updated accordingly.

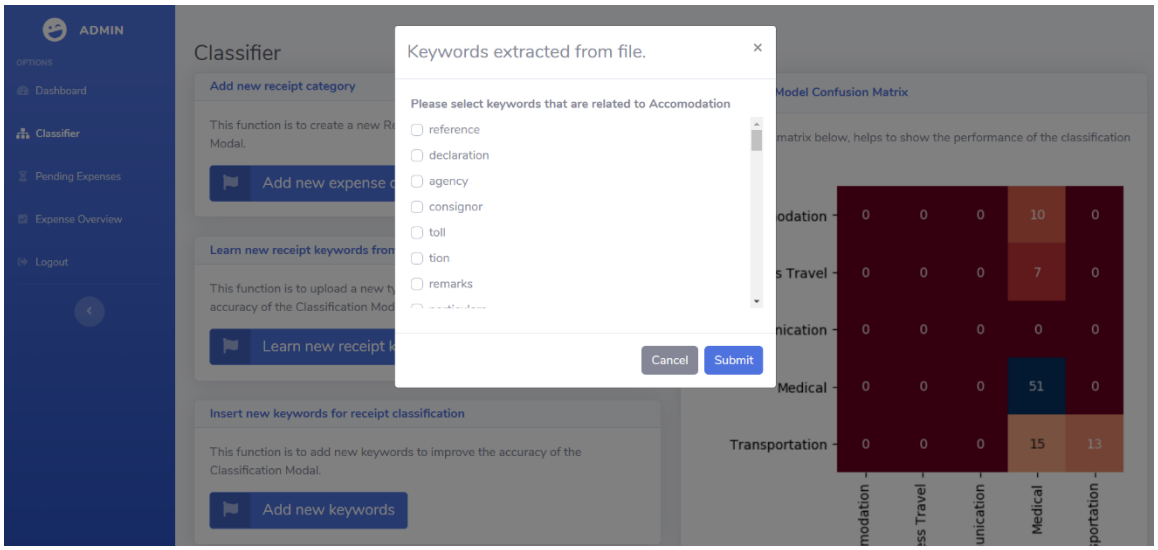


Figure 5-12 Admin Classifier Page Screenshot

The figure above shows the pop up window which displays the list of keywords that has been extracted from the file that has been uploaded when the user selects the “Learn new receipt keyword” function. The user is needed to choose the words that they wish to class as keywords from the chosen category. One the keywords are chosen and the submit button is clicked, the system will update the database and the classification model automatically.

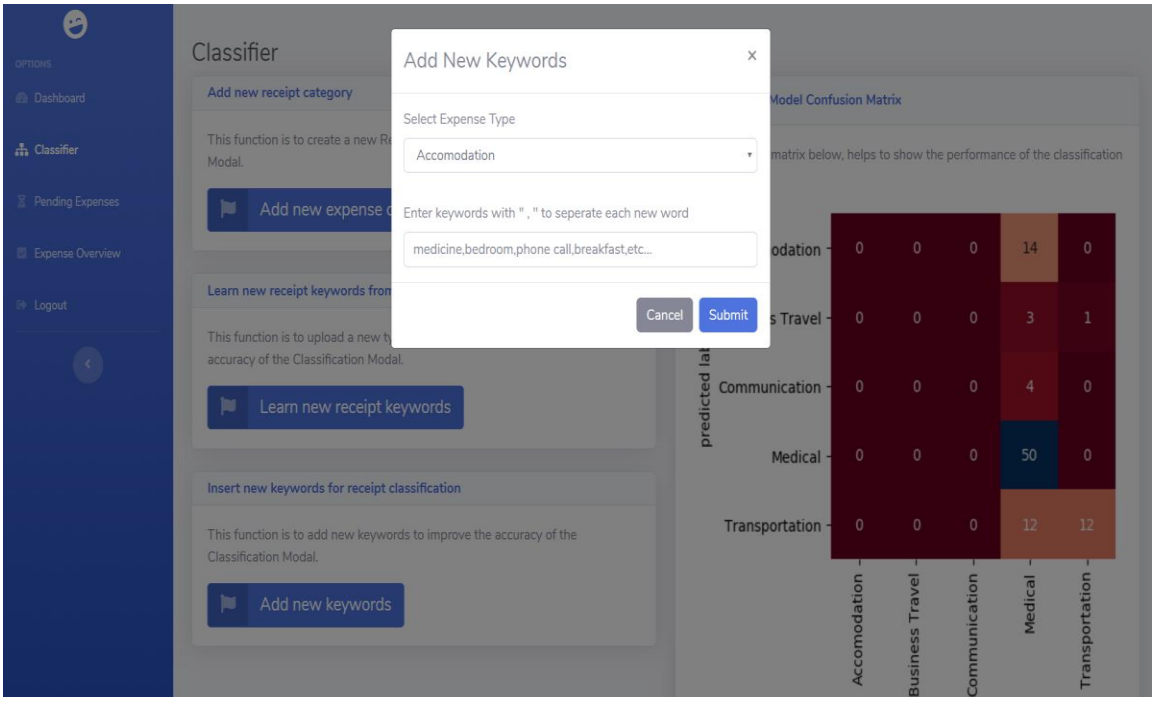


Figure 5-13 Add new keywords Popup Screenshot

The figure above shows the pop up window that is displayed when the user selects the "Add new keywords" function. The pop-up window will prompt the user to key in a list of keywords by separating them using a comma symbol and also prompting the user to choose the expense type category. Once the list of keywords is keyed in and the submit button is clicked, the system will update the database and the classification model automatically.

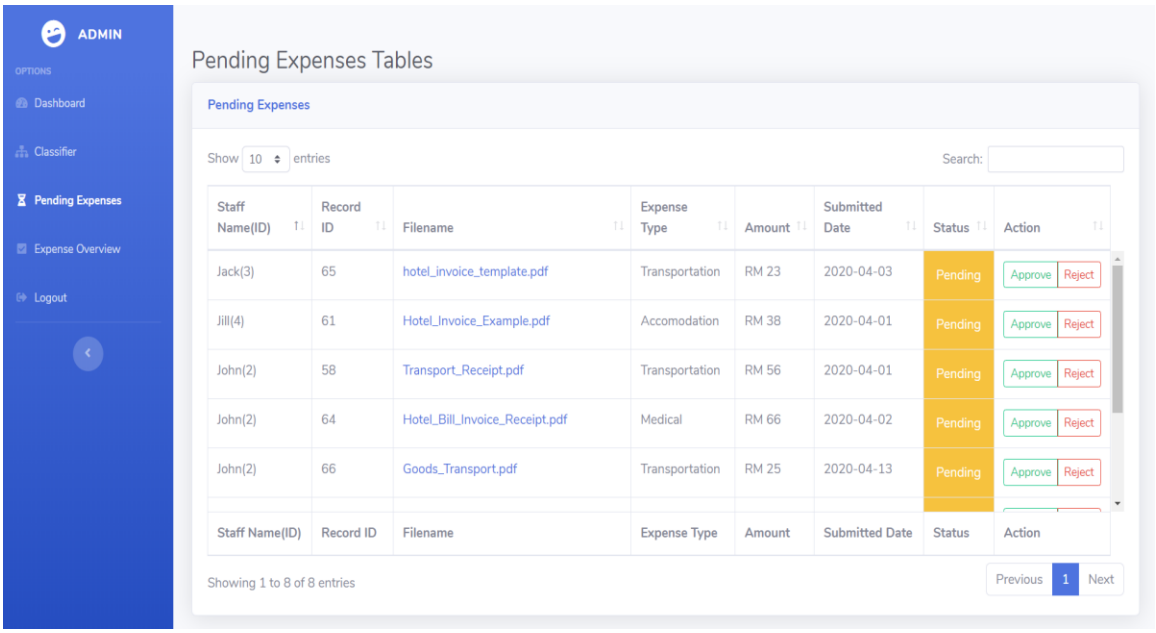


Figure 5-14 Admin Pending Expenses Page Screenshot

The figure above shows the "Admin Pending Expenses" page of the system. When the user presses the "Pending Expenses" button at the side navigation bar, this page is displayed to the user. The admin user will be able to view all of the staff's expenses that has been uploaded in a table form. The admin is also given the privilege to either "Approve" or "Reject" the claims by pressing the green and red buttons in the table respectively. When either an approve or reject action is committed the table will be updated by removing the particular record from the table respectively.

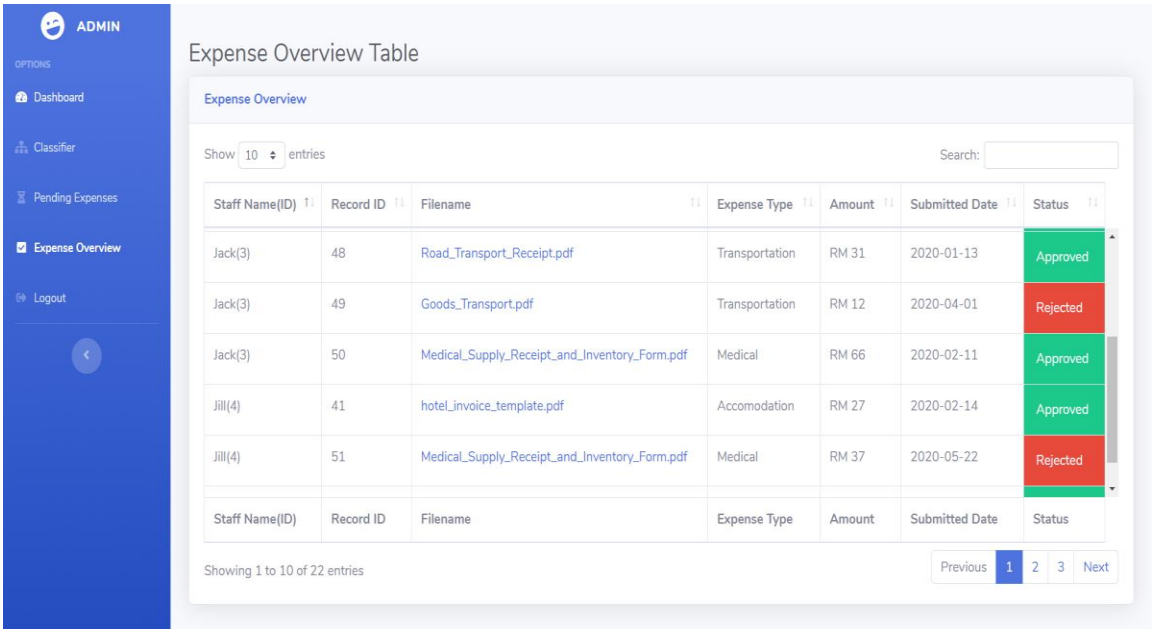


Figure 5-15 Admin Expense Overview Page Screenshot

The figure above shows the expense overview page, which shows an overview of all the expenses that has been submitted into the system. All expenses with either approved, pending or even rejected status can be view in this page. The expenses in the table can be filtered using the search bar provided. The records can also be sorted according to a specific column, by clicking on the column header.

CHAPTER 6: CONCLUSION

6.1 Project Review

To conclude, this project is aiming towards helping in reducing cost and increase efficiency by providing a system can reduce the workload of finance department staffs when managing a company's expenses. The objectives proposed for this project is specifically aimed towards achieving the results stated above. The receipt classification module helps to simplify the process of when an employee wants to submit an expense claims by automatically sorting the receipts uploaded into their respective expense type group. The visualisation module on the other hand, helps to provide a good and easy visualisation for companies to monitor their expenses efficiently.

During the FYP 1 semester period, both the main objectives proposed was able to be achieved in very small scale such as a prototype and requires a lot further development to make it a much more error prove and working system. One of the key challenges that was faced during the development was, time constraint due to a 7-week long trimester, which is a very limited amount of time for being able to achieve a higher progress completion. Besides that, another main issue face was in terms of technical skills, which is because of using new tools and software to develop the system. Learning how to use the tools, took up a great amount of time.

During the FYP 2 period, the features done in FYP 1 was further improved along with adding in several other features. Features like having 2 different types of views for the different types of user privileges such as admin and normal staff user. Besides that, a module that allows the admin to manipulate the classification model was also developed. The systems overall UI design was also updated completely to give it a much cleaner look and more user friendly. The overall system flow was also modified and fixed wherever needed. Once the overall system was developed, testing was also done to verify and validate that the system is able to function properly a normal running environment and also correctness of input and output. Unfortunately, the subobjective of being able to extract the total expense value from the receipt automatically was not able to be achieved during this project development. Throughout the entire development of the system, there were several implementation issues and challenges that were faced. The challenges are listed as below:

– **Collection of keywords data set for classification modal creation.**

  Getting a data set of key words that are related to the medical sector was somewhat possible as there were several websites that provides an open source data set bank. However, those that were free to download were always limited to a very small data set size of 100-150 rows of data. Due to the limited data size, additional keywords were manually typed and labelled in order to have an enough data size, that can help to produce a higher accuracy rate classification modal. This is also true for collecting data set for keywords related to accommodation, where all the keywords were manually done.

– **Extracting text from document uploaded using Tika library issues.**

  The Tika library's function called parser works as a document text extractor, which required an input of the file path. However, when a user uploads a file on the web application, there are security features that blocks the application from getting access to knowing the file path of the uploaded source. Hence, to fix this issue a temporary file path had to be designed whereby when the user uploads a document, the application will temporarily store that document into the self-made file path. The application will then use that file path as input for the Tika's parser function. This solution is not practical in the long run, as it creates an unnecessary additional step which takes up processing time and also memory space.

– **Extraction and identification of total expense value from documents.**

  The library used for extracting the text from a document which was used for the classification part, was not able to be reused for being able to identify the total value of expenses from a document that has been uploaded. This is because the library used functions by extracting text from the entire document and not certain parts only. This was attempted to be solved with the following solutions:

  - Filtering numerical values only, was unsuccessful as any given document may have more than one set of values, which can be mistaken for being the final total expense.
  - Filtering based on last set of numerical values only, was unsuccessful as any given document may have numerical values such as company registration number and others, which can be mistaken for being the final total expense.

  - Providing the users, a preview of the file when uploaded and requesting the user to highlight the final total expense that is on the receipt. This solution was stopped halfway through development because this solution requires the user to manually highlight the total value, where it is the same as requesting the user to manually key in the total value. This beats the purpose of trying to make the system be fully automated.

- **User Interface Design**

  The overall UI done in FYP 1 was not very pleasant and user friendly. This was due to poor design skills in general and also due to poor HTML scripting language technical skills. Manipulating certain elements in the UI to achieve a specific effect was not easy and cost a big expense in time, where there was a lot of time spent just to learn the needed technical skills. This issue was later solved by implementing Bootstrap and templating libraries that are available online. By using bootstrap, the overall design was improved significantly with least amount of issues.

– **Dashboard interactivity limitations**

  The dashboards that were developed for both the admin and staff user view were not very interactive when done in FYP 1. The library that was used for this development was a python library called “pygal”. While developing, it was noticed that the library did not provide much flexibility and interactivity to be done on the graphs generated. As to solve these issues face, the library was changed to use “Chart.js” instead, which uses “Node.js” to aid in handling all of the interactivity done on the graphs. Besides that, there were more readily available documentations that can be used when wanting to perform certain actions, as to the “Pygal” library has lesser documentations to refer. It was also much easier to develop the graphs using Chart.js in terms of its technical difficulty. There is still an issue where the interactivity of the graph are not obvious enough for first time users if they were not informed that the graphs have such interactivity.

6.2 Project Contribution and Highlight

A total of 2 features for staff users and 4 for admin users were developed. The staff user features consist of the dashboard and the manage overall expenses. The dashboard feature available for the staff helps to allow them get a better understanding and provided an overview of their expenses where they can perform analysis easily without the need of manually analysing. In the dashboard of the staff user, there are two graphs available to them. The main one is the line chart where staff users can view their total monthly expenses throughout the year. The secondary chart is the pie chart where by default it shows the total amount of expenses spent by the staff which is grouped by expense categories. When the staff interacts with the graphs by hovering over a particular month point, there will be an expense information displayed. For the line graph available the staff user can click on a specific point which will then cause the pie chart to automatically update its values to only show the expense of the selected month in the line graph. The pie chart showing the total expense value for the year will be updated to show only the total expense by category of that particular month.

Besides that, the manage overall expenses page, provide users a view all of their expenses and they can manage them easily. In the manage overall expenses page, the staff users will be able to view their expenses that have already been submitted to the system for approval. All expenses are displayed on a table which also provide sorting and filtering features that can be used by clicking on a particular column header or by typing in a query in the search box available respectively. In this page there is also a feature for users to upload a new expense by clicking on the upload feature button. The user is needed to provide the digital expense file and also the total value of the expense when uploading the new expense. The system will then perform a series of processing in the background to classify the document uploaded to identify its expense type category and label it accordingly. The system will also update and store the necessary information to the database. The newly uploaded expense is then showed in the expense table. Staff users can view their expenses status from the table itself.

On the other hand, admin users also have a dashboard feature available which has a higher amount of interactivity available for them, which allows them to be able to drill down to

specific expenses and perform a better analysis and monitor the staff's expenses. However, for the admin users they are provided with an additional chart which shows the top 3 staff's total expense of any given month. The admin can click on the month points of line chart available, which will cause the pie chart and bar chart to update according to the selected month. The admin can also click on any particular sector or bar on the pie chart or bar chart respectively, which will the display a table showing in detail of the expenses that are claimed on the particular month or expense type of the selected staff user.

Besides that, the admin also has a classification feature where in the page, shows 3 different functionalities along with a display of the confusion matrix for classification model evaluation. This feature allows the admin to manipulate the classification model by providing additional information that can help to improve the classification model's accuracy in performing the classification prediction. In this page, the 3 functions that are available is the "add new expense category", "learn new receipt" and "add new keywords". The first function is to allow the admin to add in a new expense category by providing the new category's name. The second function is to allow the classification to learn a new receipt template by providing a sample of the receipt template, which the system will first process the file and provide a list of keywords where the admin is needed to choose as part of labelling the keywords. The selected keywords are then added into the database. After performing any of the functions available in this page, the system will update the classification model to include the new changes and also update the confusion matrix evaluation diagram. The diagram below shows the confusion matrix of the default classification model created with 5 different types of expense category class and a dataset of 477 rows of keywords, which contains a prediction accuracy score of **0.65-0.70**:

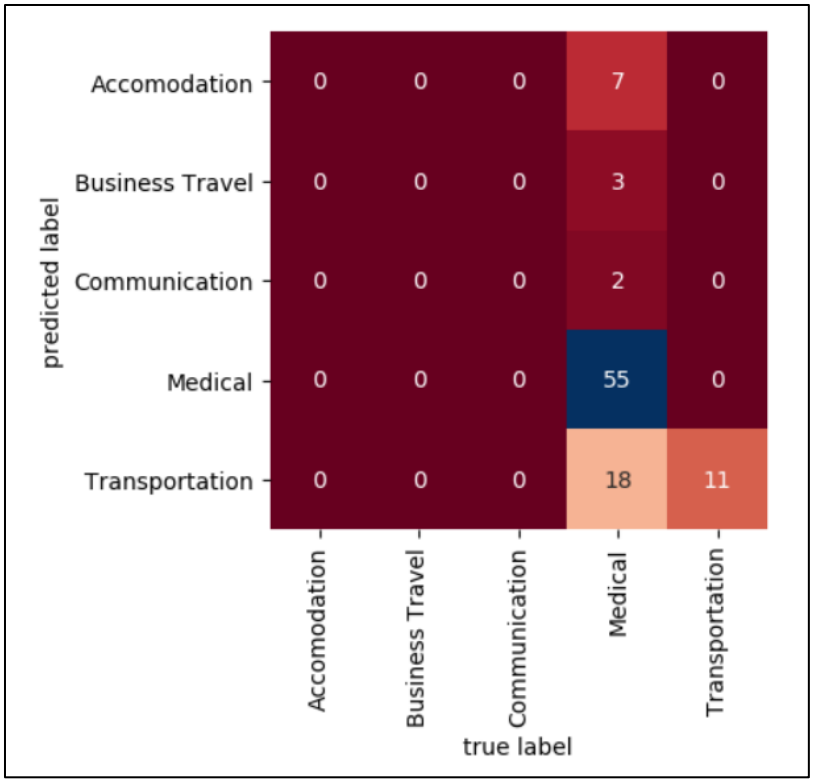


Figure 6-1 Confusion matrix evaluation Screenshot

Finally, the admin is also allowed to view all of the staff expenses, which is split as two different features namely, Pending Expenses and Expense Overview. These features provide the admin to monitor and perform actions on the expenses that have been submitted to the system by staff users in detail. This helps the admin user to also keep track of all the expenses which can be retrieved whenever needed easily. In the pending expenses feature, all of newly uploaded expenses will be shown in a table form with a status of pending. The admin can choose to either approve or reject the expenses that are uploaded. The admin can also click on the file name of any particular record to preview the file receipt file that has been submitted. In the Expense Overview feature page, there will also be a table showing all of the expenses without status of approved or rejected. The table in this page also have similar functionality as the Pending Expense page except that admin cannot select approve or reject action.

6.3 Future Work

At the end of this project all of the main features that were intended were successfully developed. However, there are still some features that can be developed to make this project better, some of which are listed below:

- **Extraction of total expense from an uploaded expense receipt**

  The current system developed is only able to perform document classification and not able to extract the total expense value from the receipt directly, which causes the user to manually key in the expense value. As a future plan to improve the system, by being able to automatically extract the final expense value from the uploaded receipt will make the system to be more efficient. This means the user will only needs to upload the expense receipt and the system does all of the processing itself automatically.

- **Improvement on Dashboard feature visibility**

  The current system developed is able to perform several interactions by clicking on certain elements available on the visuals. However, this is not clear enough to first time users if they are not guided through these features. As an improvement to this issue, a short tutorial with animated guides should be provided to first time users. Besides that, by including some animated actions to indicated that the elements on the charts are clickable can be included to make it clearer to users that they can be interacted with. Furthermore, the current system developed requires the user to click on the pie chart or bar chart elements in order to provide an expense details pop-up window. As an improvement to this, the system can include a feature where the user is only needed to hover over the elements and the details are popped up automatically without the need for the user to click on it.

BIBLIOGRAPHY

A Medium Corporation [US], n.d. *Classification Algorithms in Machine Learning.* [Online]
Available at: https://medium.com/datadriveninvestor/classification-algorithms-in-machine-learning-85c0ab65ff4

ABBYY Corporation, n.d. *What is OCR and OCR Technology - ABBYY.* [Online]
Available at: https://www.abbyy.com/en-eu/finereader/what-is-ocr/
[Accessed 2 August 2019].

Anon., n.d. *What are Agile Testing and Agile Development Activities?.* [Online]
Available at: http://tryqa.com/what-are-testing-and-agile-development-activities/
[Accessed 2 August 2019].

Author, G., 2016. *8 Major Advantages of Using MySQL.* [Online]
Available at: https://www.datamation.com/storage/8-major-advantages-of-using-mysql.html
[Accessed 3 August 2019].

Berzgal, G., 2016. *Why e-receipts are important for customers & retailers alike – Econsultancy.* [Online]
Available at: https://econsultancy.com/why-e-receipts-are-important-for-customers-retailers-alike/
[Accessed 1 August 2019].

Breathe, C., n.d. *HR Software Online | Cloud-based HR Systems for SMEs.* [Online]
Available at: https://www.breathehr.com/

Concur Technologies, Inc, 2019. *Expense Management Made Easy with Painless Expense Reports - SAP Concur Singapore.* [Online]
Available at: https://www.concur.com.sg/expense-management#/capture

Fandos, G., 2018. *7 Benefits of an Automated Expense Management Solution.* [Online]
Available at: http://blog.pixmettle.com/benefits-automated-expense-management-solution
[Accessed 1 August 2019].

freeCodeCamp.org, n.d. *Text classification and prediction using the Bag Of Words approach.* [Online]
Available at: https://www.freecodecamp.org/news/text-classification-and-prediction-using-bag-of-words-8aeb1396cded/

Gandhi, R., 2018. *Naive Bayes Classifier.* [Online]
Available at: https://towardsdatascience.com/naive-bayes-classifier-81d512f50a7c
[Accessed 3 March 2020].

Gandhi, R., 2018. *Support Vector Machine — Introduction to Machine Learning Algorithms.* [Online]
Available at: https://towardsdatascience.com/support-vector-machine-introduction-to-

machine-learning-algorithms-934a444fca47
[Accessed 3 March 2020].

Harrison, O., 2019. *Machine Learning Basics with the K-Nearest Neighbors Algorithm.* [Online]
Available at: https://towardsdatascience.com/machine-learning-basics-with-the-k-nearest-neighbors-algorithm-6a6e71d01761
[Accessed 3 March 2020].

Hillsberg, A., 2019. *Best Expenses Management Software Reviews & Comparisons | 2019 List of Expert's Choices.* [Online]
Available at: https://accounting-software.financesonline.com/c/expenses-management-software

i2tutorials.com, 2017. *Explain what Flask is and its benefits? | i2tutorials.* [Online]
Available at: https://www.i2tutorials.com/technology/explain-what-flask-is-and-its-benefits/
[Accessed 3 August 2019].

Moghe, S., 2018. *Everyone wants Digital Receipts, So Why Is the Retail Industry Not Adopting It?.* [Online]
Available at: https://hackernoon.com/digital-receipts-in-retail-b415fbdfde3f
[Accessed 1 August 2019].

Replicon , n.d. *Track Reimbursable Expenses | Simply expense tracking process.* [Online]
Available at: https://www.replicon.com/time-gross-pay-expense-capabilities/#expense-tracking

Rongala, A., 2015. *Benefits of Python over Other Programming Languages - Invensis Technologies.* [Online]
Available at: https://www.invensis.net/blog/it/benefits-of-python-over-other-programming-languages/
[Accessed 2 August 2019].

Sheela, D. L. J. & Nalini, K., 2014. Survey on Text Classification. p. 6.

Smartsheet Inc, n.d. *Understanding the Agile Software Development Lifecycle and Process Workflow.* [Online]
Available at: https://www.smartsheet.com/understanding-agile-software-development-lifecycle-and-process-workflow
[Accessed 1 August 2019].

Tan, P.-N., Steinbach, M., Karpatne, A. & Kumar, V., 2018. *Introduction to Data Mining.* 2nd Edition ed. s.l.:Pearson ©2018.

W3computing.com, n.d. *Activities, Resources, and Practices of Agile Modeling.* [Online]
Available at: https://www.w3computing.com/systemsanalysis/activities-resources-practices-agile-modeling/
[Accessed 2 August 2019].

Yegulalp, S., 2016. *Review: Six Python IDEs go to the mat.* [Online]
Available at: https://www.computerworld.com/article/3132925/review-six-python-ides-go-to-

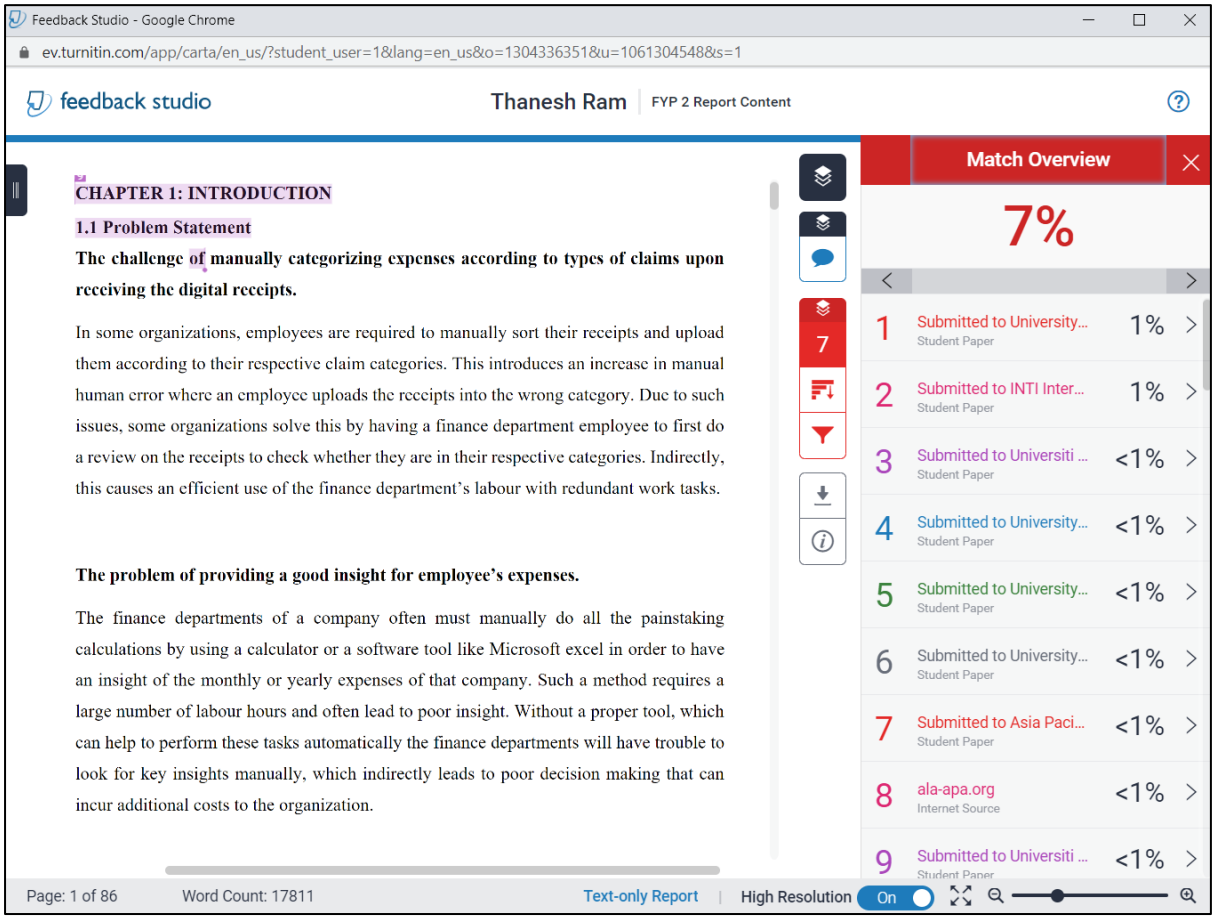
the-mat.html
[Accessed 3 August 2019].

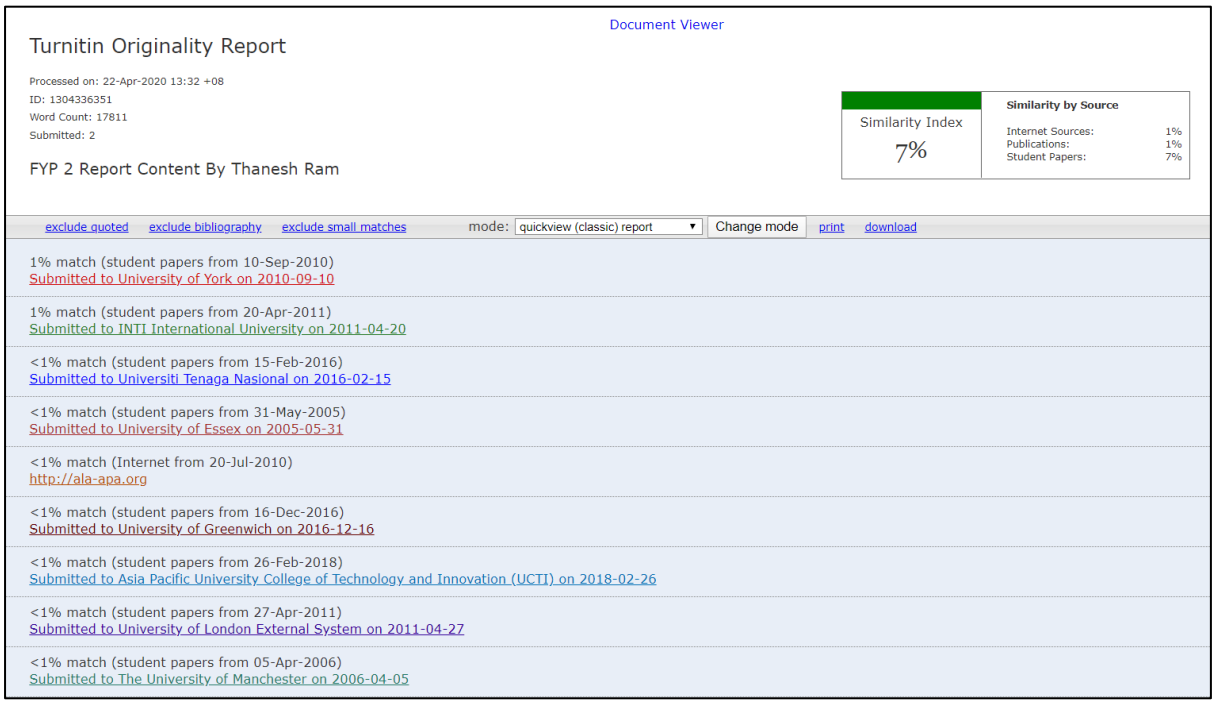
Zoho Corporation Pvt. Ltd, 2019. *Online Expense Report Software | Zoho Expense.* [Online] Available at: https://www.zoho.com/expense/?src=top-header&ireft=

Poster

Introduction:
This project is to propose an Expense Management system that focuses on helping employees to increase their efficiency and reduce the time spent when managing their expenses.
Project Scope:
* Receipt classification module to categories expense type automatically.
* Expense Visualization module to provide graphical insight for employee's expenses.
Problem Statement:
* The challenge of manually categorizing expenses type.
* The challenge of providing a good insight for employee's expenses.
A Web-Based System for Managing Employee's Expense
Student & ID: Thanesh Ram A/L Selva Sunder, 16ACB03726
Supervisor: Dr Pradeep a/l Isa@asan
Database Server
Database Storage
System
Database storage
Admin user functionalities
Staff user functionalities
View Expense Visualization
View all staff expense
View own expenses
View Expense
Upload New Expense
Reject Expense
Approve Expense
Project Objective:
• To implement a classification algorithm that will automatically sort digital receipts uploaded according to medical and accommodation categories.
• To create a functionality that provides visualization to users on expenses which can be used for analytic purposes.
Methods
‣ Naives Bayes Classification algorithm is used to perform the classification.
‣ Graphical charts are used to provide visualization for the employee's expense.
Conclusion:
This expense management system will help companies to reduce their expenditure in terms of labour cost to perform expense analysis. Besides that, this system will also help to speed up the expense uploading process.

Turnintin Report





FYP 2 Report Content

ORIGINALITY REPORT

7%	1%	1%	7%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of York Student Paper	1%
2	Submitted to INTI International University Student Paper	1%
3	Submitted to Universiti Tenaga Nasional Student Paper	<1%
4	Submitted to University of Greenwich Student Paper	<1%
5	Submitted to University of Essex Student Paper	<1%
6	Submitted to University of East London Student Paper	<1%
7	Submitted to Asia Pacific University College of Technology and Innovation (UCTI) Student Paper	<1%
8	ala-apa.org Internet Source	<1%
9	Submitted to Universiti Tunku Abdul Rahman	

Universiti Tunku Abdul Rahman			
Form Title : Supervisor's Comments on Originality Report Generated by Turnitin for Submission of Final Year Project Report (for Undergraduate Programmes)			
Form Number: FM-IAD-005	Rev No.: 0	Effective Date: 01/10/2013	Page No.: 1of 1

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of Candidate(s)	Thanesh Ram A/L Selva Sunder
ID Number(s)	16ACB03726
Programme / Course	Computer Science
Title of Final Year Project	A Web Base System for Managing Employee's Expenses

Similarity	**Supervisor's Comments (Compulsory if parameters of originality exceeds the limits approved by UTAR)**
Overall similarity index: 7 % **Similarity by source** Internet Sources: 1 % Publications: 1 % Student Papers: 7 %	
Number of individual sources listed of more than 3% similarity: 0	

Parameters of originality required and limits approved by UTAR are as Follows:
(i) Overall similarity index is 20% and below, and
(ii) Matching of individual sources listed must be less than 3% each, and
(iii) Matching texts in continuous block must not exceed 8 words
Note: Parameters (i) – (ii) shall exclude quotes, bibliography and text matches which are less than 8 words.

Note Supervisor/Candidate(s) is/are required to provide softcopy of full set of the originality report to Faculty/Institute

Based on the above results, I hereby declare that I am satisfied with the originality of the Final Year Project Report submitted by my student(s) as named above.

Signature of Supervisor

Name: PRADEEP ISAWASAN

Date: 23/04/2020

Signature of Co-Supervisor

Name: _____

Date: _____

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF INFORMATION & COMMUNICATION TECHNOLOGY (KAMPAR CAMPUS)

CHECKLIST FOR FYP2 THESIS SUBMISSION

Student Id	16ACB03726
Student Name	Thanesh Ram A/L Selva Sunder
Supervisor Name	Dr Pradeep A/L Isawasan

TICK (√)	DOCUMENT ITEMS Your report must include all the items below. Put a tick on the left column after you have checked your report with respect to the corresponding item.
√	Front Cover
√	Signed Report Status Declaration Form
√	Title Page
√	Signed form of the Declaration of Originality
√	Acknowledgement
√	Abstract
√	Table of Contents
√	List of Figures (if applicable)
√	List of Tables (if applicable)
	List of Symbols (if applicable)
	List of Abbreviations (if applicable)
√	Chapters / Content
√	Bibliography (or References)
√	All references in bibliography are cited in the thesis, especially in the chapter of literature review
√	Appendices (if applicable)
√	Poster
√	Signed Turnitin Report (Plagiarism Check Result - Form Number: FM-IAD-005)

*Include this form (checklist) in the thesis (Bind together as the last page)

I, the author, have checked and confirmed all the items listed in the table are included in my report. (Signature of Student) Date: 23/04/2020	Supervisor verification. Report with incorrect format can get 5 mark (1 grade) reduction. (Signature of Supervisor) Date: 23/04/2020

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: 3, 3	**Study week no.: 1 and 2**
Student Name & ID: Thanesh Ram A/L Selva Sunder 1603726	
Supervisor: Dr Pradeep a/l Isawasan	
Project Title: A Web-Based System for Managing Employee's Expenses	

1. WORK DONE

In the first week of the semester, most of the time was spent into fixing the classification model and migrating it into a database instead of local file based. The final expense value extraction was also researched during the first 2 weeks.

2. WORK TO BE DONE

- Improve GUI
- Improve Dashboard
- Improve Classification prediction accuracy

3. PROBLEMS ENCOUNTERED

- Fail to perform final expense value extraction
- GUI html manipulation was troublesome.

4. SELF EVALUATION OF THE PROGRESS

- OK

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: 3, 3	**Study week no.: 3 and 4**
Student Name & ID: Thanesh Ram A/L Selva Sunder 1603726	
Supervisor: Dr Pradeep a/l Isawasan	
Project Title: A Web-Based System for Managing Employee's Expenses	

1. WORK DONE

In the third and fourth week, improvement on the GUI was done. To make the GUI look nicer, Bootstrap and templating for certain elements was implemented. The dashboard was also updated to have certain interactivity available. The library used to perform the dashboard was changed due to some restrictions.

2. WORK TO BE DONE

- Improve Dashboard functionality and interactivity.
- Improve Classification module page.

3. PROBLEMS ENCOUNTERED

- Dashboard library used was not easy to use and had difficulty in implementing certain interactivity.

4. SELF EVALUATION OF THE PROGRESS

- OK

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: 3, 3	**Study week no.: 5 and 6**
Student Name & ID: Thanesh Ram A/L Selva Sunder 1603726	
Supervisor: Dr Pradeep a/l Isawasan	
Project Title: A Web-Based System for Managing Employee's Expenses	

1. WORK DONE

In week 5 and 6, most of the time was spent into improving the dashboard functionality. The dashboard was added with several new functions and interactions that can be done on the dashboard for both admin and normal staff users.

2. WORK TO BE DONE

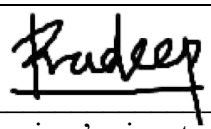
- Improvement on classification module.
- Improvement on staff expenses overview and interactivity.

3. PROBLEMS ENCOUNTERED

- Online documentations available on certain functions for the charts were limited.

4. SELF EVALUATION OF THE PROGRESS

- Decent progress rate but can be better.



Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: 3, 3	**Study week no.: 7 and 8**
Student Name & ID: Thanesh Ram A/L Selva Sunder 1603726	
Supervisor: Dr Pradeep a/l Isawasan	
Project Title: A Web-Based System for Managing Employee's Expenses	

1. WORK DONE

In week 7 and 8, most of the time was spent into developing and improving further on the GUI and classification model was done. The classification module was added with new functions to allow the admin to make changes and improve on the classification model with more flexibility directly from the system itself.

2. WORK TO BE DONE

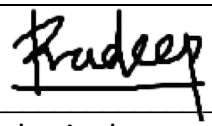
- Perform testing onto the testing with most of it's completed modules.

3. PROBLEMS ENCOUNTERED

- Document text extraction and text cleanup process had issues in displaying the output to html.
- Javascript to Flask variable passing issues for certain data type variables.

4. SELF EVALUATION OF THE PROGRESS

- Slow progress rate, needs improvement.



Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: 3, 3	**Study week no.: 9 and 10**
Student Name & ID: Thanesh Ram A/L Selva Sunder 1603726	
Supervisor: Dr Pradeep a/l Isawasan	
Project Title: A Web-Based System for Managing Employee's Expenses	

1. WORK DONE

In week 9 and 10, testing of the system was done along with minor updates to some of the modules to fix bugs and overall functionality process flow. The changes were made according to consultation to the supervisor.

2. WORK TO BE DONE

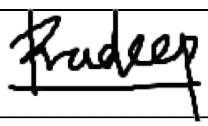
- Code clean and report writing.

3. PROBLEMS ENCOUNTERED

- Certain bugs detected did not have a clear solution.

4. SELF EVALUATION OF THE PROGRESS

- OK



Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: 3, 3	**Study week no.: 11 and 12**
Student Name & ID: Thanesh Ram A/L Selva Sunder 1603726	
Supervisor: Dr Pradeep a/l Isawasan	
Project Title: A Web-Based System for Managing Employee's Expenses	

1. WORK DONE

In week 11 and 12, due to Movement Control Orders (MCO) disruptions made by the government progress was slowed down. Report writing was started during this period.

2. WORK TO BE DONE

- Presentation slides of FYP 2 project

3. PROBLEMS ENCOUNTERED

- Communications through online medium with supervisor needed time to get used too, due to the MCO.

4. SELF EVALUATION OF THE PROGRESS

- OK

Supervisor's signature

Student's signature